

Jacob K. Javits Convention Center
Expansion Project - TRANSFORMER BUILDING

SPECIFICATIONS

ISSUE FOR BID - REVISED, 12 August 2016
VOL III

Following listed documents and sections comprise the Project Manual for the Work. Where numerical sequence of documents and sections is interrupted, such interruptions are intentional.

Project Manual for the Work consists of three complete volumes, which shall not be separated for any reason. Owner and Architect disclaim responsibility for any interpretation, assumption or action made because of not receiving a complete Project Manual.

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	Not Used																		

END OF DOCUMENT 000110

SECTION 210001
DESIGN DOCUMENTS
SEPARATION OF WORK BETWEEN THE TRADES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The specifications delineate various items of related work under separate trade headings in accordance with the Design Documents as listed below.
- B. Indications that the electrical and mechanical trades are to perform an item of work means that they are to perform the work for their own accommodation only, except as specifically noted otherwise.
- C. Key to Abbreviations:
- | | | |
|---------|---|--|
| "OTHER" | = | Provided for Owner by Construction Manager or General Contractor |
| "PLBG" | = | Plumbing |
| "FP" | = | Fire Protection |
| "HVAC" | = | Heating, Ventilating and Air Conditioning |
| "ELECT" | = | Electrical |
| "F" | = | Furnished |
| "I" | = | Installed |
| "P" | = | Provided (Furnished and Installed) |
| "C" | = | Final Connection |
- D. The following is a list of work and the trade or trades that perform the work:

	Other	Plbg	FP	HVAC	Elect	Notes
Temporary Heat	P					
Temporary Water	P					
Temporary Light & Power	P					
Temporary Fire Standpipe	P					
Temporary Toilets	P					
Excavation & Backfill for M&E Inside Bldg for M&E Outside Bldg	P	P	P	P	P	
Dewatering Site & Excavation	P					
Subsoil Drainage Inside Building Outside Building	P P	C C				
Footing Drains	P	C				
Drywells		P				
Manhole & Covers		P	P	P	P	
Concrete Equipment Bases and Pads: Inside Building Outside Building	P	P				
Masonry Pits	P					
Pit Frames & Covers	I	F				
Fuel Oil Tank Cradle	P					
Trenches in Floor Slabs	P					
Anchors and Vibration Mounts in Inertia Blocks	I	F	F	F	F	
Concrete Encasement of Underground Runs		P	P	P	P	
Fastening and Supports		P	P	P	P	
Cutting, Chasing and Patching		P	P	P	P	
Framed Slots and Openings	I	F	F	F	F	
Sleeves through Slabs, Decks and Walls		P	P	P	P	
Waterproof Sealing of Openings		P	P	P	P	
Fireproof Sealing of Excess Openings		P	P	P	P	
Drilling & Cutting of all Holes		P	P	P	P	
Hoisting and Rigging		P	P	P	P	
Floor Drain Flashing		P				

	Other	Plbg	FP	HVAC	Elect	Notes
Base Flashing for all Roof Penetrations	P					
Cap Flashing for all Roof Piping Penetrations		P	P	P	P	
Roof Curb Base Flashing	P					
Roof Curb Cap Flashing				P		
Prime Painting M&E Work		P	P	P	P	
Field Touch-Up Painting		P	P	P	P	
Rustproofing Field Cut Iron Work		P	P	P	P	
Color Coding M&E Work		P	P	P	P	
Precast Receptors		P				
Shower Stall Pan Flashing		P				
Toilet Room Accessories	P					
Soap Dispensers	P					
Domestic Water Make-Up		P				
Fire Hose & Cabinets			P			
Fire Extinguishers	P					
Fire Extinguisher Cabinets	P					
Finished Access Doors & Frames	I	F	F	F	F	
Ladders & Catwalks	P					
Motors for Mechanical Equipment		P	P	P		
Loose Motor Controls for Mechanical Equipment		F	F	F	I	
Motor Control Centers					P	
Disconnect Switches					P	
Wiring for Equipment Motors and Starters					P	
Premounted & Prewired Starters and Disconnects		P	P	P	C	
Electric Radiators and Convectors					P	
Electric Duct Heaters				P	C	
Heat Tracing Cable		F	F	F	I	
Electric Water Heater		P			C	
Plaster Frames for Ceiling Mounted Fixtures, Ceiling Diffusers, etc.	I			F	F	

	Other	Plbg	FP	HVAC	Elect	Notes
Cellular Decking	P					
Trench Headers					P	
Preset Activation Kits					P	
Power Circuit to Starter Disconnect Switch and Motor					P	
Line Voltage Control Device (Aquastat) etc.		P		P	C	
Control Device Not in Power Circuit to Motor		P		P		
Temperature Control Device & Electric Actuator		P		P		
Sprinkler & Standpipe Alarm System: Devices Panels			P		C P	
Halon, Deluge and Pre-Action Sprinkler, Smoke and Thermal Detection			P			
Space Smoke Detector					P	
Duct Smoke Detector				I	F&C	
Smoke Control/Fire Alarm Panel					P	
Boiler and Refrigeration Room Shut-off & Break Glass				P	C	
Kitchen Hood Fire Suppression System	P				C	
Lighting Fixtures					P	
Exterior Wall Louvers	P					
Radiator Enclosures				P		
Ornamental Grilles	P					
Air Boots for Air/Light Fixtures and Perimeter Slots					P	
Raised Floor	P					
Air Outlets in Raised Floor	I			F		
Masonry Chimney Breeching Frame	P					
Masonry Chimney Cleanout Door	P					
Prefabricated Chimney				P		
Kitchen Range Hood	P					
Dishwashing Hoods	P					
Food Service Equipment	P	C		C	C	

	Other	Plbg	FP	HVAC	Elect	Notes
Refrigerators	P				C	
Refrigerator Condensing Units, Air Cooled	P				C	
Refrigerator Condensing Units, Water Cooled	P			C	C	
Lightning Protection					P	
Surgical Lights	P				C	
Pneumatic Tube System	P				C	
Exterior Transformer Vault	P					
Incinerator	P	C		C	C	
Elevator	P				C	
Escalator	P				C	
Lifts	P				C	
Laboratory Equipment	P	C		C	C	
Hospital Equipment	P	C		C	C	
Laundry Equipment	P	C		C	C	
Window Washing Machines	P	C			C	
Linen/Garbage Chutes	P		C			
Vermiculite Fireproofing	P					
Rubbish Removal		P	P	P	P	
Maintenance Tools		F	F	F	F	

A. SPECIFIC NOTES:

1. Plumbing Trade to provide sizes and locations.
2. Covers and Frames for sewage ejectors, sump pump and silt pits furnished by Plumbing Trade.
3. Details furnished by individual Trades.
4. Final connections included in HVAC work.
5. When not part of premounted starter.
6. Insulation covering by each Trade after heating cable is connected and tested.
7. Preparation of cells for electricification is in Electrical work.

8. Purchased by Electrical Trade.
9. Power to Halon Control Panel by Electrical Trade; tie into fire alarm system by Electrical Trade; all other by Fire Protection Trade.
10. Power to Kitchen Hood Fire Protection System and gas pipe solenoid valve by Electrical Trade; tie into fire alarm system by Electrical Trade.
11. Duct connections and safing of unused portions of louvers by HVAC Trade.
12. Except where custom enclosures are provided by others.
13. Where one Trade furnishes and another installs, the installing Trade removes the shipping and packing materials where accumulated.

PART 2 - PRODUCTS

2.1 NOT USED.

PART 3 - EXECUTION

3.1 NOT USED.

END OF SECTION

SECTION 210003

FIRE PROTECTION SCOPE OF WORK

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide fire protection systems in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. This specification is not intended to be a complete itemization of fire protection required, but is for guidance of this contractor in estimating his work. This contractor shall examine the architectural, mechanical, electrical, plumbing and fire protection plans for all fire protection work required and shall provide same.
- B. It is intended that all items of material and equipment mentioned in this specification and shown on the plans shall be read as if the work "Provide" were prefixed thereto.
- C. Description of work included:
1. Provide a complete fire standpipe system consisting of risers and riser control valves, distribution and branch piping, hose valves, hose racks and cabinets, roof manifolds, siamese, pumps and pump controllers, and all associated appurtenances and alarm devices.
 2. Provide a complete sprinkler system consisting of risers and riser control valves, sprinkler heads, siamese, pumps and pump controllers, and all associated appurtenances and alarm devices.
 3. Provide a complete combined fire protection system consisting of:
 - a. Standpipe:
 - 1) Risers and riser control valves, distribution and branch piping, hose valves, hose racks and cabinets, roof manifolds, siamese, pumps and pump controllers, and all associated appurtenances and alarm devices.
 - b. Sprinkler:
 - 1) Connection to standpipe system, sprinkler floor control valve assembly, distribution and branch piping, sprinkler heads, all associated appurtenances and alarm devices.
 4. Provide a complete Halon system consisting of Halon agent, control panel, piping and nozzles, and all alarm and actuating devices.
 5. Operating manuals and instructions.
 6. System cleaning, balancing, testing, adjusting and inspection.
 7. Sound and vibration isolation.
 8. Painting.
 9. Supports, anchors, hangers and auxiliary structural members required for support of mechanical work. Drawings, templates, structural steel, anchor bolts, isolation materials, formwork for concrete and other equipment supports.
 10. Electric motors.
 11. Internal wiring of factory-assembled prewired equipment.
 12. Counter flashing of pipe at roof penetrations (manifolds).
 13. Firestopping of pipe penetrations through rated walls, floors, etc.

1.3 WORK NOT INCLUDED

A. The items listed below are related to this work but specified under other sections of the contract:

1. Motor control centers.
2. Finish painting, except as penetrating wall or roof.
3. Base flashing for materials penetrating walls or roof.
4. Power wiring for motors and motor controllers.
5. Concrete for equipment, support pads and pipe in casement.
6. Fire command station.
7. Wire tracing and associated insulation.
8. Alarm wiring from fire protection alarm devices to fire command station.
9. Incoming City water services including meters, backflow preventors, etc.
10. Connection to supervisory central station.
11. Floor drains and/or drain receptacles for test or drain purposes.

PART 2 - PRODUCTS

2.1 NOT USED.

PART 3 - EXECUTION

3.1 OPERATING INSTRUCTION PERIOD

A. Provide one day of instructions for standpipe and sprinkler systems.

END OF SECTION

SECTION 210004

FIRE PROTECTION UNIT PRICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide unit prices for possible revisions and alternates in the work.
- B. State and hold firm for the duration of the project all unit prices as described herein.

1.2 DEFINITIONS

- A. Unit prices, unless otherwise noted, are to include incidental work normally included in connection with the particular type of work involved and are to include, but not necessarily be limited to, the following:
 - 1. Engineering, including calculations, detailing, coordination, and shop drawings.
 - 2. Material costs, including an allowance for pipe, connections, etc.
 - 3. Necessary accessories, e.g., hangers, inserts, clips, bolts, painting, labeling, testing, etc.
 - 4. Fabrication and shop costs.
 - 5. Shop and field labor, including supervision and engineering layout costs.
 - 6. Temporary utilities required, including safety precautions.
 - 7. Costs of standby trades during or beyond normal working hours.
 - 8. Transportation, hoisting, rigging, freight, taxes of any kind, fringe benefits, overhead and profit (excluding Insurance Cost).
 - 9. Tools and equipment.
 - 10. Testing, cleaning, balancing and controlled inspection.
- B. Architect/Engineer documents will be used as the basis for calculating changes to contract work.
- C. Submit unit prices based upon the specification standards and as noted herein. Unit prices shall apply equally to work when added and also to work when deleted, except where specifically modified below.
- D. In addition to your contract proposal, quote prices for the work described below.

PART 2 - PRODUCTS

2.1 PIPING

- A. Provide Schedule 40 threaded black steel pipe and hangers.
 - 1. 1" I.D. \$____/LF
 - 2. 1¼" I.D. \$____/LF
 - 3. 1½" I.D. \$____/LF
 - 4. 2" I.D. \$____/LF
 - 5. 2½" I.D. \$____/LF
 - 6. 3" I.D. \$____/LF

B. Provide Schedule 40 welded black steel pipe and hangers.

- | | | |
|----|----------|------------|
| 1. | 2½" I.D. | \$_____/LF |
| 2. | 3" I.D. | \$_____/LF |
| 3. | 4" I.D. | \$_____/LF |
| 4. | 5" I.D. | \$_____/LF |
| 5. | 6" I.D. | \$_____/LF |

C. Provide Schedule 10 black steel pipe and hangers.

- | | | |
|----|----------|------------|
| 1. | 2½" I.D. | \$_____/LF |
| 2. | 3" I.D. | \$_____/LF |
| 3. | 4" I.D. | \$_____/LF |
| 4. | 5" I.D. | \$_____/LF |
| 5. | 6" I.D. | \$_____/LF |
| 6. | 8" I.D. | \$_____/LF |
| 7. | 10" I.D. | \$_____/LF |

2.2 VALVES

A. Gate Valves (U.L. and F.M. Listed)

- | | | |
|-----|-----|---------|
| 1. | 1" | \$_____ |
| 2. | 1¼" | \$_____ |
| 3. | 1½" | \$_____ |
| 4. | 2" | \$_____ |
| 5. | 2½" | \$_____ |
| 6. | 3" | \$_____ |
| 7. | 4" | \$_____ |
| 8. | 5" | \$_____ |
| 9. | 6" | \$_____ |
| 10. | 8" | \$_____ |
| 11. | 10" | \$_____ |
| 12. | 12" | \$_____ |

B. Pressure Reducing Valves (PRV)

- | | | |
|----|----------|---------|
| 1. | 1" I.D. | \$_____ |
| 2. | 1¼" I.D. | \$_____ |
| 3. | 1½" I.D. | \$_____ |

- | | | |
|----|----------|---------|
| 4. | 2" I.D. | \$_____ |
| 5. | 2½" I.D. | \$_____ |
| 6. | 3" I.D. | \$_____ |
| 7. | 4" I.D. | \$_____ |
- C. Check Valves (U.L. and F.M. Listed)
- | | | |
|-----|-----|---------|
| 1. | 1" | \$_____ |
| 2. | 1¼" | \$_____ |
| 3. | 1½" | \$_____ |
| 4. | 2" | \$_____ |
| 5. | 2½" | \$_____ |
| 6. | 3" | \$_____ |
| 7. | 4" | \$_____ |
| 8. | 5" | \$_____ |
| 9. | 6" | \$_____ |
| 10. | 8" | \$_____ |
- D. Butterfly Valves (U.L. and F.M. Listed) With Tamper Switch
- | | | |
|----|-----|---------|
| 1. | 1" | \$_____ |
| 2. | 1¼" | \$_____ |
| 3. | 1½" | \$_____ |
| 4. | 2" | \$_____ |
| 5. | 2½" | \$_____ |
| 6. | 3" | \$_____ |
| 7. | 4" | \$_____ |
- E. Waterflow Detectors
- | | | |
|----|-----|---------|
| 1. | 1" | \$_____ |
| 2. | 1¼" | \$_____ |
| 3. | 1½" | \$_____ |
| 4. | 2" | \$_____ |
| 5. | 2½" | \$_____ |
| 6. | 3" | \$_____ |
| 7. | 4" | \$_____ |
- F. Sprinkler Heads: Install with 10 feet of pipe and necessary elbows and hangers.
- | | | |
|----|-------------------|---------|
| 1. | Flush plate type. | \$_____ |
|----|-------------------|---------|

- | | | |
|-----|--|----------|
| 2. | Recessed type. | \$ _____ |
| 3. | Flush pendent type. | \$ _____ |
| 4. | Exposed upright or pendent type. | \$ _____ |
| 5. | Sidewall | \$ _____ |
| 6. | Sidewall extended coverage exposed type. | \$ _____ |
| 7. | Dry flush plate type. | \$ _____ |
| 8. | Dry pendent type. | \$ _____ |
| 9. | Dry horizontal type. | \$ _____ |
| 10. | Flush plate, quick response type. | \$ _____ |
- G. Sprinkler Rig: Consisting of valve and tamper switch, waterflow detector, pressure gauge, inspector test assembly.
1. Assembly Size:
- | | | |
|----|-----|----------|
| a. | 2" | \$ _____ |
| b. | 2½" | \$ _____ |
| c. | 3" | \$ _____ |
| d. | 4" | \$ _____ |

2.3 MISCELLANEOUS

A. Pre-Action Valves

- | | | |
|----|-----|----------|
| 1. | 2" | \$ _____ |
| 2. | 2½" | \$ _____ |
| 3. | 3" | \$ _____ |
| 4. | 4" | \$ _____ |
| 5. | 6" | \$ _____ |

B. Dry Valves

- | | | |
|----|-----|----------|
| 1. | 2" | \$ _____ |
| 2. | 2½" | \$ _____ |
| 3. | 3" | \$ _____ |
| 4. | 4" | \$ _____ |
| 5. | 6" | \$ _____ |

2.4 WORK REQUIRED FOR EXISTING CONDITIONS

- A. Core Drill: Core drill holes in slab. Cost includes layout and equipment costs as well as all required labor. Cost includes firestopping and plugging as required.

- | | | |
|-----------------------------|---------------------|---------|
| 1. | Holes through 1½" | \$_____ |
| 2. | Holes 2" through 3" | \$_____ |
| 3. | Holes 4" through 5" | \$_____ |
| 4. | Holes 6" and 8" | \$_____ |
| B. Tie-in to existing pipe. | | |
| 1. | 1" I.D. | \$_____ |
| 2. | 1¼" I.D. | \$_____ |
| 3. | 1½" I.D. | \$_____ |
| 4. | 2" I.D. | \$_____ |
| 5. | 2½" I.D. | \$_____ |
| 6. | 3" I.D. | \$_____ |
| 7. | 4" I.D. | \$_____ |
| 8. | 6" I.D. | \$_____ |
| 9. | 10" I.D. | \$_____ |

2.5 WAGE RATES

- A. Provide hourly wage rates excluding mark-up, overhead, profit and insurance.

		Regular Time	Overtime	Sat. P.M. Sun. & Hol.
1.	Steamfitters:			
	a. Foreman	_____	_____	_____
	b. Steamfitter	_____	_____	_____
	c. Apprentice	_____	_____	_____
2.	Other:	_____	_____	_____

PART 3 - EXECUTION

3.1 NOT USED.

END OF SECTION

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SECTION 210517

SLEEVES AND SEALS FOR FIRE SUPPRESSION PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide a U.L. approved firestopping system in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Firestop Compounds.
- B. Damming Material.
- C. Sleeves

1.3 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.4 SUMMARY

- A. Provide firestop systems consisting of a material, or combination of materials installed to retain the integrity of fire resistance rated construction by maintaining an effective barrier against the spread of flame, smoke and/or hot gases through penetrations, fire resistive joints, and perimeter openings in accordance with the requirements of the Buildings Code for this project.
- B. Firestop systems shall be used in locations including, but not limited to, the following:
 - 1. Penetrations through fire resistance rated floor and roof assemblies including both empty openings and openings containing penetrants.
 - 2. Penetrations through fire resistance rated wall assemblies including both empty openings and openings containing penetrants
 - 3. Membrane penetrations in fire resistance rated wall assemblies where items penetrate one side of the barrier.
 - 4. Joints between fire resistance rated assemblies.
 - 5. Perimeter gaps between rated floors/roofs and an exterior wall assembly.

1.5 DEFINITIONS

- A. Firestopping: The use of material or combination of materials in a fire-rated structure (wall or floor) where it has been breached, so as to restore the integrity of the fire rating on that wall or floor.
- B. System: The use of a specific firestop material or combination of materials in conjunction with a specific wall or floor construction type and a specific penetrant(s).
- C. Barrier: Any bearing or non-bearing wall or floor that has an hourly fire and smoke rating.
- D. Through-penetration: Any penetration of a fire-rated wall or floor that completely breaches the barrier.

- E. Membrane-penetration: Any penetration in a fire-rated wall or floor/roof-ceiling assembly that breaches only one side of the barrier.
- F. Fire Resistive/Construction Joint: Any gap, joint, or opening, whether static or dynamic, between two fire rated barriers including where the top of a wall meets a floor; wall edge to wall edge applications; floor edge to floor edge configurations; floor edge to wall.
- G. Perimeter Barrier: Any gap, joint, or opening, whether static or dynamic, between a fire rated floor assembly and an exterior wall assembly.
- H. Approved Testing Agencies: Not limited to: Underwriters Laboratory (UL), Factory Mutual (FM), Warnock Hersey, and Omega Point Laboratory (OPL).

1.6 SUBMITTALS

- A. Submit shop drawings, product data, and manufacturer's installation instructions for all materials and prefabricated devices, providing descriptions sufficient for identification at the job site. Literature shall indicate product characteristics; typical use, performance and limitation criteria and test data.
- B. Submit shop drawings showing proposed material, reinforcement, anchorage, fastenings, and method of installation. Construction details shall accurately reflect actual job conditions.
- C. Submit Material Safety Data Sheets with product delivered to job site.
- D. U.L. Tested Systems: Submit drawings showing typical installation details for the methods of installation. Indicate which firestop materials will be used and thickness for different hourly ratings, and approved UL system number.
- E. Engineering Judgements: Submit manufacturer's drawings for all non-standard applications where no U.L. tested system exists. All drawings must indicate the "Tested" U.L. system upon which the judgement is based so as to assess the relevance of the judgement to some known performance.
- F. Submit manufacturer's installation procedures for each type of product.
- G. Approved Applicator: Submit document from manufacturer wherein manufacturer recognizes the installer as qualified or submit a list of past projects to demonstrate capability to perform intended work.
- H. Upon completion, installer shall provide written certification that materials were installed in accordance with the manufacturer's installation instruction and details.
- I. Product Data: For each type of firestopping product selected. Manufacturers certification must verify that firestopping materials are free of asbestos, lead and contain volatile organic compounds (VOCs) within limits of the local jurisdiction.
- J. Design Listings: Submit system design listings, including illustrations, from qualified testing and inspecting agency that is applicable to each firestop configuration.
- K. Installation Instructions: Submit the manufacturer's installation instruction for each firestop assembly.
- L. Where there is no specific third party tested and classified firestop system available for a particular configuration, the Contractor shall obtain from the firestopping material manufacturer and Engineering Judgement (EJ) for submittal.

- M. Material Safety Data Sheet (MSDS): Submit for each type of firestopping product selected.
- N. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Submit documents per 1.7.
- O. A quality control manual approved by FM or UL (if applicable).
- P. Firestop Schedule: Submit schedule itemize the following:
 - 1. Manufacturer's product reference numbers and/or drawing numbers.
 - 2. Listing agency's design number
 - 3. Penetrating Item Description/Limits: Material, size, insulated or uninsulated, and combustibility.
 - 4. Maximum allowable annular space or maximum size opening.
 - 5. Wall type construction.
 - 6. Floor type construction.
 - 7. Hourly Fire resistance rating of wall or floor.
 - 8. F rating.
 - 9. T, L, and W rating, if applicable.
- Q. Firestop Application Log: A separate binder shall be prepared and kept on site for use by the Inspection Agency and the Authority Having Jurisdiction. The binder shall contain the following:
 - 1. The binder shall be a three (3) ring binder.
 - 2. Firestop Schedule.
 - 3. All approved firestopping assemblies including engineering judgements shall be provided and organized by trade.
 - 4. Copy of manufacturer's installation instruction for each firestop assembly.
 - 5. A matrix or table of contents listing each assembly shall be provided.
 - 6. The binder shall be updated as new firestop assemblies and EJ's are added.
 - 7. The binder shall be kept on-site at a location approved by the Owner.
 - 8. Qualifications or Certification of Installer.

1.7 QUALITY ASSURANCE

- A. Firestop system installation shall conform to requirements of qualified designs or manufacturer approved modifications, as supported by engineering reports. Field inspections shall be carried out by the firestop manufacturer to verify that the installation is in accordance with the manufacturer requirements.
- B. Install firestop materials and systems as required by these Contract Documents and meet and be accepted for use by applicable design building and construction codes.
- C. Submit manufacturer's product data, letter of certification, or certified laboratory test report that the material or combination of materials (firestop system) meets the requirements specified in accordance with the applicable referenced standards.
- D. The firestop compound shall not contain any solvents or inorganic fibers. The penetration seal material must be unaffected by moisture and must maintain the integrity of the floor or wall assembly for its rated time period when tested in accordance with ASTM E814 (UL1479). The system shall be U.L. Classified for up to and including 3 hours.
- E. Firestopping materials shall be asbestos and lead free and shall not incorporate or not require the use of hazardous solvents.
- F. Firestopping sealants must be flexible, allowing for normal pipe movement.

- G. All fire stopping materials shall be manufactured by one manufacturer.
- H. Installation of firestopping systems shall be performed by a Contractor (or Contractors) trained or approved by the firestop manufacturer.
- I. Material used shall be in accordance with the manufacturer's written installation instructions.
- J. Submit a line-by-line statement of compliance or non-compliance with this specification section.

1.8 PERFORMANCE REQUIREMENTS

- A. Penetrations: Provide through-penetration and membrane-membrane penetration firestop systems that are produced and installed to resist the spread of fire, passage of smoke and other hot gases according to requirements indicated, to restore the original fire-resistance rating of assembly penetrated.
 - 1. Provide and install complete penetration firestopping systems that have been tested and approved by nationally accepted testing agencies per ASTM E814 or UL 1479 fire tests in a configuration that is representative of field conditions.
 - 2. F-Rated Systems: Provide firestop systems with F-ratings indicated, as determined by ASTM E814 or UL 1479, but not less than one (1) hour of the fire resistance rating of the assembly being penetrated.
 - 3. T-Rated Systems: Provide firestop systems with T-ratings, as well as F-ratings, as per ASTM E814 or UL 1479, where required by the Building Code.
 - 4. L-Rated Systems: Provide firestop systems with L-ratings less than 5cfm/sf.
 - 5. W-Rated Systems: Provide firestop systems that are resistant to water. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
 - 6. For penetrations involving non-metallic, CPVC, PVC, or plastic piping, tubing or conduit, provide firestop systems that are chemically compatible in accordance with Manufacturer requirements.
 - 7. For penetrations involving insulated piping, provide firestop systems not requiring removal of insulation.
 - 8. For penetrations involving fire or fire/smoke dampers, only firestop products approved by the damper manufacturer shall be installed in accordance with the damper installation instructions.
- B. Fire Resistive Joints: Provide joint systems with fire resistance assembly rating indicated, as determined by UL 2079 (ASTM E1399 and E1966), but not less than the fire resistance assembly rating of the construction in which the joint occurs. Firestopping assemblies must be capable of withstanding anticipated movements for the installed field conditions.
 - 1. For firestopping assemblies exposed to view, traffic, moisture, and physical damage, provide products that after curing do not deteriorate when exposed to these conditions both during and after construction.
 - 2. For floor penetrations exposed to possible loading and traffic, provided firestop systems capable of supporting floor loads involved either by installing floor plates or by other means, as specified by the Architect.
 - 3. L-Rated Systems: Provide firestop systems with L-ratings less than 5cfm/sf
- C. Firestopping products shall have flame spread ratings less than 25 and smoke-developed ratings less than 450, as determined per ASTM E 84. Note: Firestop products installed in plenum spaces shall have smoke developed rating of less than 50.
- D. Engineering Judgement (EJ): Where there is no specific third party tested and classified firestop system available for an installed condition, the Contractor shall obtain from the firestopping material manufacturer and Engineering Judgement (EJ) to be submitted to the

Approving Authority, Design Professional and Authority Having Jurisdiction for approval prior to installation. The EJ shall follow International Firestop Council (IFC) guidelines.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver firestopping products to Project site in original, unopened containers or packages with intact and legible manufacturer's labels identifying product and manufacturer, date of manufacture/expiration, lot number, listing agency's classification marking, and mixing instructions for multi-component materials.
- B. Store and handle materials per manufacturer's instructions to prevent deterioration or damage due to moisture, temperature changes, contaminants, or other causes.
- C. All firestop materials shall be installed prior to expiration date.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Install firestopping when ambient or substrate temperatures are within limits permitted by the manufacturer's written instructions. Do not install firestopping when substrates are wet due to rain, frost, condensation, or other causes.
- B. Ventilate per the manufacturer's written instructions on the product's Material Safety Data Sheet.
- C. Verify the condition of the substrates before starting work.
- D. Care should be taken to ensure that firestopping materials are installed so as not to contaminate adjacent surfaces.

1.11 COORDINATION

- A. Coordinate areas prior to firestopping installation with the Owner, Construction Manager, and/or all other Contractors.
- B. Coordinate construction of openings and penetrating items to ensure that firestopping assemblies are installed according to specified requirements. Opening shall not exceed maximum restrictions allowable for annular spacing per listing or acceptable Engineering Judgements.
- C. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- D. Do not conceal firestopping installations until the Owner's inspection agency or Authorities Having Jurisdiction have examined each installation.
- E. Schedule firestopping after installation of penetrants and joints but prior to concealing or obstructing access to areas requiring firestopping.
- F. Preinstallation Conference: This conference should be a joint meeting attended by the Owner's Representative and all prime contractors, respective firestopping sub-contractors and firestopping company field advisor to review project requirements. The agenda for the conference should include the following topics:
 - 1. Review scope of work.
 - 2. Review shop drawings and firestop application log.
 - 3. Review mock-up requirements.
 - 4. Discuss identification labels and locations.

5. Review schedule, coordination and sequencing with all trades.
 6. Review any engineering judgments or other special requirements.
 7. Function and frequency of inspections and testing labs.
- G. Destructive testing shall be performed at mock up and at pre determined intervals according to ASTM E 2174 and ASTM E 2393-04 by the inspector and with the installing Contractor present. Inspector to test for in place installation conformance to tested and listed system or engineering judgment details. Non conformances will result in additional destructive testing, at the cost of the installer.

PART 2 - PRODUCTS

2.1 FIRESTOPPING, GENERAL

- A. Firestopping products specified in system design listings by approved testing agencies may be used providing they conform to the construction type, penetrant type, annular space requirements and fire rating involved in each separate assembly.
- B. Manufacturer of firestopping products shall have been successfully producing and supplying these products for a period of not less than three years and be able to show evidence of at least ten projects where similar products have been installed and accepted.
- C. Accessories: Provide components for each firestop system that is needed to install fill materials and to comply with "Performance Requirements" Article. Use only components specified by the firestopping manufacturer and by the approved testing agencies for the firestop systems indicated. Accessories include, but are not limited to the following items:
1. Permanent forming/damming/backing materials, including the following:
 - a. Slag wool fiber insulation.
 - b. Foams or sealants used to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Polyethylene/polyurethane backer rod.
 - e. Rigid polystyrene board.
 2. Temporary forming materials.
 3. Substrate primers.
 4. Steel sleeves.
- D. All firestopping products and systems shall be designed and installed so that the basic sealing system will allow the full restoration of the thermal and fire resistance properties of the barrier being penetrated with minimal repair if penetrants are subsequently removed.

2.2 FIRESTOPPING

- A. Provide firestop compounds for caulk, pour, trowel or pump application. Material must be capable of sealing openings around single or multiple pipes against fire, smoke and toxic gases, and maintaining rating with a thickness no greater than the structure.
- B. Provide a damming material, where required, per manufacturer's recommendations and as shown on the Drawings.
- C. Provide a firestop system consisting of a material, or combination of materials, to retain the integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke or gases through penetrations in fire-rated barriers. It shall be used in specific locations as follows:

1. Penetrations for the passage of piping through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor slabs and floor/ceiling assemblies), and vertical service shafts.
2. Locations shown specifically on the drawings or where specified in other sections of these specifications.

D. MATERIALS

1. Firestopping materials/systems shall be flexible to allow for normal movement of building structure and penetrating item(s) without affecting the adhesion or integrity of the system.
2. Firestopping materials shall not require hazardous waste disposal of used containers/packages.
3. Provide firestopping materials free of solvents which will not experience shrinkage while curing.
4. Firestopping materials shall be unaffected by moisture.

2.3 QUALITY ASSURANCE

- A. Provide firestopping system design listings from UL, FM, Warnock Hersey or OPL in accordance with the appropriate ASTM Standard(s) per article 1.5.
- B. Contractor Qualifications: An acceptable Firestop Contractor shall be:
1. Licensed by State or Local Authority where applicable, or
 2. FM Research approved in accordance with FM Standard 4991, or
 3. UL Qualified Firestop Contractor, or
 4. Meet the following requirements
 - a. Installation personnel shall be trained by the approved firestop manufacturer.
 - b. The installation firm shall be experienced in installing firestop systems and fire resistive joint systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance.
 - c. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified tested and listed system requirements.
 - d. Minimum of three (3) years experience and shown to have successfully completed not less than 5 comparable scale projects and provide references.
- C. Single Source Limitations: Obtain firestop systems for all conditions from a single manufacturer.
- D. Materials from different firestop manufacturers shall not be installed in the same firestop system or opening.
- E. Firestopping material shall be asbestos and lead free and shall not incorporate nor require the use of hazardous solvents.
- F. Firestopping sealants must be flexible, allowing for normal movement.
- G. Firestopping materials shall not shrink upon drying as evidenced by cracking or pulling back from contact surfaces such that a void is created.
- H. Firestopping materials shall be moisture resistant, and may not dissolve in water after curing.
- I. Materials used shall be in accordance with the manufacturer's written installation instructions.

- J. Identify installed firestop systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within **6 inches (150 mm)** of edge of the firestop systems so that labels will be visible to anyone seeking to remove penetrating items or firestop systems. Use mechanical fasteners for metal labels. For plastic labels, use self-adhering type with adhesives capable of permanently bonding labels to surfaces on which labels are placed and provide a label material that will result in partial destruction of label if removal is attempted. Include the following information on labels:
1. The words "Warning - Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
 2. Contractor's name, address, and phone number.
 3. Firestop system designation of applicable testing and listing agency.
 4. Date of installation.
 5. Firestop system manufacturer's name.
 6. Installer's name.
 7. Inspector's name (if applicable)
- K. Inspection of penetrations through fire rated floor and wall assemblies shall be in accordance with ASTM E2174, Standard Practice for On-Site Inspection of Installed Fire Stops and ASTM E2393-04 Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers. The Owner may engage a qualified, independent inspection agency, or material testing agency to perform these inspections. (NYC Projects are subject to the requirements of Special Inspections in accordance with Chapter 17 of the 2014 NYC Building Code.)
- L. Field Mock-up Installations: Prior to installing firestopping, erect mock-up installations for each type firestop system indicated in the Firestop Schedule to verify selections made and to establish standard of quality and performance by which the firestopping work will be judged by the Owner or Owner's Representative. Obtain acceptance of mock-up installations by the Owner or Owner's Representative before start of firestopping installation. Provide at least 72 hours notice to Owner or Owner's Representative prior to inspection.

2.4 MIXING

- A. For those products requiring mixing before application, comply with firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

2.5 SLEEVES

- A. Provide sleeves for each pipe passing through walls, partitions, and floors.
- B. Wall and floor sleeves.
1. Sleeve Materials

Type	Sleeve Materials
1	#18 gauge, galvanized steel
2	Standard weight galvanized steel pipe
3	Cast iron body with flashing clamp and underdeck clamp similar to J.R. Smith, figure 1720.

2. Sleeve Sizes

- a. Sleeves shall be of adequate diameter to allow pipe, insulation, and fire stopping to fit.
 - b. Sleeves shall provide 1" minimum clearance around pipes smaller than 4" and 2" minimum clearance around pipes 4" and larger.
3. Sleeve Lengths

Location	Sleeve Length	Material
Floor	All floor sleeves to extend minimum of 2" above finished floor level.	2
Stair Landing	Equal to depth of construction and terminated flush with finished surfaces.	2
Walls and Partitions	Equal to depth of construction and terminated flush with finished surfaces.	1

C. Foundation Wall Sleeves

1. The pipe to wall sleeve penetration closure shall be "Pipe Linx" as manufactured by Calpico, Inc. Seals shall be modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall sleeve opening. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely watertight seal between the pipe and wall opening. The seal shall be constructed so as to provide electrical insulation between the pipe and wall, thus reducing changes of cathodic reaction between these two members.
2. Contractor shall determine the required inside diameter of each individual wall opening or sleeve before ordering, fabricating or installing. The inside diameter of each wall opening shall be sized as recommended by the manufacturer to fit the pipe and Pipe Linx to assure a watertight joint. If pipe O.D. is non-standard due to coating, insulation, etc., consult manufacturer for assistance before proceeding with wall opening detail

2.6 MANUFACTURERS

- A. Subject to compliance with the requirements, provide products by one of the following or equivalent manufacturers:
1. Grace Construction Products.
 2. Nelson Firestop Products.
 3. Hilti Firestop Products.
 4. A/D Fire Protection Systems Inc.
 5. RectorSeal Corporation (The).
 6. Specified Technologies Inc.
 7. 3M; Fire Protection Products Division.
 8. Tremco; Sealant/Weatherproofing Division.

PART 3 - EXECUTION

- 3.1 Deliver materials to site in original unopened containers or packages bearing the manufacturer's name, brand designation, product description and U.L. Classification Mark.
- 3.2 Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job site.
- 3.3 Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements.
- 3.4 Comply with recommended procedures, precautions or remedies described in Material Safety Data Sheets as applicable.

3.5 EXAMINATION

- A. Examine areas and conditions under which work is to be performed and notify the Contractor in writing of conditions detrimental to proper and timely completion of the work.
- B. Verify that openings are properly sized and in suitable condition to receive the work of this section.
- C. Verify manufacturer's printed instructions for installation and when applicable, curing in accordance with temperature and humidity. Conform to ventilation and safety requirements.
- D. Verify the condition of the substrates before starting work.
- E. Verify Weather Conditions. Do not proceed with installation of firestop materials when temperatures fall outside the manufacturer's suggested limits.
- F. Verify that firestopping materials are installed so as not to contaminate adjacent surfaces.
- G. Schedule firestopping after installation of penetrants but prior to concealing the openings.
- H. Where firestopping is installed at locations which will remain exposed in the completed work, provide protection as necessary to prevent damage to adjacent surfaces and finishes, and protect as necessary against damage from other construction activities.
- I. Verify that all pipe, conduit, ducting which penetrate fire-rated construction have been permanently installed prior to installation of firestop.
- J. Examine substrates and conditions for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.
- K. Proceed with installation only after unsatisfactory conditions have been corrected.
- L. Verify that all pipes, conduits, cables, and/or other items which penetrate fire-rated construction have been permanently installed prior to installation of firestops.

3.6 PREPARATION

- A. Clean substrate of dirt, dust, grease, oil, loose materials, rust or other matter that may affect the proper fitting or adhesion of the firestopping materials.
- B. Clean metal and glass surfaces with a non-alcohol solvent.

- C. Surface Cleaning: Clean out openings immediately before installing firestop systems to comply with written recommendations of firestopping manufacturer and the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of firestop systems.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with firestop systems. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.

3.7 INSTALLATION

- A. Installation of firestops shall be performed by an applicator/installer qualified and trained by the manufacturer. Installation shall be performed in strict accordance with manufacturer's details installation procedures.
- B. Apply firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, and manufacturer's recommendations.
- C. Unless specified and approved, all insulation used in conjunction with through-penetrations shall remain intact and undamaged and may not be removed.
- D. Seal holes and penetrations to ensure an effective smoke seal.
- E. In areas of high traffic, protect firestopping materials from damage. If the opening is large, install firestopping materials capable of supporting the weight of a human.
- F. Insulation types specified in other sections shall not be installed in lieu of firestopping material specified herein.
- G. All combustible penetrants (e.g. non-metallic pipes or insulated metallic pipes) shall be firestopped using products and systems tested in a configuration representative of the field condition.
- H. Dam Construction
 - 1. When required to properly contain firestopping materials within openings, damming or packing materials may be utilized. Combustible damming material must be removed after appropriate curing. Noncombustible damming materials may be left as a permanent component of the firestop system.
- I. General: Install firestop systems to comply with "Performance Requirements" article in Part 1 and firestopping manufacturer's written installation instructions and published drawings for products and applications indicated.
- J. Installation of firestopping shall be performed by an applicator/installer qualified as described in article 1.7.
- K. Apply firestopping in accordance with approved testing agencies listed system designs or manufacturer's EJ per the manufacturer's installation instructions.
- L. Verify that environmental conditions are safe and suitable for installation of firestop products.
- M. Install forming/damming/backing materials and other accessories required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire resistance ratings required.

- N. Install joint forming/damming materials and other accessories required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths of installed firestopping material relative to joint widths that allow optimum movement capability and achieve fire resistance ratings required.
 - O. Install metal framing, curtain wall insulation, mechanical attachments, safing materials and firestop materials as applicable within the system design.
 - P. Install fill materials for firestop systems by proven techniques to produce the following results:
 - 1. Fill voids, joints and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
 - 2. Apply materials so they fully contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.
 - 4. Tool non-sag firestop materials after their application and prior to the time skinning begins. Use tooling agents approved by the firestopping manufacturer.
 - Q. On vertical pipe penetrations, lift riser clamps to permit the installation of firestopping around the entire pipe penetration. For penetrations involving fire or fire/smoke dampers, only firestop products approved by the damper manufacturer shall be installed in accordance with the damper installation instructions.
- 3.8 Firestopping may be required by other Subcontractors under related sections of the project specifications. Identify all locations requiring firestopping and coordinate the work of this section with work performed under other sections of the project to provide a uniform system of firestopping.
- 3.9 Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.
- 3.10 Do not proceed with installation of firestop materials when temperatures exceed the manufacturer's recommended limitations for installation.
- 3.11 Firestop systems do not re-establish the structural integrity of load bearing partitions. Contractor shall consult the structural engineer prior to penetrating any load bearing assembly.
- 3.12 UN-INSULATED COLD PIPES
- A. Install a pipe sleeve through the wall or slab to be penetrated with an inside diameter large enough to include the pipe and firestopping.
 - B. Install firestop material at each end of sleeve to form a U.L. approved system.
 - C. Mark penetration in an approved manner to verify manufacturer's inspection.
 - D. Cover firestopping with escutcheon cover.
- 3.13 INSULATED PIPES
- A. Install a pipe sleeve through the wall or slab to be penetrated with an inside diameter large enough to include the specified thickness of insulation.
 - B. Pipe insulation should be continuous through sleeve. Insulation should be covered with a vapor barrier. For depth of wall plus 1" on either side of wall or slab, vapor barrier shall be wrapped with a 26 gauge sheetmetal inner sleeve. Firestop shall be applied between wall sleeve and pipe protection sleeve.

- C. Install firestop material at each end of sleeve to form a U.L. approved system.
- D. Mark penetration in an approved manner to verify manufacturer's inspection.
- E. Cover firestopping with escutcheon cover.

3.14 FIELD QUALITY CONTROL

- A. Prepare and install firestopping systems in accordance with manufacturer's printed instruction and recommendations.
- B. Follow safety procedures recommended in the Material Safety Data Sheets.
- C. Finish surfaces of firestopping which are to remain exposed in the completed work to a uniform and level condition.
- D. All areas of work must be accessible until inspection by the applicable Code Authorities.
- E. Correct unacceptable firestops and provide additional inspection to verify compliance with this specification.
- F. Inspecting Agency: Authorities Having Jurisdiction, the Owner, or Owner's Representative shall be allowed to perform random destructive testing during inspection of firestop systems to verify compliance per listings or manufacturer's installation instructions. All areas of work must be accessible until inspection by the applicable Authorities Having Jurisdiction and inspection agencies. The contractor shall be responsible to repair all tested assemblies with no cost to the owner.
- G. Proceed with enclosing firestop systems with other construction only after inspections are complete.
- H. Where deficiencies are found, repair or replace firestop systems so they comply with requirements.

3.15 CLEANING

- A. Remove spilled and excess materials adjacent to firestopping without damaging adjacent surface.
- B. Leave finished work in neat, clean condition with no evidence of spill overs or damage to adjacent surfaces.
- C. Clean off excess fill materials adjacent to openings, as Work progresses by methods and with cleaning materials that are approved in writing by firestopping manufacturer(s) and that do not damage materials in which openings occur. Leave finished work in neat, clean condition with no evidence of spillovers or damage to adjacent surfaces.
- D. Provide final protection and maintain conditions during and after installation that ensure firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated firestop systems immediately and install new materials to produce firestop systems complying with specified requirements.

PART 4 - REFERENCES

- 4.1 New York City Fire and Building Code.
- 4.2 National Fire Protection Association (NFPA)
 - A. NFPA 101 (Life Safety Code)
- 4.3 American Society For Testing and Materials Standards (ASTM):
 - A. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials.
 - B. ASTM E814: Standard Test Method for Fire Tests of Through-Penetration Firestops.

END OF SECTION

SECTION 210518

ESCUTCHEONS FOR FIRE SUPPRESSION PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide fire protection systems in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Escutcheons.

1.3 SUBMITTALS

- A. Product Data: Manufacturers' catalogs, brochures.

1.4 QUALITY ASSURANCE

- A. Local Building Code.
- B. Local Fire Department.
- C. National Fire Protection Association (NFPA)
- D. Underwriters Laboratories (U.L.)
- E. Factory Mutual (FM)

PART 2 - PRODUCTS

2.1 GENERAL

- A. The following specifications represent desired design, materials and construction standards for the various items of work. Manufacturer names and model numbers are used to describe specific types, styles and quality.

2.2 ESCUTCHEONS

- A. Provide escutcheons on all exposed piping through walls, floors, partitions and ceilings.
- B. Escutcheons shall be held in place by set screws.
- C. Escutcheon Application

Location	
Finished Spaces	Chrome plated brass
Unfinished spaces: including mechanical equipment rooms.	Cast iron

- D. Two-piece or hinged escutcheons will not be permitted.
- E. Escutcheons shall be installed on both sides of pipe penetrations.

2.3 ACCEPTABLE MANUFACTURERS

- A. Escutcheons
 - 1. H. O. Trerice
 - 2. Weksler Instruments Corp.
 - 3. Taylor Sybron Corp.

END OF SECTION

SECTION 210519

METERS AND GAUGES FOR FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide meters and gauges for fire protection systems in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Gauges.

1.3 SUBMITTALS

- A. Product Data: Manufacturers' catalogs, brochures.
- B. Application Schedule: Schedule of locations and pressure gauge range.

1.4 QUALITY ASSURANCE

- A. National Fire Protection Association (NFPA)
- B. Underwriters Laboratories (U.L.)
- C. Factory Mutual (FM)

PART 2 - PRODUCTS

2.1 GENERAL

- A. The following specifications represent desired design, materials and construction standards for the various items of work. Manufacturer names and model numbers are used to describe specific types, styles and quality.

2.2 GAUGES

- A. Provide pressure gauges where indicated on the drawings and in accordance with the schedule given below. All gauges shall be provided with snubbers. Gauges shall have 4½" diameter dial, white coated with black figures and graduations. Gauges shall be H.O. Trerice Co. Shutoff cock shall be provided between gauge and piping to permit gauge removal while system is under pressure.
- B. Gauges shall have graduation such that at normal working pressure the needle is in the center of the field.

C. Gauge Schedule

1. Gauge Location
 - a. Inlet and Outlet of Pumps
 - b. Sprinkler Floor Control Valves
 - c. Inlet and Outlet of PRV's
 - d. Inlet and Outlet of Dry Pipe Valves
 - e. Main Water Service
 - f. Top and Bottom of all Risers

2.3 ACCEPTABLE MANUFACTURERS

A. Pressure Gauges

1. H. O. Trerice
2. Weksler Instruments Corp.
3. Taylor Sybron Corp.

PART 3 - EXECUTION

3.1 NOT USED

END OF SECTION

SECTION 210520

PIPING AND FITTING MATERIALS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide piping and fitting materials for fire protection systems in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Pipes.
- B. Fittings.
- C. Joints.

1.3 SUBMITTALS

- A. Prior to purchase, submit a list of all proposed piping materials including system/material (use Schedule).
- B. Submit complete back-up material where manufacturing specification standards of proposed materials differ from those specified.

1.4 QUALITY ASSURANCE

- A. Each pipe length shall have the manufacturer's name cast, stamped or rolled on.
- B. Each fitting shall have the manufacturer's name cast, stamped or rolled on.

PART 2 - PRODUCTS

2.1 BLACK STEEL PIPE (SCHEDULE 40)

- A. Pipe: Standard weight black steel pipe, Schedule 40, welded or seamless, with manufacturer's name rolled into each length.
- B. Fittings
 - 1. Threaded: Standard malleable iron couplings with flat band.
 - 2. Welded or Flanged: Standard weight steel.
 - 3. Mechanical Couplings: See Section 2.3.
- C. Joints: Red or white lead and oil or approved compound.
- D. Application
 - 1. Threaded: All sprinkler systems.
 - 2. Welded: All fire standpipe over 175 psi.
 - 3. Mechanical Couplings: Sprinkler and Fire Standpipe (See Section 2.3).

2.2 GALVANIZED STEEL PIPE

- A. Pipe: Standard weight galvanized steel pipe, Schedule 40, with makers name rolled into each length.
- B. Fittings
 - 1. Threaded: Galvanized malleable iron with flat band steam pattern.
 - 2. Mechanical Couplings: See Section 2.3. Rolled groove only.
- C. Joints: Red or white lead and oil or approved compound.
- D. Application: Dry pipe sprinkler system.

2.3 MECHANICAL COUPLINGS

- A. The following fittings are taken from the catalog of Victaulic and are representative of the style and construction required.

- B. Standpipe

Style	Pipe Weight	Pressure Rating	Sizes
77-Flexible	Schedule 40	0-500 PSI	1"-10"
Firelock - Rigid	Schedule 40	0-175 PSI	2"-6"

- C. Sprinkler

Style	Pipe Weight	Pressure Rating	Sizes
77-Flexible	Schedule 10/40	0-500 PSI	1"-10"
Firelock - Rigid	Schedule 40	0-175 PSI	2"-6"
920	Schedule 40	0-175 PSI	2"-3"
921	Schedule 40	0-175 PSI	3"-8"

- D. The following products are not acceptable:
 - 1. FIT (Style 96, 963, 969, 719, 966, 960 & 929)
 - 2. Hooker (Style 922)

2.4 ACCEPTABLE MANUFACTURERS

- A. Mechanical Couplings
 - 1. Victaulic
 - 2. Gustin-Bacon
- B. Piping
 - 1. Allied Tube and Conduit Corp.
 - 2. Berger Pipe Co.
 - 3. Wheatland Tube Co.

C. Fittings

1. Flagg
2. Nibco
3. Stockham
4. Victaulic

PART 3 - EXECUTION

3.1 JOINTS

- A. Threaded Joints: Do not damage fitting surface, remove burrs and ream smooth. Apply red lead and oil to male threads only. Clean joint thoroughly of excess jointing material.
- B. Flanged Joints: Use matched flange faces and 1/16" thick compressed gaskets.
- C. Welded Joints:
 1. Butt welded joints shall be open type by the oxyacetylene torch or electric arc process. Fuse welds thoroughly to the joint edges and extend completely to the bottom of V-groove cut. Weld width to a minimum of 2½ times the pipe wall thickness and to be symmetrical with respect to the center line of joint. Build up welds to obtain a gradual increase in thickness from edge to center and the thickness from edge to center is not to exceed 1¼ times the pipe wall thickness. Make all welds of sound metal, free from laps, gas pockets, slag inclusions, interior protrusions or other imperfections.
 2. Qualify welders to the code for Pressure Piping ANSI B31.1 with certification by the Welding Bureau of Heating, Piping and Air Conditioning Contractors National Association. Welding shall not be started until submission of evidence of qualification.
- D. Mechanical (Grooved) Joints: Joints shall be made with neoprene or synthetic rubber gaskets.
- E. Make joints between different piping materials with adaptor fittings of a type suitable for the purpose intended.
- F. Make joints between pipes of dissimilar metals with dielectric union or flanges.

3.2 PIPE AND FITTINGS

- A. Threads shall be full and clean cut and burrs formed in cutting shall be reamed. In screwing up the pipe, care shall be taken that the pipe does not extend into the fitting obstructing the waterway. Joint compound shall be applied to the threads of the pipe and not to the fittings or sprinklers. Pipe shall be straightened before installation to prevent pockets.
- B. A one-piece reducing fitting shall be used wherever a change is made in the size. The use of bushings or reducing flanges will not be permitted.
- C. Unions shall be used only on pipes 2" and smaller, and provided at connections to each piece of equipment for easy dismantling.
- D. Only shoulder nipples shall be used. Close nipples will not be acceptable.
- E. All fittings and couplings shall be made by the same manufacturer.

END OF SECTION

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SECTION 210523
FIRE SUPPRESSION VALVES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide valves for fire protection systems in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. OS&Y Valves.
- B. Gate Valves.
- C. Ball Valves.
- D. Butterfly Valves.
- E. Check Valves.
- F. Pressure Reducing Valves.
- G. Pressure Relief Valve.

1.3 SUBMITTALS

- A. Manufacturers' Specifications and Engineering Data
 - 1. Each type valve.
 - 2. Materials or all parts.
 - 3. Pressure ratings.
 - 4. Schedule of major control valves, check valves and pressure reducing valves.
 - 5. Certificates: Manufacturers' certification that valves and accessories meet or exceed specification requirements.

1.4 QUALITY ASSURANCE

- A. Each valve shall have the manufacturer's name, size and pressure rating cast or stamped on body.
- B. Each valve shall bear U.L./FM Global label or marking.
- C. Except as noted, type and size of materials and equipment as approved by:
 - 1. Local Building Code.
 - 2. Underwriter's Laboratory.
 - 3. Factory Mutual.
 - 4. National Fire Protection Association (NFPA).
 - 5. Owner's Insurance Underwriters.
 - 6. New York City Board of Standards and Appeals.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All fire protection water control valves within the building shall be either wedge gate valves with painted iron wheel handles, shall have gland followers in stuffing boxes, and shall be constructed so that they may be repacked while open and under pressure, or slow-closing quarter-turn gear-operated butterfly valves.
- B. All valves shall have the name of the manufacturer and working pressure cast or stamped on body.
- C. All valves are to be U.L. listed and FM Global approved.
- D. All valves shall be with threaded, grooved, or flanged ends as required by the piping system in which they are installed.
- E. Valves shall be selected for the maximum working pressure they will be exposed to (including churn pressure), or as indicated on the drawings.
- F. All fire protection valves shall be provided with tamper switches.

2.2 VALVE SCHEDULE

- A. Unless otherwise indicated, the valves tabulated on the Valve Schedule on drawings have been selected from the catalog of The Stockham Valve Co., and are representative of the design, materials and working features desired. All fire protection valves shall be U.L. listed and FM Global approved.
- B. The following Stockham Valve Co. numbers are applicable. Valves of corresponding features as indicated on the approved manufacturer paragraph of this section may be submitted for review.

1. Gate Valves:

Size & End	Figure No.	Pressure Rating	Material	Spindle
2" & Smaller	B133	175	Bronze	OS&Y
2½" & Larger	G634	175	IBBM	OS&Y

2. Check Valves:

Size & End	Figure No.	Pressure Rating	Material	Spindle
2" & Smaller	B319	200	Bronze	
2½" & Larger	G940	175	IBBM	

3. Drain Valves:

Size & End	Figure No.	Pressure Rating	Material	Spindle
2" & Smaller	B115	200	Bronze	Non-Rising Stem

4. Butterfly Valves as per Nibco Inc.:

Size & End	Figure No.	PSIG W.O.G.	Disc Material	Actuator
Wafer-Dead end rated	WD3510-4	250	Ductile Iron	Gear Operator
Wafer	WD3510-2	250	Ductile Iron	Gear Operator
Lug-Dead end rated	LD3510-4	250	Ductile Iron	Gear Operator
Lug	LD3510-2	250	Ductile Iron	Gear Operator

2.3 PRESSURE REDUCING VALVE (PRV) – PILOT OPERATED

- A. Valve shall maintain a constant downstream pressure regardless of varying inlet pressure. Valve shall be hydraulically-operated, diaphragm-actuated, globe or angle pattern valve. It shall contain a resilient, synthetic rubber disc, having a rectangular cross-section, contained on three and one-half sides by a disc retainer and forming a tight seal against a single removable seat.
- B. The diaphragm assembly containing a valve stem shall be fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat. This diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure. The diaphragm shall consist of nylon fabric bonded with synthetic rubber and shall not be used as a seating surface.
- C. Packing glands and/or stuffing boxes are not permitted and there shall be no pistons operating the valve or pilot controls. All necessary repairs shall be possible without removing the valve from the line.
- D. The pilot control shall be direct-acting, adjustable, spring-loaded, normally open, diaphragm valve, designed to permit flow when controlled pressure is less than the spring setting. The control system shall include a fixed orifice.
- E. This valve shall be U.L. listed and shall be similar to a Model 90-21 Pressure Reducing Valve as manufactured by Cla-Val Co.

2.4 PRESSURE REDUCING VALVES (PRV) – DIRECT ACTING

- A. The valve shall be rated for 400 psi working pressure, and able to be tested to its full rating without damage to any part of the valve. The valve is to be of all bronze construction, with bronze and stainless steel trim, with globe body. The valve shall be U.L. listed and approved by local authorities. The valve is to be set and sealed at the factory. A seal is to be affixed to the valve at the factory for protection against tampering. Valve shall be as manufactured by Potter-Roemer, Inc. Fig. PRV-4036 Reg-U-Matic or approved equal of Zurn Industries or Ford Regulator Corp.

2.5 PRESSURE RELIEF VALVE

- A. Furnish and install where indicated on drawings or downstream of all pressure reducing valves a $\frac{3}{4}$ " cast brass pressure relief valve similar to Potter-Roemer 4059.

2.6 FIRE PUMP VALVES

- A. Check Valves at Fire Pumps (Suction & Discharge): Williams-Hager Figure 636, 250 psi, w.p., semi-steel/bronze trim.
- B. Check Valves at Jockey Pump (Suction & Discharge): Williams-Hager Figure 329, 250 psi, w.p., semi-steel/bronze trim.
- C. All fire protection check valves shall be U.L. listed and FM Global approved.

2.7 MECHANICAL COUPLINGS

- A. In addition to valves scheduled on the drawings the following Victaulic mechanical coupling valves may be provided:

System	Model No.	Pressure	Size
Sprinkler/ Standpipe	705-W WTS	0-300 psi	2 1/2"-12"
Sprinkler	728 WTS	0-350 psi	1"-2"
Fire Pump	717 Check Valve	0-250 psi	4"-12"

2.8 ACCEPTABLE MANUFACTURERS

- A. Threaded and Flanged Valves
 - 1. Stockham
 - 2. Milwaukee
 - 3. Kennedy
 - 4. Nibco
- B. Mechanical Coupling Valves
 - 1. Victaulic
 - 2. Gustin-Bacon
 - 3. Stockham
- C. Check Valves
 - 1. Williams Hager (Fire Pump only)
 - 2. Nibco
 - 3. Victaulic
 - 4. Stockham
 - 5. Milwaukee
 - 6. Kennedy
- D. Pressure Reducing Valve – Direct Acting
 - 1. Potter Roemer
 - 2. Zurn
 - 3. Ford
- E. Pressure Reducing Valve – Pilot Operated

1. Cla-Val
- F. Pressure Relief Valve
1. Potter Roomer
 2. Zurn
 3. Cla-Val

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All valves shall be installed only in the upright vertical or horizontal positions unless specifically otherwise required by the drawings.
- B. All valves shall be installed in accessible locations to facilitate easy removal for repair or replacement.
- C. All grooved end valves shall be of the same manufacturer as the grooved couplings and fittings.
- D. Pressure Ratings for Check and Gate Valves
 1. Vertical Distance From Fire Pump

Vertical Distance From Fire Pump	Class
0-165'	250
165'-400'	150

2. Max. Static Head from Roof Tank

Max. Static Head from Roof Tank	Class
0-115'	150
115'-270'	250
270'-425'	350
425'-657'	500
657'-1122'	800
1122'-Larger	1000

END OF SECTION

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SECTION 210529

HANGERS, SUPPORTS, ANCHORS AND GUIDES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work of this Section shall conform to the requirements of the Contract Documents.

1.2 WORK INCLUDED

- A. Hangers and supports.
- B. Supports
- C. Seismic Restraints

1.3 SUBMITTALS

- A. Manufacturer's literature, catalog data and illustrations.
- B. Shop Drawings indicating:
 - 1. Dimensions
 - 2. Construction details of hangers, inserts, anchors and guides
 - 3. Materials
 - 4. Maximum Load
 - 5. Locations
 - 6. Recommended installation procedures

1.4 QUALITY ASSURANCE

- A. Codes and Authorities
 - 1. Federal Specification WW-H171b
 - 2. ASA Code for Pressure Piping
 - 3. ASTM A-575-73
 - 4. MSS SP-58-67
 - 5. MSS SP-69-66
 - 6. Underwriters Laboratories
 - 7. Factory Mutual
 - 8. National Fire Protection Association

PART 2 - PRODUCTS

2.1 HANGERS

- A. All bracket, clamp and rod sizes indicated in this specification are minimum sizes only. All structural hanging materials shall have a built-in safety factor of 5.
- B. Provide rolled-steel auxiliary pipe supports as required.

- C. Anchor points shall be located and constructed to permit the piping system to take up its expansion and contraction freely in opposite directions from the anchored points.
- D. Guide points shall be located and constructed wherever required or shown on drawings and at each side of an expansion joint or loop, to permit free axial movement only in a piping system.
- E. All hangers shall be U.L. listed and FM approved.
- F. C-clamps with locknut and retaining clip will be permitted.
- G. Pipe Hanger Schedule

	Carpenter Patterson 'Witch'	& Grinnell	I. R. Rauch's & Sons
C-Clamp with Retaining Clip and locknut(pipe sizes 2" & smaller	47 with 22	86 with 89	47 with 22
Beam Clamp	293	228	82
Multi-J Hook	---	---	228
J Hook	---	---	221
Clevis Hanger	100	260	100
Clevis Hanger w/Saddle	100SH	---	100SH
180° Shield	265P	168	265P
Single Rod Roll Hanger	140	181	140
Double Rod Roll Hanger	142	171	142
Trapeze	---	46	1600-1700
U-bolt Adjustable Pipe	283	137C	283
Stanchion Saddle	247	259	247
Welded Steel Bracket	84 or 139	199 or 195	84 or 139
Riser clamp	126	261	126
Welded Beam Attachment	113A	66	---
Welded Beam Attachment w/bolt & nut	113B	66	113A
Concrete Insert	108	282	180 or 181
Phillips Inserts	513	Phillips Insert	1000

H. Hanger Rod Schedule

Pipe Size	Rod Diameter
4" and smaller	3/8"
5", 6", & 8"	1/2"
10" & above	5/8"

I. Acceptable Manufacturers

1. I. R. Rauch's & Sons
2. Grinnell Company, Inc.
3. Carpenter & Patterson

2.2 FOUNDATIONS

- A. All equipment, piping, etc., shall be mounted on approved foundations, all as specified herein, or as shown on the drawings.
- B. All floor-mounted equipment shall be erected on 12" high concrete pads, provided under a separate section of the specifications, over the complete floor area of the equipment, unless specified to the contrary herein. Hereinafter, wherever vibration eliminating devices and/or concrete inertia blocks are specified, these items shall in turn be mounted upon aforementioned pads unless specified to the contrary herein.
- C. All floor-mounted equipment shall be erected on 12" high concrete pads, over the complete floor area of the equipment, unless specified to the contrary herein. Hereinafter, wherever vibration eliminating devices and/or concrete inertia blocks are specified, these items shall in turn be mounted upon aforementioned pads unless specified to the contrary herein.
- D. All concrete foundations and supports (and required reinforcing thereof) will be furnished and installed under this Section of the Specification. Furnish templates for all concrete foundations and supports, and all required hanger bolts and other appurtenances necessary for the proper installation of equipment. Submit shop drawings showing the complete details of all foundation bases including necessary concrete and steel work, vibration isolation devices, etc.

2.3 SEISMIC RESTRAINTS

- A. All piping systems shall be braced to withstand a $\frac{1}{2}$ " "g" seismic acceleration. Spacing of bracing is to be as follows:
1. Piping, lateral, braced at a maximum of 40 foot intervals.
 2. Longitudinal bracing at 80 foot intervals.
 3. Seismic restraints are not required on the following:
 - a. Branch lines 2" and smaller
 - b. All clevis hung pipe suspended by individual non-friction hanger designed to support the imposed static load and the anticipated $\frac{1}{2}$ "g" seismic acceleration 6" in length or less from the top of the pipe support to the bottom of the support for the hanger.
 4. Overstress of the building structure must not occur. Seismic bracing may occur from:
 - a. Flanges and structural beams.
 - b. Cast in place inserts or drilled and shielded inserts in concrete structures.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All piping shall be supported only from building structural steel or galvanized steel inserts imbedded in poured concrete. Where piping revisions are required after slabs are poured, pipes 3" and smaller may be supported at intermediate points by "Phillips" or other 3/4" expansion bolts and shields, provided main supports are not less than 20 feet on centers. All inserts, expansion bolts and shields in post-tensioned concrete slabs shall be submitted to Structural Engineer for approval prior to commencement of work. Intermediate supports for piping 4" and larger shall be attached to concrete beams or columns by means of 4" x 4" x 3/8" (horizontal) and supporting rod at 90° from anchor bolt. It is the intent that inserts are only permitted in poured concrete construction.
- B. Hanger Locations for Horizontal Piping
 - 1. Steel Piping 1¼" and Smaller: Every 12 feet.
 - 2. Steel Piping (Schedule 40 and larger) 1½" and Larger: Every 15 feet.
 - 3. Steel piping (less than schedule 40) 1½" and larger: Every 12 feet.
- C. Support Locations for Vertical Piping
 - 1. Threaded & Mechanical Joint Piping: At every floor, but in no case greater than 20-foot intervals.
- D. Hangers shall be installed outside of piping insulation with a semi-cylindrical galvanized shield set between the hanger and insulation.
- E. All beam attachments shall be installed on clean, smooth, and non-fireproofed sections of the beam.
- F. All fire protection piping shall be hung individually from the structure.
- G. All hangers, anchors, rods and supports shall be painted. Refer to Section 21 05 95.

END OF SECTION

SECTION 210548

VIBRATION AND SEISMIC CONTROLS FOR FIRE SUPPRESSION
PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work of this Section shall conform to the requirements of the Contract Documents.

1.2 WORK INCLUDED

- A. Provide engineered seismic restraint systems for suspended Fire Protection piping equipment compliant with the currently adopted version of the International Building Code (IBC) with local building code amendments and NFPA-13.
- B. At seismic restraint installations, provide vertical support systems engineered to accommodate dead load plus seismic force restrictions.

1.3 SUBMITTALS

- A. Contractor to convey to ISAT each overhead deck condition to which seismic attachments will be made. Information to include type and density of concrete, concrete thickness, size and gage of metal deck and any point load limitations or restrictions.
- B. Provide Seismic Design Force calculations per ASCE 7-05, Formulas 13.3-1 thru 13.3-3 stamped by a registered design professional licensed to practice in the State where project is located. For multi-story projects, provide calculated Seismic Design Force for each floor.
- C. Submit seismic restraint layouts stamped by a registered design professional licensed to practice in the State where project is located. Seismic restraint layouts to show:
1. All vertical support and seismic brace locations.
 2. All anchorage connections to structure. Anchor brand, type, quantity and size.
 3. Vertical support and brace reaction point load at all connections to structure. For review by engineer of record in checking suitability of the building structure to accommodate imposed loads.
 4. Plan set sheets showing appropriate installation details reflecting actual job site conditions.
- D. Include cover sheet with Seismic Restraint Bracing Legend delineating:
1. Maximum Allowable Size or Utility Weight (Lbs/Lf).
 2. Minimum Vertical Support Rod Diameter.
 3. Support Rod Total Vertical Load.
 4. Maximum Allowable Transverse Brace Spacing.
 5. Transverse Brace Reaction
 6. Maximum Allowable Longitudinal Brace Spacing.
 7. Longitudinal Brace Reaction
 8. Minimum Required Seismic Restraint Brace Arm Assembly.
 9. Minimum Required Seismic Restraint Anchorage to Overhead Structure.
 10. Installation Detail Drawing References.

1.4 QUALITY ASSURANCE

A. Codes and Authorities

1. Underwriters Laboratories
2. Factory Mutual
3. National Fire Protection Association

B. References

1. Publications, codes and standards listed below form a part of this specification to the extent referenced.
 - a. Applications, Design and Inspection Manual – Engineered Seismic Bracing of Suspended Utilities, 2006 International Building Code Edition.
International Seismic Application Technology (ISAT)
Vol. 2 – HVAC Duct, Mechanical Piping, Plumbing, Process Piping and Equipment
 - b. International Building Code (IBC):
Chapter 16 – Structural Design.
Chapter 17 – Structural Tests and Special Inspections
 - c. ASCE 7-05, Chapter 13, Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineers (ASCE).
 - d. ACI 318, Building Code Requirements for Structural Concrete, American Concrete Institute (ACI).

1.5 COMPONENT IMPORTANCE FACTOR

- A. In order to identify systems requiring seismic restraint and to define those from which restraints may be excluded, utility components are assigned an ASCE 7 Importance Factor (I_p) on the basis of the following:

$I_p = 1.5$ Fire Protection component which is required to function after a seismic event including fire protection sprinkler systems

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Seismic restraint hardware and engineering by International Seismic Application Technology (ISAT) or approved equal.
- B. Vertical support and seismic restraint anchorages to utilize ISAT Blue Banger Hanger Cast-In Place Dec Inserts unless noted otherwise. Post installed anchors are an acceptable alternate provided the anchors are those pre-engineered within the ISAT Applications, Design and Inspection Manual.
- C. Vertical support and seismic restraint connections to structural steel are to utilize ISAT BC-4 Beam Clamp connections unless noted otherwise. Welded or bolted connections are an acceptable alternate provided the details employed are those pre-engineered within the *ISAT Applications, Design and Inspection Manual*.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Vertical support and seismic restraint anchorages to be per the ISAT Applications, Design and Inspection Manual.
- B. For conditions not covered within the ISAT Applications, Design and Inspection Manual, the required engineering is to be performed by ISAT.
- C. ISAT shall provide field installation training prior to commencement of install.
- D. Field relocation of any seismic installation points away from that shown on the ISAT furnished shop drawing layouts shall be coordinated with ISAT Technical Service.
- E. Consult ISAT Technical Service when field conditions prohibit compliance with the supplied installation details.
- F. In order to satisfy ASCE 7 minimum yield strength requirements, the allowable brace spacing for non-ductile systems (e.g. Plastic) shall be no more than half that for ductile systems).

3.2 EQUIPMENT CONNECTIONS

- A. Where seismic bracing is allowed to be omitted due to size or proximity to overhead deck, all terminations to fixed equipment, panels, etc. or to other portions of the system requiring seismic restraint are to utilize flexible connectors.
- B. Where seismic bracing is allowed by code to be omitted due to size or proximity to overhead deck, the inspector of record, or others, shall be responsible for assuring that damaging impact or vertical support failure cannot occur. Assessment as to conformance with this requirement is outside ISAT's scope of responsibility.

3.3 SPECIAL INSPECTION

A. Special Inspection Requirements

All Designated Seismic Systems are subject to Special Inspection per IBC Chapter 17. ISAT will provide a special inspection plan to the contractor for submittal to the owner and design team for use by the project's special inspectors. The plan will include the following:

- 1. A list of all components of the seismic system that require inspection of testing.
- 2. The required frequency of testing and inspection.
- 3. Type and nature of testing required.

B. Special inspection for mechanical and electrical components shall be provided as follows:

- 1. For all Designated Seismic Systems within seismic design categories D, E or F.
- 2. Periodic special inspections during the anchorage of electrical equipment for emergency or standby power systems in structures assigned to Seismic Design Categories E or F.
- 3. Periodic special inspection during the installation of anchorages of all other electrical equipment in Seismic Design Categories E or F.
- 4. Periodic special inspection during the installation for flammable, combustible or highly toxic piping systems and their associated mechanical units in Seismic Design Categories C, D, E or F.

5. Periodic special inspection during the installation of vibration isolation systems where the construction documents indicate a maximum clearance (air gap) between the equipment support frame and restraint less than or equal to $\frac{1}{4}$ inch.
- C. Install identification tags at all seismic brace locations. Tags to include the following information:
1. Specific seismic forces (g-force) the location was designed to resist.
 2. Maximum brace reaction at connection to structure.
 3. For single hung items, the maximum pipe/conduit size the brace location was designed to accommodate.
 4. For trapeze supported items, the maximum weight (lbs/lf) the brace location was designed to accommodate.
 5. For suspended equipment, the maximum unit operating weight (lbs) the brace location was designed to accommodate.
 6. Location identifier cross matched to that on plain set layout.
- D. Upon completion of construction a Quality Assurance Representative of ISAT shall review the installation of the seismic-force-resisting system and provide documentation indicating general conformance to seismic restraint layout drawing.

END OF SECTION

SECTION 210553

IDENTIFICATION OF FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide fire protection systems identification in accordance with the Contract Documents.
- B. Provide a temporary fire standpipe system during construction.

1.2 WORK INCLUDED

- A. Labeling
- B. Valve and Equipment Tagging

1.3 SUBMITTALS.

- A. Product Data: Manufacturers' catalogs, brochures.
- B. Schedule: Provide schedule of colors to be used on each system.

1.4 QUALITY ASSURANCE

- A. Local Building Code.
- B. Local Fire Department.
- C. National Fire Protection Association (NFPA)
- D. Underwriters Laboratories (U.L.)
- E. Factory Mutual (FM)

PART 2 - PRODUCTS

2.1 GENERAL

- A. The following specifications represent desired design, materials and construction standards for the various items of work. Manufacturer names and model numbers are used to describe specific types, styles and quality.

2.2 PIPE LABELING

- A. All piping shall be identified by stenciled lettering, or self-adhesive pipe markers which legend conforms to OSHA/ANSI standards including but not limited to the identification of flow direction, pressure, supply/return, pump discharge, sprinkler, fire standpipe, dry sprinkler, etc.

- B. There shall be at least one lettering identification for each pipe in each space and at all valve locations.
- C. For painted identification use color sharply contrasting with background. If necessary, paint a strip background of black or white to obtain contrast.
- D. Vertical piping shall be labeled at each floor. Horizontal piping shall be labeled every 10', both sides of partitions, before and after turns, and close to valves and flanges.
- E. Each set consisting of one (1) band on which the name of the service is printed in black letters not less than 1½ inches high, and one (1) band on which is printed a black directional arrow. Apply bands where they can be easily read and with their long dimension parallel to the axis of the pipe. Provide bands with backgrounds of different colors from the various service groups.
- F. Adhesive Bands: "Quick-Label B-350 Perma-Code Film Markers" (W.H. Brady Company).

2.3 VALVE & EQUIPMENT TAGGING

- A. Tag valves with identifying number and system. Number valves by floor level.
- B. For valves, etc., use metal (brass, stainless steel or aluminum) tags, 3" minimum in diameter, with 1½" white painted letters with a red background. Attach tags with chain of same material.
- C. Prepare lists of all tagged valves showing location, floor level, tag number and use. Prepare separate lists for each system. Mount lists under a sheet of clear acrylic in Equipment Room. Include copies in each maintenance manual.
- D. Provide charts showing equipment lubrication points, lubrication required and frequency, and columns for date and initials.
- E. Stencil equipment with identifying letters and numbers as used on drawings. Where space is available use full name of equipment.
- F. Identify all controls such as motor starters not in motor control centers, float switches and alarms.

2.4 PAINTING

- A. Exposed black steel piping, pipe covering, equipment and support piping and enclosures shall be given two coats of paint. All piping to be painted in accordance with section 903.6 Painting of dedicated sprinkler piping and valve handles.
- B. All pipe hangers, anchors and supports shall be given a zinc chromate primer before installation.

2.5 ACCEPTABLE MANUFACTURERS

- A. Pipe Labels
 - 1. W.H. Brady
- B. Valve Tags

END OF SECTION

SECTION 210580

ACCESS DOORS IN GENERAL CONSTRUCTION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Furnish access doors located in general construction in accordance with the Contract Documents for setting under general construction work.

1.2 WORK INCLUDED

- A. Access Doors in Drywall.
- B. Access Doors in Ceilings.
- C. Access Doors in Masonry.
- D. Fire Rated Access Doors.
- E. Color Coded Buttons.

1.3 SUBMITTALS

- A. Provide manufacturer's data on access doors to be furnished in each type of general construction, by location within the project.

PART 2 - PRODUCTS

- 2.1 Wherever access is required through walls or ceilings, to valves, gauges, alarm devices, or other concealed equipment installed under this division, furnish a hinged access door with flush screwdriver operated cam locks and frame as follows:

- A. Drywall construction--Milcor Style DW.
- B. Finished acoustical tile ceiling--Milcor Style AT.
- C. Finished plaster ceiling--Milcor Style AP.
- D. Finished plaster walls or ceramic tile--similar to doors required for finished acoustical tile ceiling.
- E. Plaster or masonry walls and ceilings outside offices and in other finished areas exposed to view--Milcor Style K or M.
- F. Provide access doors in rated construction with "B" label fire construction. Furnish a U.L. label on each access door.
- G. Access doors will be installed under another Division. Coordinate all sizes and locations with General Contractor.
- H. No access door shall be installed until location and type have been approved by the Architect.

- 2.2 Furnish color coded buttons or tabs to indicate location of valves or other equipment located above removable type ceilings where access doors are not required.
- 2.3 Make access door size a minimum of 18" x 18".

PART 3 - EXECUTION

3.1 GENERAL

- A. Coordinate sizes and location of all access doors with General Contractor.
- B. Direct location and setting of access doors in hung ceilings, furred spaces, walls, etc., to provide access to all concealed work items requiring maintenance and/or adjustment and as directed by the Architect/Engineer. Obtain acceptance of the Architect/Engineer for the locations and sizes of such access doors.
- C. Locate and group equipment requiring access doors so that access door locations are aesthetically acceptable. Coordinate location of equipment requiring access with other trades to minimize number of access doors in one area. Prepare drawings of valve locations indicating proposed access door locations for review by the Architect/Engineer prior to installation of valves, etc. Include equipment of other trades on the Drawing.

END OF SECTION

SECTION 210719

INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide pipe insulation in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Piping Insulation.

1.3 SUBMITTALS

- A. Shop Drawings: Submit insulation shop drawings for each service.
- B. Product Data: Manufacturer's latest published data for materials, equipment and installation.

1.4 QUALITY ASSURANCE

- A. ASTM C335
- B. ASTM C356
- C. ASTM C411
- D. ASTM C547
- E. ASTM E-84
- F. ASTM 225
- G. U.L.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Conform to application schedule specified herein for types and thicknesses of insulation.
- B. Provide insulation (including insulation jacket or facing and adhesives used to adhere the facing or jacket to the insulation) with non-combustible material meeting all Code requirements and fire and smoke hazard ratings as tested by procedure ASTM E-84, National Fire Protection Association 225, and UL 723, not exceeding flame spread 25 and smoke developed 50.

2.2 PIPE INSULATION

- A. Materials

1. Fiberglass Density: All Fiberglass pipe insulation in equipment rooms and/or where exposed, to be of the sectional type having 6 lbs./cu. ft. density. All other fiberglass insulation to be of the 1-piece type having 4 lb. density.
 2. Thermal conductivity of fiberglass to be .23 BTU/hr/inch/sq. ft./°F at a mean temperature of 75°F.
 3. Thermal conductivity of calcium silicate to be .32 BTU/hr/inch/sq. ft./°F at a mean temperature of 100°F.
- B. Insulation Jackets
1. Pipes Concealed and Exposed: Factory applied white fire retardant jacket with self-sealing lap (ASJ) and butt strip. Ends of pipe insulation sealed off at valves, fittings and flanges with I.C. 301 or FB 30-35.
 2. Vapor jacket permeability to be 0.02 perms.
 3. Jacket Puncture Resistance to be 50 units (Beach).
 4. Piping Exposed to Outdoors: Cover piping and fittings which are exposed to weather or called for to be weatherproofed, in addition to insulation and finishes specified for piping exposed to outdoors, with a polished aluminum jacket similar to Johns-Manville "Metal-Lok" or approved equal.
- C. Application Schedule
1. Piping Exposed to Outdoors and Pipes Subject to Freezing: Cover any piping subject to freezing with 3" of glass fiber insulation.
 2. For heat-traced piping, insulation must be sized to accommodate electric cable. Cover with an aluminum jacket, as specified for piping exposed to the weather.
- D. Fittings, Valves and Flanges
1. Where manufactured, use factory premolded fittings (of the same material and thickness as the pipe insulation) for all fittings, flanges and valves.
 2. Where premolded insulation fittings are not manufactured, insulate all fittings, flanges and valves with mitered segments of the same density as the adjoining pipe covering.
 3. Insulate fittings, flanges, valves, etc. for services where calcium silicate insulation is specified as a pipe insulation with mineral wool cement of equal thickness to the pipe insulation and finished with glass cloth.
 4. PVC molding pipe fitting covers as manufactured by Zeston are acceptable.

2.3 ACCEPTABLE MANUFACTURERS

- A. Insulation
1. Owens Corning Fiberglas
 2. Johns Manville
 3. Certain-Teed
 4. Pittsburgh Corning
- B. Adhesives and Sealers
1. Benjamin Foster (B-F)
 2. Insul-Coustic (I-C)
 3. Minnesota Mining and Mfg. Co. (3M)

PART 3 - EXECUTION

3.1 INSTALLATION OF INSULATION

- A. Perform all work in strict accordance with the manufacturer's recommendation and the best practice of the trade and the intent of this specification.
- B. Apply all insulation over clean dry surface, butting all sections or surfaces firmly together and finishing as hereinafter specified.
- C. Seal all vapor barriers continuous and throughout against moisture penetration.

3.2 PROTECTION OF INSULATION

- A. Protect pipe insulation at hangers, guides, and rollers by 16 gauge galvanized metal shields (at least 3 times the insulation diameter in length and 1/3 the insulation circumference in width) on the outside of the insulation and vapor barrier. Hold shields in place by straps. Do not pierce the insulation with hangers. Where glass fiber insulation is used on piping 3" and larger, provide half-section of calcium silicate covering of equal thickness at metal shields.
- B. Do not use staples on vapor barrier jackets.

END OF SECTION

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SECTION 210750
ELECTRIC HEAT TRACING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide electric heat tracing in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Electric Heat Tracing.

1.3 SUBMITTALS

- A. Shop Drawings: Equipment sizes, locations, performance data, installation details, wiring diagrams, and controls.
- B. Product Data: Manufacturer's latest published data for materials, equipment and installation.

1.4 QUALITY ASSURANCE

- A. Underwriters Laboratories.
- B. National Electric Code.

PART 2 - PRODUCTS

2.1 ELECTRIC HEAT TRACING CABLE

- A. The heat tracing shall consist of two (2) 16 AWG tinned-copper bus wires, embedded in parallel, in a self-regulating polymer core that varies its power output to respond to temperature along its length. Heater shall be able to be crossed over itself without overheating and to be cut to length in the field.
- B. The heat tracing shall be covered by a cross-linked modified polyolefin dielectric jacket.
- C. The heat tracing shall operate on voltage as shown on the drawings without the use of transformers.
- D. Power connection, end seals, splice and tee kits shall be as provided by the manufacturer to make up an Underwriters Laboratories listed system.
- E. Heat tracing shall be sized using manufacturer's standard procedure and shall maintain fluid within pipe at 40°F when outside temperature is 0°F.
- F. This Contractor shall furnish and install the heat tracing cable.
- G. The heat tracing cable shall be similar to XL-Trace as manufactured by Raychem Corporation.

2.2 CONTROLS

- A. Provide a line voltage thermostat for on-off control of heat tracing cable. The thermostat shall sense ambient temperature at the traced pipe and turn heat tracing on when outside temperature is below 35°F and turn the heat tracing off when outside temperature is above 35°F.

2.3 ACCEPTABLE MANUFACTURERS

- A. Raychem Corporation
- B. Nelson Electric

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the manufacturer's recommendations.
- B. Heater shall be secured to piping with cable ties or fiberglass tape.
- C. Install heater cable linearly along the pipe's lower quadrants after pipe has been successfully pressure tested.
- D. Wrap extra cable around fittings and valves as required to offset heat loss at these areas.
- E. Apply "electric traced" signs to the outside of insulation. Signs shall be located at all valves and on piping where they can be easily read.
- F. Powering of heat tracing is provided under Division 26.
- G. After installation and before and after installing thermal insulation, subject heating cable to testing using a 500 VDC megger. Minimum insulation resistance should be ten (10) mega-ohms regardless of length.

END OF SECTION

SECTION 210800

COMMISSIONING OF FIRE PROTECTION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General

1. Work under this contract shall conform under requirements of Division 1, General Requirements, Conditions of the Contract, and Supplementary Conditions. This specification covers commissioning of the Fire Protection systems for the entire facility.
2. Furnish labor and material to accomplish complete Fire Protection commissioning as specified herein.

B. Commissioning work shall be a team effort to ensure that all Fire Protection equipment and systems have been completely and properly installed, function together correctly to meet the design intent, and document system performance parameters for fine tuning of control sequences and operational procedures. Commissioning shall coordinate system documentation, equipment start-up, control system calibration, testing, and verification and performance testing.

C. The commissioning team shall be made up of representatives from the user, design professionals, major equipment suppliers, and construction trades. The trades represented on the commissioning team shall include, but not be limited to, piping and fitting, BMCS (Division 25), test and fire pump manufacturer, fire protection trade and electrical trade. The lead person for each trade who will actually perform or supervise the work is to be designated and the representative to the commissioning team. Responsibility for various steps of the commissioning process shall be divided among the members of the commissioning team, as described in this section.

D. The Commissioning Authority, retained by (Name of Project) shall have responsibility for coordinating and directing each step of the commissioning process.

E. Fire Protection system installation, start-up, testing, preparation of O&M manuals, and operator training are the responsibility of the Division 21 Fire Protection Contractors, with coordination, observation, verification and commissioning the responsibility of the Commissioning Authority. The commissioning process does not relieve Division 21 from the obligations to complete all portion of work in a satisfactory and fully operational manner.

F. Definitions

1. Commissioning: the process of ensuring that systems are designed, installed functionally tested and capable of being operated and maintained to perform in conformity with the design intent. For this project, the commissioning includes construction, start-up, acceptance, and training.
2. Commissioning authority: the designated person, company, or agent, retained by the Owner who implements the overall commissioning process.
3. Commissioning Plan: A document defining the commissioning process, which is developed by the commissioning authority.
4. Commissioning report: the document that records the results of the commissioning process, including the as-built performance of the Fire Protection system and documents all sign-offs.

5. Commissioning specification: the contract document that details the objective, scope, and implementation of the construction and acceptance phases of the commissioning process as developed in the Commissioning Plan.
6. Commissioning team: those people responsible for working together in carrying out the commissioning process.
7. Functional performance testing (FPT): the process of determining the ability of the Fire Protection system to deliver services in accordance with the final design intent.
8. User: the authorized Representative of the Owner.
9. Construction Documents: design plans and specifications. Also referred to as Contract Documents.
10. Design Professional: the Architectural, Engineering and Other Consultants who prepared the Construction Documents.
11. TA – Testing and Adjusting work.
12. Verification: that full range of checks and tests carried out to determine if all components , subsystems, systems, and interfaces between systems operate in accordance with the contract documents. In this context, “operate” includes all modes and sequences of control operation, interlocks and conditional control responses, and specified responses to abnormal or emergency conditions.

G. Purpose

The commissioning is a process and its purpose is:

1. to clearly document the design intent
2. to verify that the systems installation and performance is in accordance with the plans, specifications and design intent.
3. to train the user's operators so that they fully understand the design intent and the operation and maintenance requirements of the equipment.

1.2 SCOPE OF WORK

A. Commissioning work of Division 21 (Fire Protection) shall include, but not be limited to:

1. Testing and start-up of the equipment.
2. Testing and adjusting piping and central systems.
3. Cooperation with the Commissioning Authority.
4. Providing qualified personnel for participation in commissioning tests, including seasonal testing required after the initial testing.
5. Providing equipment, materials, and labor as necessary to correct construction and/or equipment deficiencies found during the commissioning process.
6. Providing operation and maintenance manuals, and as-built drawings to the Commissioning Authority for verification.
7. Providing training and demonstrations for the systems specified in this Division.

B. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems, and sub-systems. The following equipment and systems shall be evaluated:

1. Fire standpipe systems.
2. Fire pumps
3. Pump controllers
4. Starters furnished by Division 21 (Fire Protection)
5. Coordination with the BMCS (Division 25)
6. Storage tanks.

- C. Timely and accurate documentation is essential for the commissioning process to be effective. Documentation required as part of the commissioning process shall include but not be limited to:
 - 1. Progress and status reports, including deficiencies noted.
 - 2. Minutes from all meetings.
 - 3. Pre-start, and start-up procedures.
 - 4. Training agenda and materials.
 - 5. As-built records.
 - 6. Commissioning report.
 - 7. Operational and maintenance (O&M) manuals.
- D. Detailed testing shall be performed on all installed equipment and systems to ensure that operation and performance conform to contract documents. All tests shall be witnessed by the Commissioning Authority. The following testing is required as part of the commissioning process:
 - 1. Verification tests are comprised of a full range of checks and tests to determine that all components, equipment, systems, and interfaces between systems operate in accordance with contract documents. This includes all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions.
 - 2. Functional performance tests (FPT) shall determine if the Fire Protection system is providing the required services in accordance with the finalized design intent.
- E. Comprehensive training of O&M personnel shall be performed by the Fire Protection Contractor, and where appropriate by other sub-contractors, and vendors prior to turnover of building to the User. The training shall include classroom instruction, along with hands-on instruction on the installed equipment and systems. All training sessions shall be videotaped or recorded on alternative audiovisual media.

1.3 QUALITY ASSURANCE

- A. Commissioning Authority shall meet the following qualifications:
 - 1. Have a minimum of five (5) years of demonstrated commissioning authority experience in the commissioning of HVAC Systems similar in size and complexity to this Project.
 - 2. Commissioning Authority shall hold a Certified Commissioning Professional (CCP) designation from the Building Commissioning Association.
- B. The following reference is a guideline to the commissioning process and shall be applied as appropriate.
- C. Reference:
 - 1. ASHRAE Guideline 1-1996: The Fire Protection Commissioning Process
 - 2. ASHRAE Application Handbook – 1995: Chapter 39 – Building Commissioning.
 - 3. ASHRAE Guideline 4-1993: Preparation of Operating and Maintenance Documentation for Building Systems.

1.4 ROLES AND RESPONSIBILITIES

- A. User:
 - 1. User will advise Commissioning Authority regarding changes in building occupancy and/or usage.
 - 2. Assign maintenance personnel and schedule them to participate in meetings, training session as follows:

- a. Construction Phase coordination meeting.
 - b. Initial User training session at initial placement of major equipment.
 - c. Maintenance orientation and inspection
 - d. Pipe test and flushing verification meetings.
 - e. Procedures meeting for Testing and Adjusting.
 - f. Users training session.
 - g. Verification demonstrations.
 - h. Final review at acceptance meeting.
3. Provide qualified personnel for videotaping and editing of training sessions.
 4. Video tape construction process, hidden shafts, etc.
 5. Provide any utilities required for the commissioning process.
 6. Provide detailed program clearly stating the User's objectives, parameters, budgets, etc. for this facility.

B. Commissioning Authority

1. Develop the commissioning requirements and all related testing, verification and quality control sections.
2. Prepare the commissioning program required as part of the Commissioning Specification. Include lists of all contractors for commissioning events by name, firm, and trade specialty.
3. Develop detailed pretest and final test reports forms, to be used by the Commissioning Authority for data recording purposes throughout the testing process. The Commissioning Authority shall specifically develop these forms for each system and piece of equipment installed on the project. All forms to be submitted for approval a minimum of one hundred and twenty (120) days prior to initial testing.
4. Execute the commissioning program, through organization of all tests, meetings, demonstrations, training events and performance verifications described in the Contract Documents and the approved commissioning program. Organizational Responsibilities include preparation of agendas, attendance lists; arrangements for facilities, and timely notification to participants for each commissioning event. The Commissioning Authority shall act as chairman at all commissioning events and assure the execution of all agenda items. The Commissioning Authority shall prepare minutes of every commissioning event and send copies to all those in attendance and the User within 5 workdays of the event.
5. Review the Lease Construction Documents which define the scope of the commissioning process and the final performance of the system. This include verification that appropriate commissioning guidelines have been followed, and to document the performance of each piece of equipment and each system.
6. Review all approved submittals for coordination with the commissioning process and the performance testing of the Courts Systems.
7. Schedule regular Construction Phase coordination meetings to include User, Landlord and Contractor. This meeting shall be for the purpose of reviewing the complete commissioning program and establishing tentative schedules for Fire Protection system orientation and inspections, O&M submittals, training sessions, system flushing and testing, job completion, test and adjust (TA) work and verification and functional performance testing.
8. Schedule User training sessions so that they will be held at an appropriate timeframe relative to the turnover of the Systems to the User. These sessions shall be attended by the User's O&M personnel, the Contractor, and the Commissioning Authority.
9. The Commissioning Authority shall be solely responsible for conducting and recording the results of periodic inspections, undertaken by the Commissioning Authority, of work in progress to ensure that all systems are installed according to specifications. The Commissioning Authority shall note any deficiencies discovered in writing. Once the deficiencies have been corrected, as reported by the Contractor, the Commissioning Authority shall re-inspect the work and report that the correction have been made

10. The Commissioning Authority shall assist the contractor in recommending solutions to minor deficiencies.
11. Receive and review the Operation and Maintenance (O&M) manuals as submitted by the contractor, and reviewed and approved by the Design Professional.
12. Witness equipment and system start-up and testing. Ensure the results are documented (including a summary of deficiencies), and incorporated in the O&M manuals. The Commissioning Authority shall record all test results on pre-test forms for each piece of equipment.
13. Prior to initiating the TAB work, the Commissioning Authority shall meet with the User, Contractor, and TAB Contractor. The TAB Contractor shall outline TAB procedures and get concurrence from the Design Professional and Commissioning Authority. Ensure that the TAB Contractor has all forms required for the job database and understands their importance and use.
14. Schedule the O&M training sessions. All training sessions shall be on-site, except where otherwise specified. These training sessions are to be attended by the User, Commissioning Authority, Contractors and equipment suppliers as required by Construction Documents. The format shall follow the outline in manuals. This mechanical system orientation and inspection should include hands on training. The Commissioning Authority shall be solely responsible for recording all demonstration and training sessions on videotape, or alternative approved media, and furnish two (2) copies of the recording media to the User. Each session shall clearly reflect the content of each training session. Video Tapes or other approved media and enclosures shall be neatly labeled.
15. Provide detailed FPT procedures for review and acceptance by the Design Professional.
16. Upon receipt of notification from the Contractor that the systems have been completed and are operational, the Commissioning Authority shall proceed to verify the TAB report and operation of the control systems in accordance with the Commissioning Specification.
17. Conduct Verification tests.
18. Record verification test data.
19. Provide detailed checklists data sheets to document verification tests.
20. Provide and install calibrated test instrumentation to monitor and record data as necessary.
21. The Commissioning Authority shall document the results of all Functional Performance Testing.
22. Observe and record Functional Performance Tests.
23. Submit functional performance test report.
24. Participate in re-testing, if necessary, if performance deficiencies are found, corrected and additional testing is requested.
25. Review as-built drawings for accuracy with respect to installed systems. Review revisions to achieve accuracy.
26. Ensure that the O&M manuals and all other as-built records have been updated to include all modifications made during the construction phase.
27. Observe and record repeated Functional Performance Tests to accommodate seasonal tests and correct any performance deficiencies. Revise and re-submit the commissioning report.
28. Prepare the final commissioning report
29. Assemble the final project documentation, which shall include the commissioning report and all as-built records. Submit this documentation to the User for review and acceptance.
30. The CA shall verify that all O and M manuals; "as-built" documentation and training manuals and training sessions are complete in every aspect and in accordance with the project specifications. The CA shall supplement the above documentation, as required, to make them complete.

C. Architect

1. Provide support to the Design Professional who must provide a service as a part of the commissioning process. This shall include providing adequate space for equipment installation and maintenance.
2. Conduct periodic inspections of work in progress to ensure that all systems and equipment are installed according to specifications.
3. Provide data on structure, building materials, interior finishes, and furnishings for their effect on Fire Protection systems.

D. Fire Protection Design Professional

1. Provide Construction Documents.
2. The Design Professional retains responsibility for the system evaluation, adequacy of the system to meet design intent, capacity of the system, quality control check or any of the other elements of the system design.
3. Participate in inspection at the final construction stage.
4. Review verification and functional performance testing procedures submitted by the Commissioning Authority, for conformance with Construction Documents.
5. Review TA report and verification data sheets for system conformance to contract documents. Issue a report noting deficiencies requiring correction to the Commissioning Authority.
6. Review functional performance testing report for deficiencies in meeting the finalized design intent.
7. Review as-built records as required by contract documents and turn them over to the Commissioning Authority for inclusion in final project documentation.
8. Review and comment on the final commissioning report.

E. Electrical Design Professional

1. Provide documentation or design narratives for electrical services to be provided for specific Fire Protection equipment requirements.
2. Provide electrical system information confirming compatibility with electrical service requirements specified by the mechanical design professional for all Fire Protection equipment and systems. Provide information necessary for the basis of design.
3. Prepare contract documents that coordinate interfaces between life safety systems, BMCS, and Fire Protection systems including commissioning specifications.
4. Attend construction-phase coordination meeting scheduled by the commissioning authority.
5. Participate in the start-up of Fire Protection equipment and systems.
6. Participate in the Fire Protection training sessions as required.
7. Participate in review of shop drawings for Fire Protection equipment.
8. Prepare electrical ladder wiring diagrams indicating power source connections to Fire Protection equipment and systems and interrelationships between life safety systems and Fire Protection systems and equipment, including a review of the automatic control and/or building automation system.
9. Prepare as-built electrical service record drawings as required by contract documents.
10. Verify that any space requirements for electrical equipment are in accordance with relevant code requirements.
11. Participate in O&M personnel orientation and inspection sessions.

F. General Contractor

1. Include cost for commissioning requirements in the contract price
2. General contractor shall coordinate construction progress with the commissioning schedule to assure that the building envelope and systems that affect proper operation and control of Fire Protection equipment and systems being tested are completed prior to testing.

3. Include commissioning requirements in the Fire Protection, electrical, and Division 25 (BMCS) contracts, as well as all other sub-contractors, to ensure cooperation of all parties in the Fire Protection commissioning program.
4. Ensure acceptable representation, with the means and authority to prepare and coordinate execution of the Fire Protection commissioning program as described in the contract documents.
5. Issue a statement that TA work has been completed, and submit the final TA reports for review.
6. Issue a statement that fire suppression system controls have been tested and adjusted.
7. Remedy deficiencies identified in verification tests.
8. Evaluate any performance deficiencies identified in the FPT report for non-performance with contract documents.
9. The equipment supplier shall document the performance of his equipment. Performance testing shall be witnessed by the commissioning authority.

G. Fire Protection Contractor

1. Include cost of commissioning requirements in the contract price.
2. Include requirements for submittal data, O&M data, and training in each purchase order or sub-contract written.
3. Ensure cooperation and participation of specialty sub-contractors such as testing and adjusting (TA).
4. Ensure participation of major equipment manufacturers in appropriate training and testing activities.
5. Attend Construction Phase coordination meeting scheduled by the Commissioning Authority.
6. Assist the Commissioning Authority in all verification and functional performance tests.
7. Prepare preliminary schedule for Fire Protection system orientations and inspections, O&M manual submissions, training sessions, pipe system testing, flushing and cleaning, equipment startup, TA and task completion for use by the Commissioning Authority. Update schedule as appropriate throughout the construction period.
8. Attend initial training session.
9. Conduct Fire Protection system orientation and inspection at the equipment placement completion stage.
10. Update drawings to the record condition to date, and review with the Commissioning Authority.
11. Gather O&M data on all equipment, and assemble in binders as required by the Commissioning Specification. Submit to Commissioning Authority prior to the completion of construction.
12. Coordinate with the Commissioning Authority to provide sufficient advance notice so that the witnessing equipment and system start-up and testing can begin.
13. Notify the Commissioning Authority a minimum of two weeks in advance of the time for start of the TA work. Attend the initial meeting for review of the official TA procedures.
14. Participate in, and schedule vendors and Contractors to participate in the training sessions as set up by the Commissioning Authority.
15. Provide written notification to the General Contractor and Commissioning Authority that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.
 - a. Fire Protection equipment including all pumps, alarm devices, and all other equipment furnished under this Division.
 - b. Fire standpipe system and equipment, sprinkler systems and equipment.
 - c. Fire stopping in the fire rated construction, including caulking, gasketing and sealing of smoke barriers.
 - d. Fire detection and smoke detection devices furnished under the fire suppression system as they affect the operation of the smoke control systems.

16. The equipment supplier shall document the performance of his equipment. Performance testing shall be witnessed by the commissioning authority.
17. Provide a complete set of as-built records to the Commissioning Authority.

H. Test and Adjust Contractor

1. Include cost for commissioning requirements in the contract price.
2. Attend initial commissioning coordination meeting scheduled by the Commissioning Authority.
3. Submit the TA procedures to the Commissioning Authority and Design Professional for review and acceptance.
4. Attend the TA review meeting scheduled by the Commissioning Authority. Be prepared to discuss the procedures that shall be followed in testing and adjusting the Fire Protection system.
5. At the completion of the TA work, and the submittal of the final report, notify the Fire Protection Contractor and the General Contractor.
6. Participate in training sessions as scheduled by the Commissioning Authority.
7. At the completion of TA work, and the submittal of the final TA report, notify the Fire Protection Contractor and the General Contractor.
8. Participate in verification of the TA report, which will consist of repeating any selected measurement contained in the where required by the Commissioning Authority for verification or diagnostic purposes.
9. The equipment supplier shall document the performance of his equipment. Performance testing shall be witnessed by the commissioning authority.

I. Equipment Suppliers and Miscellaneous Contractors.

1. Include cost for commissioning requirements in the contract price.
2. Provide submittals, and appropriate O&M manual section(s).
3. Attend initial commissioning coordination meeting scheduled by the Commissioning Authority.
4. Participate in training sessions as scheduled by the Commissioning Authority.
5. Demonstrate performance of equipment as applicable.

J. Electrical Contractor

1. Include costs for commissioning requirements in the contract price.
2. Ensure participation in testing of fire pumps equipment.
3. Ensure coordination, installation, and operation interfaces between life safety and Fire Protection systems.

1.5 DOCUMENTATION

- A. The Commissioning Authority shall oversee and maintain the development of commissioning documentation. The commissioning documentation shall be kept in three ring binders, and organized by system and sub-system when practical. All pages shall be numbered, and a table of contents page(s) shall be provided. The commissioning documentation shall include, but not be limited to, the following:
1. Approved test and balance report for the systems being commissioned.
 2. All accepted shop drawings and hydraulic calculations of Fire Protection equipment. Shop drawings shall be full size sheets folded as required to fit in binders.
 3. All pre-functional performance test checklists, signed by indicating personnel, organized by system and sub-system.
 4. All verification and functional performance test checklists/results, signed by indicated personnel, organized by system and sub-system.

5. Three copies of the operation and maintenance (O&M) manuals specified in other sections of these specifications shall be included with the commissioning documentation. The manuals shall be incorporated in the commissioning documentation prior to commencement of O&M training required in this and other sections of the specification. Preparation of O&M manuals shall be as specified in section 3.07 of these specifications.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. The appropriate Contractor(s) shall furnish all special tools and equipment required during the commissioning process. A list of all tools and equipment to be used during commissioning shall be submitted to the Commissioning Authority for approval. The user shall furnish necessary utilities for the commissioning process.

2.2 TEST EQUIPMENT – PROPRIETARY

- A. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the user upon completion of the commissioning process.

PART 3 - EXECUTION

3.1 GENERAL

- A. A pre-construction meeting of all commissioning team members shall be held at a time and place designated by the user. The purpose shall be to familiarize all parties with the commissioning process, and to ensure that the responsibilities of each party are clearly understood.
- B. The Contractor shall complete all phases of work so the systems can be started, tested, balanced, and acceptance procedures undertaken. This includes the complete installation of all equipment, materials, pipe, wire, insulation, controls, etc. per the contract documents and related directives, clarifications, and change orders.
- C. A Commissioning Plan shall be developed by the Commissioning Authority. The Contractor shall assist the Commissioning Authority in preparing the Commissioning Plan by providing all necessary information pertaining to the actual equipment and installation. If contractor initiated system changes have been made that alter the commissioning process, the commissioning authority shall notify the user.
- D. Acceptance procedures are normally intended to begin prior to completion of a system and/or sub-systems, and shall be coordinated with the Division 21 Fire Protection contractor. Start of acceptance procedures before system completion does not relieve the contractor from completing those systems as per the schedule.
- E. The commissioning authority shall develop a detailed schedule for acceptance procedures and training. The commissioning authority shall work in a cooperative manner with the Contractor to assure that the commissioning process does not interfere with the completion of work in accordance with the overall schedule.

3.2 PARTICIPATION IN ACCEPTANCE PROCEDURES

- A. The Contractor shall provide skilled technicians to start-up and debug all systems within Fire Protection Division 21. These same technicians shall be made available to assist the Commissioning Authority in completing the commissioning program. Work schedules, time required for testing, etc. shall be requested by the Commissioning Authority and coordinated by the contractor. Contractor shall ensure that the qualified technician(s) are available and present during the agreed upon schedules and of sufficient duration to complete the necessary tests, adjustments, and/or problem resolutions.
- B. System performance problems and discrepancies may require additional technician time, Commissioning Authority time, reconstruction of systems, and/or replacement of system components. The additional technician time shall be made available for subsequent commissioning periods until the required system performance is obtained.
- C. Qualifications of technicians shall include expert knowledge relative to the specific equipment involved and a willingness to work with the Commissioning Authority. Contractor shall provide adequate documentation and tools to start-up and test the equipment, system, and/or sub-system.

3.3 DEFICIENCY RESOLUTION

- A. In some systems, improper adjustments, misapplied equipment, and/or deficient performance under varying loads will result in additional work being required to commission the systems. This work shall be completed under the direction of the User, with input from the contractor, equipment supplier, and Commissioning Authority. Whereas all members shall have input and the opportunity to discuss, debate, and work out problems, the Design Professional shall have final jurisdiction over any additional work done to achieve performance.
- B. Corrective work shall be completed in a timely fashion to permit the completion of the commissioning process. Experimentation to demonstrate system performance may be permitted. If the Commissioning Authority deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the Commissioning Authority shall notify the User, indicating the nature of the problem, expected steps to be taken, and suggested deadline(s) for completion of activities. If the deadline(s) pass without resolution of the problem, the User reserves the right to obtain supplementary services and/or equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner shall be the contractor's responsibility.

3.4 ADDITIONAL COMMISSIONING

- A. Additional commissioning activities may be required after system adjustments, replacements, etc., are completed. The contractor(s) suppliers, and Commissioning Authority shall include a reasonable reserve to complete this work as part of their contractual obligations.

3.5 ACCEPTANCE PROCEDURES

- A. Verification Tests
 - 1. Scope of verification tests
 - a. Operating tests and checks to verify that all components, equipment, systems, sub-systems, and interfaces between systems, operate in accordance with contract documents. These tests are to include all operating modes, interlocks, specified control responses, specific responses to abnormal or emergency conditions and

- verifications of the proper response of the building automation system controllers and sensors.
 - b. Verify the validity of the TA report.
2. Participants in verification tests
- a. The Commissioning Authority shall be responsible for preparing the scope of these tests. The Commissioning Authority shall schedule the tests and assemble the commissioning team members who shall be responsible for the tests. Participating contractors, manufacturers, suppliers, etc. shall include all costs to do the work involved in these tests in their proposals. Following is a list of tasks and supporting information that shall be required.
 - b. Fire Protection contractor – provide the services of a technician(s) who is (are) familiar with the construction and operation of this system. Provide access to the contract plans, shop drawings, and equipment cut sheets of all installed equipment.
 - c. Electrical contractor – provide a foreman electrician familiar with the electrical interlocks, interfaces with emergency power supply, and interfaces with alarm and life-safety systems. Provide access to the contract plans, and all as-built schematics of sub-systems, interfaces, and interlocks.
3. Documentation and Reporting Requirements.
- a. Provide checklists for each component, piece of equipment, system, and sub-system, including all interfaces, interlocks, etc. Each item to be tested shall have a different entry line with space provided for comments. Separate checklists shall be prepared for each mode of operation. Provide space to indicate whether the mode under test responded as required or not. Also, provide space for all necessary parties to sign off on each checklist.
 - b. Data sheets used in verification of the proper operation of the control system shall include each controller to be verified, and its location. For each controller, provide space for recording the readout of the controller, the reading at the controller's sensor(s), and any comments. Also, provide space for all necessary parties to sign off on each checklist.
 - c. All test procedures and data sheets shall be submitted to the design professional for review and acceptance.
4. Instrumentation
- a. The Commissioning Authority shall furnish all measurement instrumentation for the verification tests. All instruments will have calibrated within the six-month period prior to these tests.
5. Verification Procedures
- a. The Commissioning Authority shall direct and witness the verification operating tests and checks for all equipment and systems.
 - 1) Set the system equipment (i.e. pumps, controllers) into the operating mode to be tested, i.e. normal shut down, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions.
 - 2) The Commissioning Authority shall inspect and verify the position of each device and interlock identified on the checklist. Each item shall be signed off as acceptable (yes), or failed (no).
 - 3) This test shall be repeated for each operating cycle that applies to the Fire Protection system being tested.
 - 4) Operating checks shall include all safety cutouts, alarms and interlocks with life safety systems during all modes of operation of the Fire Protection system.
 - 5) If during a test an operating deficiency is observed, appropriate comments shall be added to the checklist data sheet.

- 6) Verification of the interface of the monitoring and control system, and the criteria shall be included.
- 7) Verification of the proper responses of monitoring and control system controllers and sensors shall be included.
- b. The Commissioning Authority shall direct and witness the field verification of the final report.
 - 1) The Commissioning Authority shall select, at random, 10 percent of the report data for verifications.
 - 2) The contractor shall be given sufficient advance notice of the date of field verification. However, they shall not be informed in advance of the data points to be verified. The contractor must use the same instruments (by model and serial number) that were used when the original data were collected.
 - 3) Failure of an item is defined as:
 - a) For all readings, a deviation of more than 10 percent.
- c. If the deficiencies are identified during verification, the General Contractor must be notified, and action taken to remedy the deficiency. The final tabulated checklist data sheets shall be reviewed by the Design Professional and the Commissioning Authority, to determine if verification is complete, and the operating system is functioning in accordance with the contract documents.

B. Functional Performance Testing

1. Scope of Functional Performance Testing
 - a. Functional performance tests shall determine if the Fire Protection system is providing the required flows and pressure in accordance with the final design intent. Following is a list of test examples:
 - 1) Determine capacity of electric heating system to deliver heating at the design temperature.
 - 2) Determine the ability of the Fire pumps to deliver the required volume and pressure to the distribution system.
2. Submittals
 - a. Detailed procedures for each series of tests shall be submitted to the Commissioning Authority for review and acceptance. The procedures shall include samples of the data sheets that will be part of the reports.
3. Participants in Functional Performance Tests
 - a. Participants in the functional performance tests shall be the same as those listed in the verification tests.
4. Instrumentation
 - a. In addition to the instrumentation requirements detailed under verification, the Commissioning Authority may need to provide data acquisition equipment to record data for the complete range of testing.
5. Functional Performance Test Procedures
 - a. The Commissioning Authority shall supervise and direct all functional performance tests.
 - b. For each test, the Commissioning Authority shall install the measuring instruments and logging devices to record test data for the required test period. The instrumentation shall monitor and record all operating conditions to allow for complete evaluation of the test results.

- c. Measurement will be required to allow for calculation of total capacity of the system for each mode of operation under test.
- 6. Documentation and Reporting Requirements
 - a. All measured data, data sheets, and a comprehensive summary, describing the operation of the Fire Protection system at the time of testing shall be submitted to the Commissioning Authority.
 - b. A preliminary functional performance test report shall be prepared by the Commissioning Authority and submitted to the Design Professional or review. Any identified deficiencies need to be evaluated by the Design Professional and Construction Manager to determine if they are part of the contractor's contractual obligations. Construction deficiencies shall be corrected by the responsible contractor(s) and the specific functional performance test repeated.
 - c. If it is determined that the Fire Protection system is constructed in accordance with the contract documents, and the performance deficiencies are not part of the contract documents, the User must decide whether any required modifications needed to bring the performance of the Fire Protection system up to the finalized design intent shall be implemented, or if the test shall be accepted as submitted. If corrective work is performed, the User shall determine if a portion or all required functional performance tests should be repeated, and a revised report submitted.

3.6 OPERATING AND MAINTENANCE MANUAL:

- A. The operating and maintenance manual shall consist of a sturdy binder with 8-1/2" x 11" sheets in accordance with the Contract Documents.

3.7 OPERATING AND MAINTENANCE TRAINING

- A. The Fire Protection Contractor, and appropriate sub-contractors, shall provide comprehensive operating and maintenance instruction on building systems in accordance with the Contract Documents prior to delivery. The instruction shall include classroom instruction deliver by competent instructors based upon the contents of the operating manual.
- B. Each classroom training period shall be followed by an inspection, explanation and demonstration of the system concerned by the instructors. All specified equipment shall be started up and shut down, with the exception of sprinkler system.
- C. The contractor shall be responsible for organizing, arranging, and delivering manner on a schedule agreeable to the User.
- D. The contractor shall provide, at or before substantial completion, a proposed agenda and schedule of the above training for approval by the Commissioning Authority and the User.
- E. Each classroom training session and demonstration shall be recorded on videotape or alternative acceptable media and submitted to the User.

END OF SECTION

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SECTION 211119

FIRE DEPARTMENT CONNECTIONS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide fire protection connections in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Escutcheons.
- B. Siamese Connections.

1.3 SUBMITTALS

- A. Product Data: Manufacturers' catalogs, brochures.

1.4 QUALITY ASSURANCE

- A. Local Building Code.
- B. Local Fire Department.
- C. National Fire Protection Association (NFPA)
- D. Underwriters Laboratories (U.L.)
- E. Factory Mutual (FM)

PART 2 - PRODUCTS

2.1 GENERAL

- A. The following specifications represent desired design, materials and construction standards for the various items of work. Manufacturer names and model numbers are used to describe specific types, styles and quality.
- B. All hose threads shall conform with local Fire Department requirements.

2.2 SIAMESE CONNECTIONS

- A. Siamese shall be cast brass body with drop clappers with a polished chrome plated brass plate lettered "AUTO. SPKR.", "STANDPIPE", "DRY STANDPIPE" "AUTO. SPKR. STANDPIPE".
- B. Siamese shall be flush type with back outlet, bottom outlet or top outlet as required. Inlet and outlet sizes shall be as shown or as required and shall be Potter-Roemer Series 5020.
- C. Siamese connection shall be rated for the maximum pump pressure to which it could be exposed.

2.3 ACCEPTABLE MANUFACTURERS

A. Siamese Connections

1. Potter-Roemer
2. Elkhart Brass
3. Croker

B. Automatic Ball Drip

1. Potter-Roemer
2. Elkhart-Brass

C. Croker

END OF SECTION

SECTION 211200
STANDPIPE AND HOSE SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide a complete wet and/or dry standpipe and temporary fire standpipe system in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. All piping, equipment, hangers, etc., as specified herein, as shown on drawings and as required by local authorities.
- B. Angle Hose Valves
- C. Pressure Reducing Valves
- D. Fire Hose and Nozzles
- E. Accessories for Valves and Hoses
- F. Cabinets
- G. Roof Manifold

1.3 SUBMITTALS

- A. Product Data: Manufacturers' catalogs, brochures and equipment.
- B. Shop Drawings: Detail construction drawings indicating materials, performance data, and piping layouts, and fire standpipe equipment layouts, etc.

1.4 QUALITY ASSURANCE

- A. NFPA
- B. National Electric Code
- C. Local Authority
- D. Local Building Code
- E. Local Building Code.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All threads are to conform to local Fire Department requirements.
- B. Figure numbers listed are those of Potter-Roemer.

2.2 2½ ADJUSTABLE-VALVE HOSE CONNECTIONS

- A. Manufacturers
 - 1. Standard: UL 668 hose valve, with integral UL 1468 restricting pressure-control device, for connecting fire hose.
 - 2. Pressure Rating: 300 psig minimum.
 - 3. Material: Brass or bronze.
 - 4. Inlet: Female pipe threads.
 - 5. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads matching local fire-department threads.
 - 6. Pattern: Angle.
 - 7. Pressure-Control Device Type: Pressure restricting.
 - 8. Design Outlet Pressure Setting: <Insert psig (kPa)>.
 - 9. Finish: Rough brass or bronze.
 - 10. Similar to Potter Roemer 4085.

2.3 2½ PRESSURE REDUCING HOSE CONNECTIONS

- A. Manufacturers Standard: UL 668 hose valve with integral UL 1468 pressure control device for connecting fire hose.
- B. Pressure Rating: 400 psig (2070 kPa) minimum.
- C. Material: Bronze or brass.
- D. Inlet: Female pipe threads.
- E. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads matching local fire-department threads.
- F. Pattern: Angle.
- G. Finish: [Polished chrome-plated] [Rough brass or bronze] [Rough chrome-plated].
- H. Field adjustable.
- I. Similar to Potter Roemer 4023

2.4 1½" HOSE RACK

- A. In addition to the hose valve, provide a Fig. 2794 red enamel steel hose rack, 2½" Fig. 2756 brass hose rack nipple, 2½" x 1½" Fig. 2810 brass reducer, 1½" Fig. 2934 brass pin lug coupling, 1½" Fig. 2915 lined poly flex hose (1125'), 1½" Fig. 2947 brass nozzle and 2½" Fig. 2751 escutcheon.

2.5 CABINETS

- A. Fire Hose Cabinets: Series 1100, 18 gauge steel box; wall mounting and size as required.
- B. Angle Hose Valve Cabinets: Series 1800, 18 gauge steel box; wall mounting and size as required.

2.6 ROOF MANIFOLD

- A. Roof manifold shall be Potter-Roemer Fig. No. 58 Series-Select one [two-way, three-way], cast brass angle inlet body.
- B. Roof manifold shall be rated for the maximum pressure it could be exposed.

2.7 ACCEPTABLE MANUFACTURERS

- A. Valves and Accessories
 - 1. Potter-Roemer
 - 2. Elkhart Brass
 - 3. Croker
 - 4. Larsens
- B. Fire Hose
 - 1. Potter-Roemer
 - 2. Elkhart Brass
 - 3. Larsens
 - 4. Croker
- C. Cabinets
 - 1. Potter-Roemer
 - 2. Elkhart Brass
 - 3. Croker
 - 4. Larsens

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Pipe and Fittings
 - 1. Threads shall be full and clean cut. All threaded pipe shall be reamed or filed to original bore of pipe and all burrs shall be removed. Care shall be taken that the pipe does not extend into the fitting obstructing the waterway. Teflon tape shall be applied to the threads of the pipe and not to the fittings.
 - 2. A one-piece reducing fitting shall be used wherever a change is made in the size. The use of bushings or reducing flanges will not be permitted.
 - 3. Unions shall be provided at connections to each piece of equipment for easy dismantling.
 - 4. All control valves, pressure reducing valves, check valves, water flow switches, pressure switches, etc., shall be easily accessible for maintenance and removal.
 - 5. Only shoulder nipples shall be used. Close nipples will not be acceptable.

3.2 TESTS

- A. During the progress of the work, test the fire standpipe systems piping. Such tests shall be made in the presence of the Owner's representative, and all other authorities having jurisdiction.
- B. The piping shall be tested in accordance with local requirements and NFPA Code requirements, but in no case shall the system be tested at less than 200 psig hydrostatic pressure for two (2) hours.
- C. Defects disclosed by the tests shall be repaired or replaced with new work. Tests shall be repeated as directed, until all work is proven satisfactory.
- D. Take due precautions to prevent damage to the building and its contents as a result of such tests. Repair any damage caused.
- E. During construction, properly cap all lines and equipment nozzles so as to prevent the entrance of sand, dirt, etc. Each system of piping shall be flushed to remove grit, dirt, sand, etc., from the piping for as long a time as is required to thoroughly clean the system.

3.3 TEMPORARY FIRE STANDPIPE

- A. Concurrent with the erection of the superstructure, install the permanent fire standpipe system at stair locations.
- B. Provide a temporary siamese connection and identify with a red light.
- C. Interconnect the riser bases and provide for plugging or capping when work is not being done on the system.
- D. Temporary fire standpipe shall remain as the permanent system providing that it complies with this specification.

END OF SECTION

SECTION 211313
WET PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide a complete wet pipe sprinkler system in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Sprinkler Heads.
- B. Water Flow Switch.
- C. Tamper Switch.
- D. Floor Control Valve
- E. Pressure Reducing Valve.
- F. Pressure Relief Valve.
- G. Piping
- H. Inspectors Test Connection

1.3 SUBMITTALS

- A. Shop Drawings
 - 1. Dimensioned sprinkler layouts.
 - 2. Identification chart and tags for valves and alarm devices.
 - 3. Hydraulic calculations.
- B. Permits and Approvals
 - 1. Arrange and pay for all permits, approvals and tests.

1.4 QUALITY ASSURANCE

- A. Factory Mutual
- B. NFPA 13
- C. National Electric Code
- D. Local Fire Department
- E. Local Building Code

PART 2 - PRODUCTS

2.1 SPRINKLER HEADS

- A. Spray type, with 1/2" nominal discharge orifice. Ordinary temperature rating 160° - 175° throughout except where special conditions exist which will require higher temperature sprinklers or when indicated on the drawings. All heads shall be U.L. listed and Factory Mutual approved.

2.2 QUICK RESPONSE STANDARD COVERAGE SPRINKLERS

- A. Pendant, upright, horizontal sidewall, and semi-recessed: Sprinklers shall be of all brass frame construction with a coated metal to metal seating mechanism. Sprinklers utilizing non-metal parts in the sealing portion of the sprinkler are strictly prohibited. Sprinklers shall have a quick response frangible bulb type fusible element. Sprinklers to be installed in areas with no ceilings shall be of a brass finish and shall be of adequate temperature for the hazard semi-recessed heads shall have chrome plated recessed escutcheon.
- B. Concealed: Sprinklers shall be of all brass frame construction with a coated metal to metal seating mechanism. Sprinklers utilizing non-metal parts in the sealing portion of the sprinkler are strictly prohibited. Quick response concealed pendent sprinkler orifice shall be standard nominal 1/2" with a K factor of 5.5. Quick response concealed pendent sprinklers shall be listed for installation in an ordinary hazard occupancy if installed in an ordinary hazard occupancy. Concealed pendent sprinkler shall have a cover that is a push-on, thread-off assembly. Quick response concealed pendent sprinklers shall be Viking Horizon Mirage Quick Response Model B-2.

2.3 QUICK RESPONSE EXTENDED COVERAGE SPRINKLERS

- A. Pendant: Sprinklers shall be of all brass frame construction with a coated metal to metal seating mechanism. Extended coverage pendent sprinklers shall have a quick response frangible bulb type fusible element. Extended coverage quick response pendent sprinkler shall be installed in conformance with the manufacturer's listing and installation guidelines. Extended coverage quick response pendent sprinklers shall be UL listed for light hazard occupancies. Extended coverage quick response pendent sprinklers shall have nominal orifices of 1/2" and 17/32" with K factors of 5.5 and 8.0, respectively. Extended coverage quick responses sprinklers shall be Viking Microfast Model M Quick Response Extended Coverage.
- B. Concealed: Sprinklers shall be of all brass frame construction with a coated metal to metal seating mechanism. Sprinklers utilizing non-metal parts in the sealing portion of the sprinkler are strictly prohibited. Quick response extended coverage concealed pendent sprinkler orifice shall be standard nominal 1/2" with a K factor of 5.5. Quick response extended coverage concealed pendent sprinklers shall be listed for extended coverage application. Concealed pendent sprinkler shall have a cover that is a push-on, thread-off assembly. Sprinklers shall be Viking Horizon Mirage Quick Response Extended Coverage Model B-1.
- C. Sidewall: Sprinklers shall be of all brass frame construction with a coated metal to metal seating mechanism. Sprinklers utilizing non-metal parts in the sealing portion of the sprinkler are strictly prohibited. Sidewall sprinklers shall have a quick response frangible bulb type fusible element. Quick response horizontal sidewall sprinkler shall be installed in conformance with the manufacturer's installation guidelines. Sidewall sprinklers shall be Viking Microfast Model M/M-5 Quick Response Extended Coverage Horizontal Sidewall.

2.4 STANDARD RESPONSE, STANDARD COVERAGE

- A. Upright, pendant, semi-recessed and concealed: Sprinklers shall be of all brass frame construction utilizing a coated metal to metal seating mechanism. Sprinklers utilizing non-metal parts in the sealing portion of the sprinkler are strictly prohibited. Sprinkler orifices shall be standard nominal $\frac{1}{2}$ " and $\frac{17}{32}$ " with K factors of 5.5 and 8.0, respectively. Sprinklers shall have a frangible bulb type fusible element. Sprinklers to be installed in areas with no ceilings shall be of a brass finish and shall be of adequate temperature for the hazard. Sprinklers to be installed through a ceiling shall be a finished pendent sprinkler with an adjustable semi-recessed escutcheon of same specified finish. Sprinklers shall be UL listed and Factory Mutual approved. Sprinklers shall be Viking Micromatic Model M.
- B. Sidewall: Sprinklers shall be of brass frame construction with a coated metal to metal seating mechanism. Sprinklers utilizing non-metal parts in the sealing portion of the sprinkler are strictly prohibited. Horizontal sidewall sprinkler orifice shall be standard nominal $\frac{1}{2}$ " with a K factor of 5.5. Sprinklers shall have a frangible bulb type fusible element. Sprinklers to be installed in areas with no ceilings shall be of a brass finish and shall be of adequate temperature for the hazard. Sprinklers to be installed through a ceiling or wall shall be of a finished sidewall sprinkler with an adjustable semi-recessed escutcheon of the same specified finish. Horizontal sidewall sprinklers shall be listed for installation in an ordinary hazard occupancy if installed in an ordinary hazard occupancy. Sprinklers shall be Viking Micromatic Model M Sidewall.
- C. Concealed: Sprinklers shall be of all brass frame construction with a coated metal to metal seating mechanism. Sprinklers utilizing non-metal parts in the sealing portion of the sprinkler are strictly prohibited. Concealed pendent sprinkler shall have cover plate that is a push-on, thread-off assembly with a $2\frac{3}{4}$ " diameter. Concealed pendent sprinkler orifice shall be standard nominal $\frac{1}{2}$ " with a K factor of 5.5. Concealed pendent sprinklers shall be listed for installation in an ordinary hazard occupancy if installed in an ordinary hazard occupancy. Concealed Pendent Sprinklers shall be Viking Horizon Mirage Model B-2.

2.5 WATER FLOW SWITCH

- A. Paddle type, inserted into horizontal piping systems. The paddle shall actuate a pneumatic time-delay mechanism between the paddle stem and the micro-switch. After the preset time delay, the micro-switch shall operate and either open or close the electrical circuit. Time delays shall be adjustable from 0 to 70 seconds. Switch shall be similar to Reliable Model A1.

2.6 TAMPER SWITCH

- A. Valve supervisory switches shall be on each valve as designated on the drawings. Switches shall be mounted so not to interfere with the normal operation of the valve and shall be adjusted to operate within two revolutions of the valve control or when the stem has moved no more than one-fifth of the distance from its normal position. The switch mechanism shall be contained in a weatherproof die-cast aluminum housing which shall provide $\frac{3}{4}$ " tapped conduit entrance and incorporate the necessary facilities for attachment to the valve. Switch housings shall be finished in red baked enamel. The switch mechanism shall have a minimum rated capacity of 7 amp, 125 volt, 0.25 amp., 24 volt D.C. The entire assembly shall be tamper proof and arranged to cause a switch operation if the housing cover is removed or if the unit is removed from its mounting. Tamper switch shall be similar to Potter-Roemer 6220 or 6221.

2.7 PRESSURE REDUCING VALVE

- A. Valve shall maintain a constant downstream pressure regardless of varying inlet pressure. Valve shall be a hydraulically-operated, diaphragm-actuated, globe or angle pattern valve. It

shall contain a resilient, synthetic rubber disc, having a rectangular cross-section, contained on three and one-half sides by a disc retainer and forming a tight seal against a single removable seat.

- B. The diaphragm assembly containing a valve stem shall be fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat. This diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure. The diaphragm shall consist of nylon fabric bonded with synthetic rubber and shall not be used as a seating surface.
- C. Packing glands and/or stuffing boxes are not permitted and there shall be no pistons operating the valve or pilot controls. All necessary repairs shall be possible without removing the valve from the line.
- D. The pilot control shall be direct-acting, adjustable, spring-loaded, normally open, diaphragm valve, designed to permit flow when controlled pressure is less than the spring setting. The control system shall include a fixed orifice.
- E. This valve shall be U.L. listed and shall be similar to a Model 90-21 Pressure Reducing Valve as manufactured by Cla-Val Co.

2.8 PRESSURE RELIEF VALVE

- A. Furnish and install where indicated on drawings or downstream of all pressure reducing valves a 3/4" cast brass pressure relief valve similar to Potter-Roemer 4059.

2.9 INSPECTOR'S TEST CONNECTIONS (OPEN DRAIN)

- A. Bronze female pipe connection with orifice equivalent to one sprinkler head flow similar to Reliable Model A.

2.10 ACCEPTABLE MANUFACTURERS

A. Sprinkler Heads

- 1. Reliable
- 2. Central
- 3. Viking
- 4. Grinnell

B. Water Flow Switches

- 1. Potter-Roemer
- 2. Potter Electric
- 3. Reliable
- 4. Viking
- 5. Central

C. Tamper Switch

- 1. Potter-Roemer
- 2. Potter Electric
- 3. Reliable

D. Sprinkler Floor Control Valve Cabinet

- 1. Potter-Roemer

2. Elkhart Brass
 3. Croker
- E. Pressure Reducing Valve
1. Star Sprinkler
 2. Potter-Roemer
 3. Cla-Val
 4. Gunzenhauser
- F. Pressure Relief Valve
1. Potter-Roemer
 2. Elkhart Brass
 3. Reliable

PART 3 - EXECUTION

3.1 GENERAL

- A. Information included in this specification and of various agency requirements are given as a guide only. The contract documents do not relieve Contractor's responsibility to provide all work and equipment necessary to complete the installation in accordance with all requirements.

3.2 INSTALLATION

- A. No pipes or other apparatus shall be installed so as to interfere in any way with the full swing of the doors. The arrangement, positions and connections of pipes, drains, valves, etc., shown on the drawings, shall be taken as a close approximation and while they shall be followed as closely as possible, the right is reserved by the architect to change the locations to accommodate any conditions which may arise during the progress of the work without additional compensation to this contractor for such changes, provided that the changes are requested prior to the installation of this work.
- B. All piping shall drain back to the risers or be provided with drain valves. Special precautions must be taken to avoid electrical work and ventilation ducts, and no piping shall pass below lighting fixtures in luminous ceilings or under skylights.
- C. All piping shall be unexposed except in no-ceiling areas. Where required, heads shall be located below ducts. Diffusers and lighting fixtures take preference in room layout.
- D. In areas with restricted head room, heads and piping shall be tight to ceilings and provided with guards.
- E. No heads shall be nearer than 6 inches to a ceiling support, and where 12" x 12", 24" x 24" or 24" x 48" ceiling panels are used, the heads shall be located in the center of the panel.
- F. Install sprinkler heads in all areas on a true axis line in both directions with a maximum deviation from the axis line of $\frac{1}{2}$ " plus or minus. In acoustical tile ceilings, sprinkler heads shall be located on center of tile. At the completion of the installation, remove and reinstall any heads found to exceed the above mentioned tolerances.
- G. Where sprinklers are installed in areas without hung ceiling, install sprinklers both above and below all ductwork 48" and larger in width or where the total aggregate of multiple ducts exceeds 48" in width or length.

3.3 SPRINKLER COVERAGE

- A. For determination of sprinkler systems, spacing and sizing, the following coverage ratings as listed in NFPA 13 and as listed by the insurance company for this project shall be followed. Also comply with local authorities' requirements.
- B. Provide sprinklers where shown on the drawings.
- C. Hydraulically Calculated System: The system shall be hydraulically designed to provide a density based on NFPA requirements and the requirements of the insurance company and the local authorities.

AREA	HAZARD CLASSIFICATION	DENSITY GPM/SQ. FT.	AREA OF APPLICATION
General Public Areas.	Light	.10	1500
Parking	Ordinary	.16	1500
Mechanical Retail Shops	Ordinary	.16	1500
Offices	Light	.10	1500

- D. Escalator: A curtain of sprinkler heads on 6 feet 0 inch centers shall be provided to encircle the escalator opening at the draft curtain to conform to NFPA 13, 4-4.8.2.3 and A4-4.8.2.3.
- E. Hydraulically Calculated System: Provide automatic sprinkler system throughout the entire project. The system shall be hydraulically designed to provide a density based on Factory Mutual requirements, according to the following schedule.

AREA	HAZARD CLASSIFICATION	DENSITY GPM/SQ. FT.	AREA OF APPLICATION
General Public Areas & Offices	Light	.10	3000
(Wet System) Parking Garages & Retail	Ordinary	.15	2500
(Dry System) Parking Garages & Retail	Ordinary	.15	3500
(Wet System) Power Houses (Switchgear Room, MER)	* Ordinary	.20	4500
(Dry System) Power Houses (Switchgear Room, MER)	* Ordinary	.20	5000
* Using 160°F fusible link.			

3.4 DRAINS AND TEST PIPES

- A. Provide drains at base of riser, valved sections inside building, and at other locations indicated or requiring same for complete drainage of systems. Siamese drains shall be automatic ball drips. Other drains shall be valves and/or plugs as indicated and/or required. Pipe drains to locations as required.
- B. Test pipes shall be valved and piped to discharge through proper orifice at approved locations.

END OF SECTION

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SECTION 211316
DRY PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide a complete dry pipe sprinkler system in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Sprinkler Heads.
- B. Pressure Switches.
- C. Tamper Switch.
- D. Dry Pipe Valve and Accelerator.
- E. Air Compressor.
- F. Air Maintenance Device.
- G. Piping, Fittings and Valves

1.3 SUBMITTALS

- A. Shop Drawings
 - 1. Dimensioned sprinkler layouts.
 - 2. Identification chart and tags for valves and alarm devices.
 - 3. Hydraulic calculations.
- B. Permits and Approvals
 - 1. Arrange and pay for all permits, approvals and tests.

1.4 QUALITY ASSURANCE

- A. FM Global
- B. NFPA 13
- C. National Electric Code.
- D. Local Authority.
- E. International Building Code.
- F. Local Building Code.

PART 2 - PRODUCTS

2.1 SPRINKLER HEADS

- A. Shall be scheduled on drawing.
- B. Spray type, with ½ nominal discharge orifice. Ordinary temperature rating 160° - 175° throughout except where special conditions exist which will require higher temperature sprinklers or when indicated on the drawings. All heads shall be U.L. listed and Factory Mutual approved.
- C. Types
 - 1. Dry pendent and dry horizontal sidewall with 1½" escutcheon adjustment.
 - 2. Dry pendent recessed sprinkler with ½" escutcheon adjustment.
 - 3. Dry pendent concealed sprinkler with ½" cover plate adjustment.
- D. All sprinkler heads shall be quick response.
- E. Samples shall be submitted for review and acceptance.
- F. Furnish and install approved sprinkler head wire guards for all sprinkler heads located 7'-6" or lower above finished floor level.
- G. In addition to the heads actually required, furnish a stock of extra sprinklers of amounts as recommended by NFPA Standards including a minimum of six heads of each type and temperature rating used and two suitable socket wrenches, contained in neat steel boxes, suitable for use as a service kit on the job. The steel boxes shall be installed in the fire pump room or fire command center.

2.2 PRESSURE SWITCH

- A. Furnish and install at each dry pipe valve a system sensor EPJ or Reliable J54-8295 pressure switch to indicate water flow.

2.3 TAMPER SWITCH

- A. Valve supervisory switches shall be on each valve as designated on the drawings. Switches shall be mounted so not to interfere with the normal operation of the valve and shall be adjusted to operate within two revolutions of the valve control or when the stem has moved no more than one-fifth of the distance from its normal position. The switch mechanism shall be contained in a weatherproof die-cast aluminum housing which shall provide ¾" tapped conduit entrance and incorporate the necessary facilities for attachment to the valve. Switch housings shall be finished in red baked enamel. The switch mechanism shall have a minimum rated capacity of 7 amp, 125 volt, 0.25 amp., 24 volt D.C. The entire install assembly shall be tamper proof and arranged to cause a switch operation if the housing cover is removed or if the unit is removed from its mounting. Tamper switch shall be similar to System Sensor model 05Y2 or PIBV2 or Potter Roemer 6220 or 6221.

2.4 DRY PIPE VALVE

- A. Furnish and install where indicated on drawings a Victaulic series 756 VIC quick riser with S753-A dry activator dry pipe valve complete with all trimmings, and a shutoff valve with tamper switch. Valve shall be externally resettable and internal parts shall be replaceable without removing the valve from the installed position,

2.5 AIR COMPRESSORS

- A. Furnish and install at each dry pipe valve a GAST, oil-less, direct drive air compressor. Air compressor shall be sized to fill the system in 30 minutes. The compressor shall be 480 volt 3 phase.

2.6 AIR MAINTENANCE DEVICE

- A. Furnish and install at each dry pipe valve a Victaulic series 757 automatic air maintenance drive. Air maintenance device shall be complete with all accessories and wiring to the air compressor.

2.7 ACCEPTABLE MANUFACTURERS

- A. Sprinkler Heads
 - 1. Victaulic
 - 2. Reliable
 - 3. Central
 - 4. Viking
 - 5. Grinnell
- B. Pressure Switches
 - 1. System Sensor
 - 2. Potter Roemer
 - 3. Potter Electric
 - 4. Reliable
 - 5. Viking
 - 6. Central
- C. Tamper Switch
 - 1. System Sensor
 - 2. Potter Roemer
 - 3. Potter Electric
 - 4. Reliable
- D. Dry Pipe Valve & Accelerator
 - 1. Victaulic
 - 2. Central
 - 3. Viking
 - 4. Reliable
- E. Air Compressor
 - 1. GAST
 - 2. Reliable
 - 3. Central
 - 4. Viking
- F. Air Maintenance Device
 - 1. Victaulic
 - 2. Reliable
 - 3. Central
 - 4. Viking

PART 3 - EXECUTION

3.1 GENERAL

- A. Information included in this specification and of various agency requirements are given as a guide only. The contract documents do not relieve Contractor's responsibility to provide all work and equipment necessary to complete the installation in accordance with all requirements.

3.2 INSTALLATION

- A. No pipes or other apparatus shall be installed so as to interfere in any way with the full swing of the doors. The arrangement, positions and connections of pipes, drains, valves, etc., shown on the drawings, shall be taken as a close approximation and while they shall be followed as closely as possible, the right is reserved by the architect to change the locations to accommodate any conditions which may arise during the progress of the work without additional compensation to this contractor for such changes, provided that the changes are requested prior to the installation of this work.
- B. All piping shall drain back to the risers or be provided with drain valves. Special precautions must be taken to avoid electrical work and ventilation ducts, and no piping shall pass below lighting fixtures in luminous ceilings or under skylights.
- C. All piping shall be unexposed except in no-ceiling areas. Where required, heads shall be located below ducts. Diffusers and lighting fixtures take preference in room layout.
- D. In areas with restricted head room, heads and piping shall be tight to ceilings and provided with guards.
- E. No heads shall be nearer than 6 inches to a ceiling support, and where 12" x 12", 24" x 24" or 24" x 48" ceiling panels are used, the heads shall be located in the center of the panel.
- F. Install sprinkler heads in all areas on a true axis line in both directions with a maximum deviation from the axis line of $\frac{1}{2}$ " plus or minus. In acoustical tile ceilings, sprinkler heads shall be located on center of tile. At the completion of the installation, remove and reinstall any heads

3.3 SPRINKLER COVERAGE

- A. For determination of sprinkler system, spacing and sizing, the coverage ratings as listed in shall be followed. Also comply with the local authorities' requirements.
- B. Provide sprinklers where shown on the drawings
- C. This contractor shall layout all sprinkler heads and piping.

- D. Hydraulically Calculated System: Automatic sprinklers throughout the entire area shall be installed as hydraulically calculated systems to provide a density based on FM Global requirements, according to the following schedule:

AREA	HAZARD CLASSIFICATION	DENSITY GPM/SQ. FT.	AREA OF APPLICATION FOR HYDRAULIC APPLICATION	TEMPERATURE RATING
General Room	Ordinary	.15	1960	212°F

END OF SECTION

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SECTION 211318
PRE-ACTION SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide a pre-action sprinkler system in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Piping, Fitting and Valves.
- B. Sprinkler Heads.
- C. Hangers, Brackets and Supports.
- D. Signs, Valve Tags and Charts.
- E. Smoke Detectors/Heat Detectors.
- F. Control Panel.
- G. Automatic Air Compressor.

1.3 SUBMITTALS

- A. Shop Drawings: Submit catalog cuts of valves, sprinkler heads, pipe and fittings, signs, valve tags and charts.
- B. Lay out drawings of complete fire protection systems, indicating relationship of all other items, including ceiling tiles, light fixtures, speakers and air diffusers. Location of risers and piping, etc. shall be as inconspicuous as possible, provide a pleasing overhead appearance and all functional requirements.
- C. Submit equipment data and pipe sizing hydraulic calculations bearing seal of a Registered Professional Engineer licensed in the State of New York.

1.4 QUALITY ASSURANCE

- A. Type and size of materials and equipment to be as approved by the local Fire Department and as required by governing agencies.
- B. Install system in accordance with local Building Code, with latest amendments, NFPA and requirements of authorities having jurisdiction and FM Global.
- C. All equipment shall be FM Global approved and Underwriters Laboratory labeled.
- D. Obtain and pay for all necessary permits, licenses, and approvals.
- E. Minimum Design Requirements

1. Piping in areas having ceilings shall be concealed. Piping in service areas may be exposed but kept at a minimum distance from ceiling. All piping shall be clean and free of rust.
 2. Sprinkler heads in areas with finished ceilings shall be flush plate pendent type. Heads in areas of exposed piping may be exposed pendent or upright types.
 3. Designs requiring cutting of structural members for passage of fire protection piping or hangers shall be avoided. When design, due to economy, appearance, etc. denotes the necessity of cutting, it shall be held to an absolute minimum and done only with Owner's written approval.
 4. Prepare all hydraulic design calculations, layout all sprinkler heads, and size all sprinkler piping, submit same to the authorities for approval prior to installation. See drawings for minimum design requirements.
- F. Approvals, except those required for field installations, field applications, and field tests, shall be obtained before delivery of materials or equipment to the project site.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide a double interlocked electric release pre-action system. The method of release of the deluge valve priming water pressure shall be by an electric solenoid valve. The electric solenoid valve will open upon activation of the electrical supplemental detection system. The pre-action system shall be of a listed and approved assembly. The system shall be equipped with a rubber seated check valve downstream of the deluge valve and prior to the supervisory air connection. The pre-action system shall be provided with all necessary appurtenances to complete the system.

2.2 SYSTEM DEVICES

- A. Pre-action system components shall be installed in a 72" X 36" X 16" 14 gauge steel cabinet as built per NEMA-12. Cabinet shall house a factory assembled and tested pre-action system piping assembly. Pre-action system piping shall be equipped with a water supply manifold, system drain manifold, grooved and system discharge outlet, grooved by grooved system control valve and all trim listed as part of the deluge valve assembly. Pre-action system supervisor air pressure and water flow pressure switches shall be supplied as part of the assembly. Pre-action system release control panel shall be equipped with a cabinet. The cabinet manufacturer shall terminate electrical connections to the solenoid valve and system pressure switches from the release control panel. The cabinet shall be painted fire red with oven baked polyester powder in phosphate base. The cabinet finish shall be rustproof. The cabinet shall be equipped with a door that has gauge viewing ports for supply water pressure, deluge valve priming water pressure and supervisory air pressure as well as a window to monitor panel activity. The cabinet door shall be equipped with separate access doors for the system emergency release and system release control panel. All devices shall be substantially secured to the panel. Cabinet door shall be equipped with a neoprene gasket to eliminated vibration. The Integrated Pre-action System shall be pre-assembled, pre-wired, and tested.
- B. The system shall utilize a 90° pattern deluge valve. The deluge valve shall employ a positive vent on the priming line to ensure that the deluge valve will not prematurely reset. Inlet and outlet connections of the deluge valve shall be flanged by flanged or flanged by grooved, respectively. The deluge valve shall be UL listed and FM Global approved. The deluge valve shall have a working pressure of 175 PSI. Valve trim shall be compatible and installed in accordance with the manufacturer's recommendation.

- C. The release system shall incorporate as part of the operation of the system, a compatible electric heat detection system. The detection devices installed shall be compatible electric heat detection devices. The detection devices installed shall be compatible with the Deluge Valve Release Control Panel.
- D. The system release panel shall be capable of a single hazard one-zone release. The release panel shall be equipped with a local tone alarm to annunciate loss of A/C power, system trouble, circuit trouble and low auxiliary D/C power supply. The release panel shall be capable of supervising trouble and alarm audible alarms. Audible trouble alarms shall be able to be silenced at the release panel. The release panel shall be housed in a vented enclosure with ambient temperature compatibility of 32°F to 120°F. Panel enclosure shall be of adequate size to house auxiliary D/C power supply. Auxiliary D/C power supply shall consist of (2) 12 volt lead acid batteries of the same ampere hour rating. Actual ampere hour rating to be established by auxiliary D/C power requirement.
- E. The Deluge valve priming water release device shall be an electrically operated solenoid valve. The solenoid valve shall be constructed of a ½" brass body with a stainless steel core tube, core, plugnut and springs. The solenoid valve shall be UL listed for its intended use.
- F. Air Maintenance Device.
- G. Pre-assembled air maintenance device with bypass.
- H. The System Check Valve shall be UL listed and FM Global approved for use on fire protection systems. The sprinkler check valve shall be manufactured with supply side and system side gauge connections and a main drain outlet in conformance with N.F.P.A. 13. The check valve shall be constructed of a ductile iron body with a brass seat and a rubber faced clapper assembly hinged to a removable access cover for periodic inspection. The check valve shall have a working water pressure of 250 PSI.
- I. Supervisory air pressure shall be maintained on the pre-action system piping. Low air pressure alarm shall activate by way of a pressure supervisory alarm pressure switch. The low air pressure alarm switch shall be compatible with system devices. Low air pressure alarm switch enclosure shall be UL listed and FM Global approved for the application in which it is used. The low air pressure alarm switch shall have the ability to be wired for Class A or Class B service. The low air pressure alarm switch shall be Viking Corporation, part number 09472 or 09473.
- J. Water flow will activate an alarm by way of an alarm pressure switch. The alarm pressure switch shall be compatible with system devices. Alarm pressure enclosure shall be UL listed and FM Global approved. The alarm pressure switch shall have the ability to be wired for Class A or Class B service.

2.3 DUAL TONE HORN/STROBE COMBINATION.

- A. Notifier MA.SS Multi-Alert Dual Tone. Horn/Strobe combination. U.L. listed, FM Global approved. M.E.A. #427-91-E (MA).

2.4 WIRING

- A. Furnish and install in accordance with the manufacturer's instructions all wiring, conduit and outlet boxes required for the erection of a complete system. All wiring shall be in conduit and shall be in conformity with the requirements of the National Electric Code. Wiring shall meet all state and local codes and all authorities having jurisdiction.

- B. The sizes of the different conductors shall be those specified by the manufacturer. Color code shall be used where specified. All wires shall be tagged at all junction points and shall test free from grounds or crosses between conductors. Final connections between equipment and the wiring system shall be made under direct supervision of a representative of the manufacturer.
- C. Controls shall be mounted with sufficient clearance for observing and testing. All system junction boxes must be clearly marked for easy identification.
- D. All wiring shall be in conduit, or EMT thin-wall. Flexible connector shall be used for all devices mounted in suspended lay-ceiling panels. All conduit, mounting boxes, junction boxes and panels shall be securely hung and fastened with appropriate fittings to insure positive grounding throughout the entire system.
- E. No wiring other than that directly associated with fire alarm, detection alarm, suppression or auxiliary functions shall be permitted in fire alarm conduits. Wiring splices are to be avoided to the extent possible, and, if needed, they must be made only in junction boxes and shall be crimp connected. Transposing or changing color coding of wires shall not be permitted. Wire nut-type connections are not acceptable. All conductors in conduit containing more than one wire shall be labeled at each end with "PA" markers or equivalent. Conductor in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its terminal. Cabinet terminals shall be numbered and coded. All controls, function switches, etc., shall be clearly labeled on all equipment panels.
- F. All wiring shall be checked and tested to insure that there are no grounds, opens or shorts. The minimum allowable resistance between any two conductors or between conductors and ground is ten (10) megaohms as checked by a megger after all conduit, conductors, etc., have been installed.
- G. The complete electrical installation of the system and all components shall be grounded in accordance with the requirements of the National Electrical Code.
- H. All wiring shall be in accordance with FM Global requirements.

2.5 SIGNS

- A. Provide signs made of aluminum enamel, red background with white marking at each valve, pull station, alarm indicating device, etc.

PART 3 - EXECUTION

3.1 SEQUENCE OF OPERATION (SINGLE ZONE)

- A. Activation of a single detector shall:
 - 1. Illuminate the integral alarm lamp of the detector.
 - 2. Sound pre-action strobe/horn combinations.
 - 3. Activate corresponding LED on graphic annunciator.
 - 4. Illuminate the alarm lamp on the pre-action panel.
 - 5. Activate dry contacts to alarm building fire alarm system.
 - 6. Activate dry contacts to alarm remote alarms.
 - 7. Activate dry contacts to shut down equipment.
 - 8. Release pre-action valve.
 - 9. Operation of a manual pull station, smoke detector, flow switch, tamper switch, low air pressure switch, and trouble shall indicate individually at the control panel.

10. Activate dry contacts to remote alarm to indicate waterflow.
- B. Activation of a Manual Pull Station
1. Perform all action of A except 1 and 3.
- C. Activation of a Trouble Alarm
1. Illuminate the trouble LED on the pre-action panel.
 2. Sound the pre-action strobe/bell combinations.
 3. Activate dry contacts to indicate trouble to building fire alarm system.
- D. Activation of a Tamper Switch or Low Air Pressure
1. Illuminate the proper LED on the pre-action panel.
 2. Sound the pre-action chime/strobe combination.
 3. Activate dry contacts to indicate trouble to building fire alarm system.
- 3.2 SEQUENCE OF OPERATION (ELEVATOR SHUTDOWN)

- A. Activation of a single detector shall:
1. Illuminate the integral alarm lamp of the detector.
 2. Sound pre-action strobe/horn combinations.
 3. Activate corresponding LED on graphic annunciator.
 4. Illuminate the alarm lamp on the pre-action panel.
 5. Activate elevator recall.
 6. Activate dry contacts to alarm building fire alarm system.
 7. Activate dry contacts to alarm remote alarm to indicate first detector.
- B. Activation of a second detector shall:
1. Continue all action of A except 4.
 2. Sound pre-action horn/strobe combination.
 3. Illuminate the integral alarm lamp of the detector.
 4. Illuminate the corresponding lamp on the pre-action control panel.
 5. Illuminate the corresponding lamp on the graphic annunciator.
 6. Activate dry contacts to alarm building fire alarm system.
 7. Release pre-action valve.
 8. Shut down power to elevator.
 9. Activate dry contacts to remote alarm to indicator waterflow.
- C. Activation of a Trouble Alarm
1. Illuminate the trouble LED on the pre-action panel.
 2. Sound the pre-action strobe/bell combinations.
 3. Activate dry contacts to indicate trouble to building fire alarm system.

3.3 TROUBLE ALARMS

- A. The following condition shall constitute a trouble alarm condition:
1. Tamper switch.
 2. Low air pressure.
 3. Electrical malfunction.
 4. Detector circuit open.
 5. Audible circuit open.

3.4 REMOTE ALARM

- A. Provide remote alarm annunciation in the following areas:

3.5 SUPERVISION

A. Alarm and Detector Systems

1. All systems including detectors, manual release stations, releases, low air pressure and valves shall be electrically supervised against open or short circuits. An open or ground in the system shall actuate a trouble light, and cause a trouble signal to sound continuously on the control panel, activate a trouble bell, and the control cabinet until the system is restored to normal or until the signal is silenced by means of a cutoff switch on the control cabinet. When the system is restored to normal operation, the trouble signal shall sound again, and shall be silenced only by restoring the cutoff switch to its normal position thereby also extinguishing the pilot lights and audible signals.

B. Pre-Action Piping

1. All pre-action sprinkler piping shall be supervised by an automatically maintained source of low pressure air. The check valve, mounted immediately above the pre-action valve retains the supervisory air pressure sprinklers or piping damaged causing a loss of air pressure will result in a trouble alarm without operation of the pre-action valve.

3.6 INSTALLATION

- A. There shall be no change in the number of sprinkler heads or smoke detectors without prior written authorization of the Owner.
- B. Coordinate work to avoid conflict between the location of the sprinkler heads, smoke detectors, and electric fixtures, ceiling supports, piping or ducts. Notify Owner before installing sprinkler work that may interfere with other work.
- C. Provide drain valves and plugs for sections which cannot be drained at the riser, and install valves and plugs at low points. Drains shall be provided for proper system drainage throughout and shall be discharged into funnel or floor drains.
- D. All supply lines shall be thoroughly flushed to remove all scale and sediment before connection is made to the fire protection piping as required by NFPA and the authority having jurisdiction.
- E. Install fire protection systems as indicated on the drawings and also as required by Code, authority having jurisdiction and Insurance Underwriter to provide approved and operable systems.
- F. Provide drain piping, flushing connections, drain plugs, valved drains, etc., at drain points and low points of the system.
- G. Flushing connections on cross mains, headers, and risers and auxiliary drains shall conform to NFPA Pamphlet No. 13. Include pressure gauges and inspector's plugged test connections.

3.7 TESTS

- A. Piping

1. When the installation of the pre-action system has been completed, it shall be tested, independent of the rest of the building.
 2. The sprinkler system shall be hydrostatically tested under pressure of 200 psi for two hours.
 3. The tests shall be conducted in the presence of building officials and Architect/Engineers. Minimum of five (5) days written notice shall be provided prior to system testing.
 4. Disconnect devices, equipment and piping which are not designed for the test pressure and install blind flanges to close openings.
 5. Replace work found defective if so directed. After replacement, test work again as specified. Repeat until satisfactory.
 6. Keep complete and accurate record of all test data. Submit in triplicate, typewritten report of all test data on a floor-by-floor basis.
- B. Detection and Alarm System Test
1. Each detector shall be alarmed using required testing medium. The system and equipment interlocks, such as releases, audible and visual alarms and equipment shutdowns, shall function at the same time.
 2. Measure and adjust each of the detectors to the maximum stable sensitivity setting. This shall be performed at the operational location of the unit and under normal operational environmental conditions in the area.

3.8 OPERATING INSTRUCTIONS

- A. Upon acceptance of the systems, a complete briefing of personnel shall be conducted for each personnel shift. The briefing will include a complete demonstration of the systems.
- B. Three complete sets of as-built drawings and operating manuals shall be given to the Owner.

END OF SECTION

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SECTION 211339

WET PIPE AFFF SPRINKLER SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The sprinkler system shall be a closed-head wet pipe AFFF foam water sprinkler system designed to provide adequately proportioned foam water solution at listed water flows past proportioning device. System shall be installed in accordance with NFPA 16, Standard for the Installation of Closed Head Foam-Water Sprinkler Systems, NFPA 11, Standard for Low Expansion Foam, NFPA 13, Standard for Installation of Sprinkler Systems and all other applicable codes or requirements.

PART 2 - PRODUCTS AND EXECUTION

2.1 SYSTEM DEVICES

- A. Alarm Valve
 - 1. Wet sprinkler systems shall be equipped with an alarm valve designed to initiate an alarm during sustained water flow. The valve shall be UL Listed/Factory Mutual Approved for installation in the vertical or horizontal position and have an operating pressure up to 250 PSI (17 BAR). The valve shall be equipped with an external bypass to eliminate false water flow alarms and gauge connections on the system side and supply side of the valve clapper. Valve body to be ductile iron and trim galvanized. Alarm valve shall be Viking, Model J-1. Valve shall be trimmed with brass Model J-1 Trim. (No Substitutions Allowed)
- B. Concentrate Controller (Proportioner)
 - 1. Foam concentrate shall be introduced into the water flow by a concentrate controller utilizing balanced-pressure injection. Concentrate controller shall be a UL listed or FM approved device. Concentrate controller shall be listed and approved with the foam concentrate to be proportioned and the foam bladder tank. Concentrate controller shall be a brass, wafer or threaded type device. The concentrate controller shall be listed with a nominal orifice plate size for the foam concentrate to be proportioned. Concentrate Controller manufacturer to be Chemguard. (No Substitutions Allowed)
- C. Foam Bladder Tank
 - 1. Provide a low expansion foam bladder tank system for storage of the foam concentrate. The tank shall be stamped as meeting ASME pressure vessel requirements and UL Listed/FM Approved for use with the foam concentrate and proportioning method utilized. Foam bladder tank shall be located as close to the riser as practical and located to allow adequate access for filling and inspection. Connect bladder tank water supply to the system riser at or above the level of the top of the tank and provide a primary relief valve. Foam bladder tank shall be UL listed and FM approved. Bladder tanks shall be Chemguard Horizontal or Vertical Bladder Tanks. (No Substitutions Allowed)
- D. Concentrate Control Valve

1. Install a deluge valve utilized as a concentrate control valve between the bladder tank and concentrate controller. The CCV valve shall open automatically when the sprinkler system experiences water flow. The CCV shall be UL Listed/FM Approved for use on fire protection systems and have an operating pressure up to 250 PSI (17 BAR) and utilize a 90° or straight-through pattern type of deluge valve manufactured with a corrosive resistant Halar coating. Concentrate control valve trim shall be compatible and installed following the manufacturer's installation instructions. Halar Coated Concentrate Control Valve shall be Viking Model E-2, E-4 or F-2. (No Substitutions Allowed)

E. Foam Concentrate Piping

1. Foam concentrate piping shall be compatible with foam concentrate to be used. Foam provider shall be consulted for acceptable materials of construction. Foam concentrate piping shall be designed for the least equivalent feet of pipe run from bladder tank discharge outlet to proportioning device and water supply to bladder tank. Excessive use of elbows and tees shall be avoided. Foam concentrate piping shall be substantially secured and restrained against movement, thrust and vibration. Foam concentrate piping shall be protected from excessive heat and freezing temperatures. Foam concentrate piping shall be installed with a fitting, such as a grooved coupling or union, to be readily removed between proportioning assembly and concentrate control valve.

F. Foam Concentrate

1. Synthetic Aqueous Film Forming Foam (AFFF) or Alcohol Resistant Aqueous Film Forming Foam (AR-AFFF) shall be utilized. Water-soluble liquids shall be protected with Alcohol resistant type foam concentrate. Foam concentrates shall be UL Listed or FM Approved for the required application as well as for use with proportioning equipment and discharge devices. Stored foam concentrate shall not be a mixture of different types and/or brands and shall be stored in accordance with the manufacturer's guidelines. The AHJ should be consulted to determine reserve foam supply requirements. Foam concentrates shall be Chemguard Synthetic Foam Concentrates. (No Substitutions Allowed)

G. Discharge Devices

1. Closed head sprinklers that have been specifically tested and found suitable for the discharge of low expansion synthetic foam/water solution shall be installed. Standard sprinklers used for discharge outlets shall have been tested for minimum densities or minimum pressures as foam/water solution discharge outlets. Discharge devices shall be UL listed or FM approved for the application for which they are used. Closed head sprinklers shall be UL listed or FM approved for use with the foam concentrate being used. All sprinklers, which are to discharge foam/water solution, shall be Viking sprinklers. (No Substitutions Allowed)

H. Alarm Pressure Switch

1. Provide an alarm pressure switch to facilitate the transmission of an alarm during waterflow conditions. The switch shall be factory adjusted to operate with a pressure increase of 5-7 psi and waterflow equal to or in excess of the discharge from one sprinkler. The switch shall be cULus Listed/FM Approved for operating pressures up to 250 psi (17 BAR) and capable of being wired for a class A or class B circuit. Housing for the switch shall be NEMA 4 rated incorporating tamper-resistant screws. The alarm pressure switch shall be Potter PS101A or PS102A.

I. System Overhead Piping

1. Overhead sprinkler piping shall be in accordance with materials deemed acceptable by NFPA 13, Standard for the Installation of Sprinkler Systems, NFPA 16, Standard for the Installation of Foam-Water Sprinkler Systems and all other applicable building standards.
- J. System Control Valve
1. Low Flow Foam system control valve shall consist of a listed indicating type of control valve. Control valve shall be listed for use in fire protection systems. Control valve shall be rated for system working water pressure not less than 175 PSI.
- K. Hangers and Supports
1. System piping shall be substantially supported from the building structure. The installation of hangers and supports shall adhere to the requirements set forth in NFPA 13, Standard for the Installation of Sprinkler Systems. Materials used in the installation or construction of hangers and supports shall be listed and approved for such application. Hangers or supports not specifically listed for service shall be designed and bear the seal of a professional engineer.
- L. Fire Department Connection
1. A system fire department connection shall be provided on the system riser in accordance with NFPA 16, Standard for Installation of Foam-Water Sprinkler Systems. Fire department connection shall be of a brass body with an integral clapper assembly to separate flow between inlets. Fire department connection shall be installed in an area accessible for the first response unit. Actual fire department location shall be installed and located only after proper coordination with fire officials. Fire department connection shall be UL listed and FM approved for fire protection use.
- M. Underground Piping
1. Piping and fittings used for the installation of underground water mains shall be listed for such service. Local water system requirements shall be adhered to. Compatible fittings and connection methods shall be reviewed with the water department authority. Standards of the AWWA and NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances shall be minimum installation guidelines.
- N. Drains and Flushing Connections
1. System drains shall adhere to the requirements set forth in NFPA 13, Standard for the Installation of Sprinkler Systems. Flushing connections shall be provided where system piping is subject to accumulation of sediments or where periodic flushing is required by the Authority Having Jurisdiction. System auxiliary drains shall be installed so that the drain valve is accessible and labeled as a sprinkler system drain. Drains shall terminate to the exterior of the building where practical. Drains that do terminate to the exterior shall be installed with a 45° elbow directed to a splash block or other permanent erosion limiting material.
- O. Riser Test Connections
1. A test connection shall be provided on the system riser with a downstream isolation valve for the purpose of testing foam proportioning. System test header shall be of adequate size for at least a mid-range flow of the proportioning system. System test header shall be installed with a means of draining any trapped sections of discharge piping subject to freezing.

P. System Supervision

1. Control valves larger than 2" in size shall be equipped with UL listed and FM approved supervisory switches. Control valves 2" and smaller shall be sealed in the position of their normal operating condition. Others shall execute the termination of supervisory switch wires. Supervisory switches shall be Potter Electrical Signal Company Control Valve Supervisory Switch.

Q. System Commissioning

1. Foam water sprinkler system shall be tested in accordance with NFPA 11, NFPA 13, NFPA 16 and all other applicable codes and jurisdictions. An Owner's representative, local fire officials and a representative of the installing contractor shall witness foam-proportioning tests. Additional foam concentrate shall be provided for testing by the installing contractor. The installing contractor shall provide maintenance and material safety data sheets (MSDS) to the Owner.

END OF SECTION

SECTION 21 31 13

ELECTRIC DRIVEN CENTRIFUGAL FIRE PUMPS

PART 1 - - GENERAL

1.1 DESCRIPTION

- A. Provide fire protection pumps in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Fire Protection Pumps.

1.3 SUBMITTALS

- A. Catalog Data: Manufacturer's literature and illustrations.
- B. Shop Drawings
 - 1. Dimensions.
 - 2. Detail of valving and piping arrangements.
 - 3. Wiring diagram of prewired controllers, required control wiring and power wiring diagrams.
 - 4. Written description of sequence of operation.
 - 5. Pump curves indicating service conditions.
- C. Installation: Manufacturer's installation instructions.
- D. Operating Instructions: Written operating instructions including start-up and shutdown.
- E. Maintenance Data
 - 1. Written instructions on items requiring periodic maintenance.
 - 2. Parts List.
- F. Factory Tests and Certificates
 - 1. Pumps hydraulically tested for pressure/flow performances.
 - 2. Provide certified test data.
- G. Responsibility of Manufacturer
 - 1. The manufacturer shall be responsible for the complete pumping system and shall guarantee pumps, motors, control and all components of the pumping system.

1.4 QUALITY ASSURANCE

- A. Factory Mutual (FM)
- B. Underwriters Laboratories
- C. NFPA
- D. Local authorities.

PART 2 - - PRODUCTS

2.1 GENERAL

- A. All pumps shall be as scheduled on the drawings.
- B. Pumping systems shall be complete with all necessary controls, starters and alarms.
- C. All pumps shall be U.L. listed and FM approved.

2.2 AUTOMATIC FIRE PUMPS

- A. Automatic fire pump shall be as scheduled on the drawings.
- B. The pump shall be of horizontal centrifugal single stage multi-stage construction specifically labeled for fire service and shall be connected to the fire standpipe system. The pump casing shall be cast iron with 125 pound rating suction flange and 125 250 pound rating discharge flange machined to ANSI dimensions.
- C. The pump driver shall be horizontal foot mounted ball bearing induction motor of horsepower shown on drawings. The motor locked rotor current shall not exceed the values in NFPA 20. The motor shall be mounted on a steel base common to the pump and shall be connected to the pump with a flexible coupling protected by a suitable guard. Pump and motor shall be accurately aligned.
- D. Provide a Williams-Hager Model No. 636 spring loaded bronze mounted check valve, or equivalent Smolensky model, in the pump discharge line. Water working pressure shall conform to or exceed system static pressure.
- E. Provide casing relief valve, suction and discharge gauges and all other accessories required for the pump.
- F. Fire pump to be 2,500 gpm, pump to be 460 V, pump to be 250 hp and match the pressure rating of to match existing fire pump in the north-west.

2.3 AUTOMATIC FIRE PUMP MOTOR CONTROLLER

- A. The fire pump control panel shall be completely assembled, wired and tested at the manufacturer's plant, and shall be specifically approved for fire pump service. The design of the controller shall conform to the requirements outlined in Pamphlet No. 20 issued by the National Fire Protection Association (NFPA). All equipment shall be approved by Factory Mutual, Underwriters' Laboratories, and all authorities having jurisdiction. The panel shall be enclosed in a driptight, free-standing formed

sheet steel cabinet arranged to permit installation with back against the wall with all operating handles, wiring and components accessible from the front. Entire assembly, including enclosure, shall have a withstand rating of not less than that noted below at 460 volts.

1. Automatic - 150,000 Amps.

B. Controller shall be combined manual and automatic type, with automatic transfer switch as hereinafter described for emergency power supply, suitable for wye-delta, closed circuit transition starting of squirrel cage motor, and shall consist of the following components:

1. One isolating switch, 3 pole, non-fusible of approved capacity, with latch-in device manually operated.
2. One circuit breaker, manually operated, 3 pole, 600 volts, a.c., having a rating of at least 115% of the rated full load current of the motor. Breaker shall permit normal starting without tripping and shall provide stalled rotor protection and instantaneous short circuit protection. Breaker of the inverse time delay type with a time delay of not over 20 seconds on 600% (locked rotor current) of the motor full load current. The magnetic trips shall be calibrated at least up to and set at 300% of the motor full load amperes. The interrupting capacity of the circuit breaker shall be not less than 25,000 amperes at 460 volts.
3. One motor starter, magnetic, wye-delta, closed circuit transition type without overload protection, designed to be energized automatically through action of the pressure regulator, or manually by means of a start button on the front of the enclosure. Under emergency conditions it shall be possible to close the starter mechanically through an externally operated handle provided with a latch-in device.
4. One pressure regulator switch of the Bourdon tube type with mercury tube contact for controlling the running of the motor automatically and provided with independent adjusting screws for cut-in and cutout pressure points. Connection to the pressure switch shall be separated from all electrical components by a waterproof barrier.
5. One running period timer to determine the minimum length of time the motor will run when started automatically provided the pressure regulator has reached the cutout setting at or before the end of the timing interval. If not, the pressure regulator shall govern the stopping of the motor.
6. One control relay to operate in conjunction with the running period timer with provision to bypass the timer to permit an automatic start of the pump and continuous operation until manually stopped.
7. One deluge valve relay for remote starting.
8. One power availability relay energized from the load side of the circuit breaker so that it will drop out if the circuit breaker is opened or the power fails. This relay shall be provided with one normally closed and one normally open isolated contact for remote alarm indication.

9. One pilot light connected to load side of circuit breaker to indicate power is available at the controller.
10. Listed pressure recording device on the pressure sensing line capable of operating for seven days without being reset.
11. One start button on front of enclosure.
12. One manual release button on front of enclosure.
13. Terminal blocks and red nameplates shall be provided as required by the Underwriters.

C. Transfer Switch for Emergency Power Supply

1. The automatic transfer switch shall be housed in a barriered compartment of the fire pump controller.
2. The transfer switch and fire pump controller combination shall be listed for fire pump service.
3. Electrical ratings of automatically operated transfer switches shall comply with NFPA requirements.
4. Transfer switches shall be mechanically held.
5. Manual operation shall be by direct mechanical or electrical remote manual control.
6. Automatic transfer switches shall be capable of manual (non-electrical) operation.
7. An isolating means, located within the automatic transfer switch enclosure, shall be provided ahead of the emergency input terminals of the transfer switch.
8. The generator control circuit from the Fire Pump Room shall be of closed circuit design, so arranged that the opening of the circuit will start emergency generator.
9. Auxiliary contacts, installed on the isolating means of the emergency side of the transfer switch, shall be arranged in the generator control circuit (from the Fire Pump Room) to prevent starting of the generator from this transfer switch signal when the controller of transfer switch is being serviced.
10. The position of the transfer switch emergency side isolating means shall be supervised to indicate when it is open. Supervision shall operate an audible and visual signal in the Pump Room and at a remote point when required.
11. Indication of Switch Position: Two pilot lights, properly identified, shall be provided to indicate transfer switch position, with duplicate sets of such contacts for remote indication of switch position.
12. Voltage Sensing: Voltage sensing devices shall be provided to monitor all ungrounded lines of the normal and emergency sources of power.

13. The transfer switch shall transfer and retransfer the load automatically. Power to accomplish transferal shall be supplied by the source to which the load is being transferred.
 14. Time Delay on Starting of Alternate Power Source: An adjustable .5-6 second time delay device shall be provided to delay starting of the alternate source generator in the event of momentary power dips and interruptions of the normal source. Relays shall be set to transfer to emergency at 90% normal voltage, and retransfer at 90%.
 15. Transfer to Alternate Power: Transfer to the alternate power source shall be delayed until proper alternate source voltage and frequency are achieved.
 16. Time Delay of Retransfer to Normal Power: An adjustable timer with a bypass shall be provided to delay retransfer from the alternate source of power to the normal until the normal source is stabilized.
 17. Means shall be provided to prevent higher than normal starting currents when transferring the fire pump motor from one source to the other by providing an in-phase monitor to protect against abnormal in-rush currents which may result from out-of-phase transfer of motor loads. The monitor shall initiate operation of the transfer switch when the remote or local pushbutton is actuated and the phase angle between both sources is approaching zero phase angle. The motor currents upon reconnection shall not exceed normal starting values. In-phase transfer shall be provided in either direction whenever both power sources are above 70% of nominal voltage.
 18. The fire pump controller-transfer switch assembly shall be marked to indicate that the isolating means for both the controller and transfer switch must be opened before servicing the controller, transfer switch or motor.
 19. Automatic transfer switch shall be Joslyn Clark.
- D. The fire pump control panel and automatic transfer switch shall be U.L. listed and FM approved.
- E. Control panel shall be similar to Joslyn Clark.
- F. See Equipment Schedule for start/stop pressure settings.
- G. Jockey Pump and Controller
1. Jockey pump shall be as scheduled on the Drawings.
 2. Pump controller shall consist of a NEMA Type 1 wall mounted formed sheet steel enclosure with the following parts assembled and wired therein:
 - a. One externally operated fusible disconnecting switch.
 - b. One across-the-line type magnetic starter with thermal overload protection.
 - c. One hand/off/automatic selector switch.

- d. One running period timer to keep motor running for a predetermined time after each automatic start to prevent too frequent starting and stopping.
- e. One pressure regulator of the Bourdon tube type with adjustable cut-in and cutout points.
- 3. Controller shall meet requirements of NFPA, Underwriters Laboratories and Factory Mutual, and shall be similar to Joslyn Clark.
- 4. See Equipment Schedule for start/stop pressure settings.

2.4 ACCEPTABLE MANUFACTURERS

- A. Fire Pump
 - 1. Peerless Pump Company
 - 2. Paterson Pump
 - 3. Aurora Pump Company
- B. Jockey Pump
 - 1. Grundfos
 - 2. MTH Pumps
- C. Fire Pump Controllers, Jockey Pump Controllers, Automatic Transfer Switch
 - 1. Firetrol
 - 2. Joslyn Clark

PART 3 - - EXECUTION

3.1 INSTALLATION

- A. All pumps, and controllers to be located above the flood plain level set by the F.E.M.A. flood map.
- B. Completely align and level pumps, motors and bases. Where pumps and motor are shipped as a unit, realign them in the field.
- C. Grout base plates completely to provide a non-deflecting support.
- D. Secure pumps to bases with proper size anchor bolts.
- E. Install and align mechanical seals in accordance with the manufacturer's recommendation.
- F. Pump manufacturer to set packing, adjust impellers and check alignment prior to start-up.

- G. Each concrete base (rectangular or 'T' shaped) for horizontally split pumps to include supports and base elbows for the suction and discharge connections. Base elbows to be bolted and grouted to the concrete foundation.
- H. Construct all apparatus of materials and pressure ratings suitable for the conditions encountered during continuous operation.
- I. Provide casing connections for vent, drain, suction and discharge pressure gauges.
- J. Balance impellers and all other moving components statically and dynamically.
- K. Match centrifugal pump impellers and casings so that at specified operating conditions the impeller diameter is not more than 90% of the maximum diameter impeller which can satisfactorily operate in the casing.
- L. Pumps must operate stably without pulsation, vibration or internal recirculation. Pump operating characteristics at the design point must be such that a variation of 10% in head results in not more than a 15% variations in gpm and does not affect the stability of operation of the pump.
- M. Select pumps so that when operating at rated RPM, the pump motor cannot be overloaded despite variations in pumping head.

END OF SECTION

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SECTION 22 00 01
DESIGN DOCUMENTS
SEPARATION OF WORK BETWEEN THE TRADES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The specifications delineate various items of related work under separate trade headings in accordance with the Design Documents as listed below.
- B. Indications that the electrical and mechanical trades are to perform an item of work means that they are to perform the work for their own accommodation only, except as specifically noted otherwise.
- C. Key to Abbreviations:
- | | | |
|---------|---|--|
| "OTHER" | = | Provided for Owner by Construction Manager or General Contractor |
| "PLBG" | = | Plumbing |
| "FP" | = | Fire Protection |
| "HVAC" | = | Heating, Ventilating and Air Conditioning |
| "ELECT" | = | Electrical |
| "F" | = | Furnished |
| "I" | = | Installed |
| "P" | = | Provided (Furnished and Installed) |
| "C" | = | Final Connection |
- D. The following is a list of work and the trade or trades that perform the work:

	Other	Plbg	FP	HVAC	Elect	Notes
Temporary Heat	P					
Temporary Water	P					
Temporary Light & Power	P					
Temporary Fire Standpipe	P					
Temporary Toilets	P					
Excavation & Backfill for M&E Inside Bldg	P	P	P	P	P	

	Other	Plbg	FP	HVAC	Elect	Notes
for M&E Outside Bldg						
Dewatering Site & Excavation	P					
Subsoil Drainage Inside Building Outside Building	P P	C C				
Footing Drains	P	C				
Drywells		P				
Manhole & Covers		P	P	P	P	
Concrete Equipment Bases and Pads: Inside Building Outside Building	P	P				
Masonry Pits	P					1
Pit Frames & Covers	I	F				2
Fuel Oil Tank Cradle	P					
Trenches in Floor Slabs	P					
Anchors and Vibration Mounts in Inertia Blocks	I	F	F	F	F	3
Concrete Encasement of Underground Runs		P	P	P	P	
Fastening and Supports		P	P	P	P	
Cutting, Chasing and Patching		P	P	P	P	
Framed Slots and Openings	I	F	F	F	F	
Sleeves through Slabs, Decks and Walls		P	P	P	P	
Waterproof Sealing of Openings		P	P	P	P	
Fireproof Sealing of Excess Openings		P	P	P	P	
Drilling & Cutting of all Holes		P	P	P	P	
Hoisting and Rigging		P	P	P	P	
Floor Drain Flashing		P				
Base Flashing for all Roof Penetrations	P					
Cap Flashing for all Roof Piping Penetrations		P	P	P	P	
Roof Curb Base Flashing	P					
Roof Curb Cap Flashing				P		
Prime Painting M&E Work		P	P	P	P	
Field Touch-Up Painting		P	P	P	P	

	Other	Plbg	FP	HVAC	Elect	Notes
Rustproofing Field Cut Iron Work		P	P	P	P	
Color Coding M&E Work		P	P	P	P	
Precast Receptors		P				
Shower Stall Pan Flashing		P				
Toilet Room Accessories	P					
Soap Dispensers	P					
Domestic Water Make-Up		P				4
Fire Hose & Cabinets			P			
Fire Extinguishers	P					
Fire Extinguisher Cabinets	P					
Finished Access Doors & Frames	I	F	F	F	F	
Ladders & Catwalks	P					
Motors for Mechanical Equipment		P	P	P		
Loose Motor Controls for Mechanical Equipment		F	F	F	I	
Motor Control Centers					P	
Disconnect Switches					P	5
Wiring for Equipment Motors and Starters					P	
Premounted & Prewired Starters and Disconnects		P	P	P	C	
Electric Radiators and Convectors					P	
Electric Duct Heaters				P	C	
Heat Tracing Cable		F	F	F	I	6
Electric Water Heater		P			C	
Plaster Frames for Ceiling Mounted Fixtures, Ceiling Diffusers, etc.	I			F	F	
Cellular Decking	P					7
Trench Headers					P	
Preset Activation Kits					P	8
Power Circuit to Starter Disconnect Switch and Motor					P	
Line Voltage Control Device (Aquastat) etc.		P		P	C	

	Other	Plbg	FP	HVAC	Elect	Notes
Control Device Not in Power Circuit to Motor		P		P		
Temperature Control Device & Electric Actuator		P		P		
Sprinkler & Standpipe Alarm System: Devices Panels			P		C P	
Halon, Deluge and Pre-Action Sprinkler, Smoke and Thermal Detection			P			9
Space Smoke Detector					P	
Duct Smoke Detector				I	F&C	
Smoke Control/Fire Alarm Panel					P	
Boiler and Refrigeration Room Shut-off & Break Glass				P	C	
Kitchen Hood Fire Suppression System	P				C	10
Lighting Fixtures					P	
Exterior Wall Louvers	P					11
Radiator Enclosures				P		12
Ornamental Grilles	P					
Air Boots for Air/Light Fixtures and Perimeter Slots				P		
Raised Floor	P					
Air Outlets in Raised Floor	I			F		
Masonry Chimney Breeching Frame	P					
Masonry Chimney Cleanout Door	P					
Prefabricated Chimney				P		
Kitchen Range Hood	P					
Dishwashing Hoods	P					
Food Service Equipment	P	C		C	C	
Refrigerators	P				C	
Refrigerator Condensing Units, Air Cooled	P				C	
Refrigerator Condensing Units, Water Cooled	P			C	C	
Lightning Protection					P	
Surgical Lights	P				C	

	Other	Plbg	FP	HVAC	Elect	Notes
Pneumatic Tube System	P				C	
Exterior Transformer Vault	P					
Incinerator	P	C		C	C	
Elevator	P				C	
Escalator	P				C	
Lifts	P				C	
Laboratory Equipment	P	C		C	C	
Hospital Equipment	P	C		C	C	
Laundry Equipment	P	C		C	C	
Window Washing Machines	P	C			C	
Linen/Garbage Chutes	P		C			
Vermiculite Fireproofing	P					
Rubbish Removal		P	P	P	P	13
Maintenance Tools		F	F	F	F	

E. SPECIFIC NOTES:

1. Plumbing Trade to provide sizes and locations.
2. Covers and Frames for sewage ejectors, sump pump and silt pits furnished by Plumbing Trade.
3. Details furnished by individual Trades.
4. Final connections included in HVAC work.
5. When not part of premounted starter.
6. Insulation covering by each Trade after heating cable is connected and tested.
7. Preparation of cells for electricification is in Electrical work.
8. Purchased by Electrical Trade.
9. Power to Halon Control Panel by Electrical Trade; tie into fire alarm system by Electrical Trade; all other by Fire Protection Trade.
10. Power to Kitchen Hood Fire Protection System and gas pipe solenoid valve by Electrical Trade; tie into fire alarm system by Electrical Trade.
11. Duct connections and safing of unused portions of louvers by HVAC Trade.
12. Except where custom enclosures are provided by others.
13. Where one Trade furnishes and another installs, the installing Trade removes the shipping and packing materials where accumulated.

PART 2 - PRODUCTS

- 2.1 NOT USED.

PART 3 - EXECUTION

- 3.1 NOT USED.

END OF SECTION

SECTION 220003

PLUMBING SCOPE OF WORK

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide plumbing systems in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. This specification is not intended to be a complete itemization of plumbing required, but is for guidance of this contractor in estimating his work. This contractor shall examine the architectural, mechanical, electrical, fire protection and plumbing plans for all plumbing work required and shall provide same.
- B. It is intended that all items of material, fixtures and equipment mentioned in this specification and shown on the plans shall be read as if the word "Provide" were prefixed thereto.
- C. Sanitary Drainage System
1. Connections to Utilities.
 2. House Traps.
 3. Sanitary Drainage Piping.
 4. Sanitary Vent Piping.
 5. Vent Through Roof.
 6. Fresh Air Inlets.
 7. Floor Drains.
 8. Grease Interceptors.
 9. Oil Interceptors.
 10. Acid Neutralizer.
 11. Sewage Ejectors and Controls.
 12. Ejector Piping.
 13. Ejector Pit Covers.
 14. Connections to Plumbing Fixtures.
 15. Cleanouts.
- D. Storm Water System
1. Connections to Utilities.
 2. House Traps.
 3. Storm Water Piping.
 4. Roof Drains.
 5. Area Drains.
 6. Support Drains (terrace, balcony, promenade, etc.).
 7. Overflow Drains.
 8. Overflow Drain Piping.
 9. Fresh Air Inlets.
 10. Sand Interceptors.
 11. Sump Pumps and Controls.
 12. Sump Pump Piping.
 13. Sump Pit Covers.
 14. Cleanouts.

15. Storm Water Retention.

E. Domestic Water Systems

1. Connections to Utilities.
2. Water Meters.
3. Backflow Preventers.
4. Connections to Plumbing Fixtures.
5. Domestic Water Piping.
6. Constant Pressure Booster Systems.
7. House Tanks.
8. House Tank Fill Pumps.
9. Insulation.
10. Central Domestic Water Heaters.
11. Local Domestic Water Heaters.
12. Booster Heaters.
13. Hot Water Circulation Pump, Piping and Controls.
14. Electric Heat Tracing.
15. Hose Bibbs and Wall Hydrants.
16. Connections to Equipment.
17. Tempering, Pressure Reducing, Balancing and Shut-off Valves.

F. Miscellaneous Items

1. Foundation Wall Sleeves.
2. Sleeves in Walls and Floor Slabs.
3. Access doors.
4. Firestopping.
5. Hangers and Supports.
6. Painting.
7. Vibration Isolation.
8. Pipe Labeling.
9. Housekeeping Pads.
10. Testing.
11. Permits.
12. Fees.
13. Royalties.
14. Plumbing Fixtures.
15. Seismic Restraints.

PART 2 - PRODUCTS

2.1 NOT USED.

PART 3 - EXECUTION

3.1 NOT USED.

END OF SECTION

SECTION 220004

PLUMBING UNIT PRICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide unit prices for possible revisions and alternates in the work.
- B. State and hold firm for the duration of the project all unit prices as described herein.

1.2 DEFINITIONS

- A. Unit prices, unless otherwise noted, are to include incidental work normally included in connection with the particular type of work involved and are to include, but not necessarily be limited to, the following:
 - 1. Engineering, including calculations, detailing, coordination, and shop drawings.
 - 2. Material costs, including an allowance for waste, connections, etc.
 - 3. Necessary accessories, e.g., hangers, inserts, clips, bolts, painting, labeling, testing, etc.
 - 4. Fabrication and shop costs.
 - 5. Shop and field labor, including supervision and engineering layout costs.
 - 6. Temporary utilities required, including safety precautions.
 - 7. Costs of standby trades during or beyond normal working hours.
 - 8. Transportation, hoisting, rigging, freight, taxes of any kind, fringe benefits, overhead and profit (excluding Insurance Cost).
 - 9. Tools and equipment.
 - 10. Testing, cleaning, balancing and controlled inspection.
- B. Architect/Engineer documents will be used as the basis for calculating changes to contract work.
- C. Submit unit prices based upon the specification standards and as noted herein. Unit prices shall apply equally to work when added and also to work when deleted, except where specifically modified below.
- D. In addition to your contract proposal, quote prices for the work described below.

PART 2 - PRODUCTS

2.1 PIPING

- A. Provide Type 'L' copper piping with 95-5 solder joints and hangers.
 - ½" I.D. \$_____/LF
 - ¾" I.D. \$_____/LF
 - 1" I.D. \$_____/LF
 - 1¼" I.D. \$_____/LF
 - 1½" I.D. \$_____/LF
 - 2" I.D. \$_____/LF

2½" I.D.	\$_____/LF
3" I.D.	\$_____/LF
4" I.D.	\$_____/LF
6" I.D.	\$_____/LF
8" I.D.	\$_____/LF

B. Provide Schedule 40 threaded black steel pipe and hangers.

¾" I.D.	\$_____/LF
1" I.D.	\$_____/LF
1¼" I.D.	\$_____/LF
1½" I.D.	\$_____/LF
2" I.D.	\$_____/LF
2½" I.D.	\$_____/LF
3" I.D.	\$_____/LF
4" I.D.	\$_____/LF
6" I.D.	\$_____/LF

C. Provide Type 'L' copper piping with 95-5 solder joints and hangers.

6" Ductile Iron Buried Water Pin	\$_____/LF
8" I.D.	\$_____/LF
10" I.D.	\$_____/LF
12" I.D.	\$_____/LF
14" I.D.	\$_____/LF
16" I.D.	\$_____/LF
18" I.D.	\$_____/LF
6" I.D.	\$_____/LF

D. Provide Schedule 40 galvanized black steel pipe and mechanical couplings, joints, and hangers.

10" I.D.	\$_____/LF
12" I.D.	\$_____/LF
14" I.D.	\$_____/LF
16" I.D.	\$_____/LF
18" I.D.	\$_____/LF

E. Provide Schedule 40 welded black steel pipe and hangers.

¾" I.D.	\$_____/LF
1" I.D.	\$_____/LF

1 1/4" I.D.	\$_____/LF
1 1/2" I.D.	\$_____/LF
2" I.D.	\$_____/LF
2½" I.D.	\$_____/LF
3" I.D.	\$_____/LF
4" I.D.	\$_____/LF
5" I.D.	\$_____/LF
6" I.D.	\$_____/LF
F. Provide cast iron no-hub pipe and hangers.	
1½" I.D.	\$_____/LF
2" I.D.	\$_____/LF
2½" I.D.	\$_____/LF
3" I.D.	\$_____/LF
4" I.D.	\$_____/LF
5" I.D.	\$_____/LF
6" I.D.	\$_____/LF
8" I.D.	\$_____/LF
G. Provide cast iron hub and spigot pipe and hangers.	
2½" I.D.	\$_____/LF
3" I.D.	\$_____/LF
4" I.D.	\$_____/LF
5" I.D.	\$_____/LF
6" I.D.	\$_____/LF
8" I.D.	\$_____/LF
10" I.D.	\$_____/LF
12" I.D.	\$_____/LF
15" I.D.	\$_____/LF
H. Provide galvanized steel pipe and hangers.	
1½" I.D.	\$_____/LF
2" I.D.	\$_____/LF
2½" I.D.	\$_____/LF
3" I.D.	\$_____/LF
4" I.D.	\$_____/LF

5" I.D.	\$_____/LF
6" I.D.	\$_____/LF
8" I.D.	\$_____/LF

I. Provide unions.

½" I.D.	\$_____
¾" I.D.	\$_____
1" I.D.	\$_____
1¼" I.D.	\$_____
1½" I.D.	\$_____
2" I.D.	\$_____
2½" I.D.	\$_____
3" I.D.	\$_____

2.2 PIPING

A. Provide the following plumbing fixtures, including all required roughing, core drilling, hangers, vent, waste and water connections within 10 feet of a wet stack (if more than one fixture is specified, unit price for each specified fixture).

Water closet flush valves and supports.	\$_____
Water closet with flush tank.	\$_____
Urinal with flush valves and supports.	\$_____
Lavatory with lavatory fittings.	\$_____
Pantry sink.	\$_____
Shop sink.	\$_____
Shower base and trim.	\$_____
Mop receptor.	\$_____
Bath tub.	\$_____
Drinking fountain.	\$_____

2.3 DRAINS

A. Provide the following drains within 10 feet of a drain connection. Include all accessories, clamps, piping, core drilling and extensions.

General floor drain.	\$_____
Mechanical room floor drain.	\$_____
Garage drain.	\$_____
Kitchen floor drain and/or floor sink.	\$_____
Roof drain.	\$_____

2.4 VALVES

A. Gate Valves

3/4"	\$_____
1"	\$_____
1¼"	\$_____
1½"	\$_____
2"	\$_____
2½"	\$_____
3"	\$_____
4"	\$_____
5"	\$_____
6"	\$_____
8"	\$_____

B. Globe Valves

3/4"	\$_____
1"	\$_____
1¼"	\$_____
1½"	\$_____
2"	\$_____
2½"	\$_____
3"	\$_____
4"	\$_____
5"	\$_____
6"	\$_____
8"	\$_____

C. Ball and Butterfly Valves

3/4"	\$_____
1"	\$_____
1¼"	\$_____
1½"	\$_____
2"	\$_____
2½"	\$_____
3"	\$_____

4"	\$ _____
5"	\$ _____
6"	\$ _____
8"	\$ _____

D. Gas Valves

½"	\$ _____
¾"	\$ _____
1"	\$ _____
1¼"	\$ _____
1½"	\$ _____
2"	\$ _____
2½"	\$ _____
3"	\$ _____
4"	\$ _____
5"	\$ _____
6"	\$ _____

E. Vacuum Breakers

½" I.D.	\$ _____
¾" I.D.	\$ _____
1" I.D.	\$ _____
1¼" I.D.	\$ _____
1½" I.D.	\$ _____
2" I.D.	\$ _____

F. Check Valves

½"	\$ _____
¾"	\$ _____
1"	\$ _____
1¼"	\$ _____
1½"	\$ _____
2"	\$ _____
2½"	\$ _____
3"	\$ _____
4"	\$ _____

5"	\$_____
6"	\$_____
8"	\$_____

G. Backflow Preventers

3/4" I.D.	\$_____
1" I.D.	\$_____
1¼" I.D.	\$_____
1½" I.D.	\$_____
2" I.D.	\$_____
2½" I.D.	\$_____
3" I.D.	\$_____
4" I.D.	\$_____
6" I.D.	\$_____
8" I.D.	\$_____
10" I.D.	\$_____

2.5 INSULATION

A. Piping

½" I.D.	\$_____/LF
3/4" I.D.	\$_____/LF
1" I.D.	\$_____/LF
1¼" I.D.	\$_____/LF
1½" I.D.	\$_____/LF
2" I.D.	\$_____/LF
2½" I.D.	\$_____/LF
3" I.D.	\$_____/LF
4" I.D.	\$_____/LF
5" I.D.	\$_____/LF
6" I.D.	\$_____/LF
8" I.D.	\$_____/LF
10" I.D.	\$_____/LF
12" I.D.	\$_____/LF
14" I.D.	\$_____/LF
18" I.D.	\$_____/LF

B. Valves	
3/4" I.D.	\$_____
1" I.D.	\$_____
1¼" I.D.	\$_____
1½" I.D.	\$_____
2" I.D.	\$_____
2½" I.D.	\$_____
3" I.D.	\$_____
4" I.D.	\$_____
5" I.D.	\$_____
6" I.D.	\$_____
8" I.D.	\$_____

2.6 MISCELLANEOUS

Non-Freeze Wall Hydrant: Provide a 3/4" non-freeze wall hydrant within 10 feet of a water line. \$_____

Wall Hydrant: Provide a 3/4" wall hydrant within 10 feet of a water line. \$_____

Hose Bibb: Provide a 3/4" hose bibb within 10 feet of water line. \$_____

2.7 WORK REQUIRED FOR EXISTING CONDITIONS

- A. Core Drill: Core drill holes in slab. Cost includes layout and equipment costs as well as all required labor. Cost includes firestopping and plugging as required.

Holes through 1½"	\$_____
Holes 2" through 3"	\$_____
Holes 3½" and greater	\$_____

- B. Tie-in to existing pipe.

1" I.D.	\$_____
1¼" I.D.	\$_____
1½" I.D.	\$_____
2" I.D.	\$_____
2½" I.D.	\$_____
3" I.D.	\$_____
4" I.D.	\$_____
6" I.D.	\$_____

2.8 WAGE RATES

A. Provide hourly wage rates excluding mark-up, overhead, profit and insurance.

	Regular Time	Overtime	Sat. P.M. Sun. & Hol.
Plumbers:			
Foreman	_____	_____	_____
Plumber	_____	_____	_____
Apprentice	_____	_____	_____
Steamfitters:			
Foreman	_____	_____	_____
Steamfitter	_____	_____	_____
Apprentice	_____	_____	_____
Other:	_____	_____	_____

PART 3 - EXECUTION

3.1 NOT USED.

END OF SECTION

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SECTION 220517

SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide sleeves and U.L. approved firestopping system in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Firestop Compounds.
- B. Damming Material.
- C. Sleeves.

1.3 SUBMITTALS

- A. Submit shop drawings, product data, and manufacturer's installation instructions for all materials and prefabricated devices, providing descriptions sufficient for identification at the job site. Literature shall indicate product characteristics, typical use, performance and limitation criteria and test data.
- B. Submit shop drawings showing proposed material, reinforcement, anchorage, fastenings, and method of installation. Construction details shall accurately reflect actual job conditions.
- C. Submit Material Safety Data Sheets with product delivered to job site.
- D. U.L. Tested Systems: Submit drawings showing typical installation details for the methods of installation. Indicate which firestop materials will be used and thickness for different hourly ratings, and approved UL system number.
- E. Engineering Judgements: Submit manufacturer's drawings for all non-standard applications where no U.L. tested system exists. All drawings must indicate the "Tested" U.L. system upon which the judgement is based so as to assess the relevance of the judgement to some known performance.
- F. Submit manufacturer's installation procedures for each type of product.
- G. Approved Applicator: Submit document from manufacturer wherein manufacturer recognizes the installer as qualified or submit a list of past projects to demonstrate capability to perform intended work.
- H. Upon completion, installer shall provide written certification that materials were installed in accordance with the manufacturer's installation instruction and details.

1.4 QUALITY ASSURANCE

- A. Firestop system installation shall conform to requirements of qualified designs or manufacturer approved modifications, as supported by engineering reports. Field inspections

shall be carried out by the firestop manufacturer to verify that the installation is in accordance with the manufacturer requirements.

- B. Install firestop materials and systems as required by these Contract Documents and meet and be accepted for use by applicable design building and construction codes.
- C. Submit manufacturer's product data, letter of certification, or certified laboratory test report that the material or combination of materials (firestop system) meets the requirements specified in accordance with the applicable referenced standards.
- D. The firestop compound shall not contain any solvents or inorganic fibers. The penetration seal material must be unaffected by moisture and must maintain the integrity of the floor or wall assembly for its rated time period when tested in accordance with ASTM E814 (UL1479). The system shall be U.L. Classified for up to and including 3 hours.
- E. Firestopping materials shall be asbestos and lead free and shall not incorporate or not require the use of hazardous solvents.
- F. Firestopping sealants must be flexible, allowing for normal pipe movement.
- G. All fire stopping materials shall be manufactured by one manufacturer.
- H. Installation of firestopping systems shall be performed by a Contractor (or Contractors) trained or approved by the firestop manufacturer.
- I. Material used shall be in accordance with the manufacturer's written installation instructions.
- J. Submit a line-by-line statement of compliance or non-compliance with this specification section.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The following specifications represent desired design, material, and construction standards for the various items of work. Manufacturer names and model numbers are used to describe specific types, styles and quality.

2.2 SLEEVES

- A. Provide sleeves for each pipe passing through walls, partitions, and floors.
- B. Sleeve Materials

Type	Sleeve Materials
1	#18 gauge, galvanized steel.
2	Standard weight galvanized steel pipe.
3	Cast iron body with flashing clamp and underdeck clamp similar to J.R. Smith, figure 1720.

- C. Sleeve Sizes

1. Sleeves shall be of adequate diameter to allow pipe, insulation, and fire stopping to fit.
2. Sleeves shall provide a minimum 1" clearance around pipes smaller than 4" and 2" clearance around pipes 4" and larger.

D. Sleeve Lengths

Location	Sleeve Length
Floor	All floor drains to extend minimum of 2" above finished floor level.
Stair Landing	Equal to depth of construction and terminated flush with finished surfaces.
Walls and Partitions	Equal to depth of construction and terminated flush with finished surfaces.

E. Foundation Wall Penetrations

1. The pipe to wall sleeve penetration closure shall be "Pipe Linx" as manufactured by Calpico, Inc. Seals shall be modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall sleeve opening. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely watertight seal between the pipe and wall opening. The seal shall be constructed so as to provide electrical insulation between the pipe and wall, thus reducing chances of cathodic reaction between these two members.
2. Contractor shall determine the required inside diameter of each individual wall opening or sleeve before ordering, fabricating or installing. The inside diameter of each wall opening shall be sized as recommended by the manufacturer to fit the pipe and Pipe Linx to assure a watertight joint. If pipe O.D. is non-standard due to coating, insulation, etc., consult manufacturer for assistance before proceeding with wall opening detail.

2.3 GENERAL

- A. The following specifications represent desired design, material, and construction standards for the various items of work. Manufacturer names and model numbers are used to describe specific types, styles and quality.

2.4 SLEEVES

- A. Provide sleeves for each pipe passing through walls, partitions, and floors.
- B. Sleeve Materials

Type	Sleeve Materials
1	# 18 gauge, galvanized steel
2	Standard weight galvanized steel pipe
3	Cast iron body with flashing clamp and underdeck clamp similar to

	J.R. Smith, figure 1720.
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C. Sleeve Sizes

1. Sleeves shall be of adequate diameter to allow pipe, insulation, and fire stopping to fit.
2. Sleeves shall provide a minimum 1" clearance around pipes smaller than 4" and 2" clearance around pipes 4" and larger.

D. Sleeve Lengths

Location	Sleeve Length
Floor	All floor sleeves to extend minimum of 2" above finished floor level.
Stair Landing	Equal to depth of construction and terminated flush with finished surfaces.
Walls and Partitions	Equal to depth of construction and terminated flush with finished surfaces.

E. Foundation Wall Penetrations

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2. Contractor shall determine the required inside diameter of each individual wall opening or sleeve before ordering, fabricating or installing. The inside diameter of each wall opening shall be sized as recommended by the manufacturer to fit the pipe and Pipe Linx to assure a watertight joint. If pipe O.D. is non-standard due to coating, insulation, etc., consult manufacturer for assistance before proceeding with wall opening detail.

2.5 FIRESTOPPING

- A. Provide firestop compounds for caulk, pour, trowel or pump application. Material must be capable of sealing openings around single or multiple pipes against fire, smoke and toxic gases, and maintaining rating with a thickness no greater than the structure.
- B. Provide a damming material, where required, per manufacturer's recommendations and as shown on the Drawings.
- C. Provide a firestop system consisting of a material, or combination of materials, to retain the integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke or gases through penetrations in fire-rated barriers. It shall be used in specific locations as follows:

1. Penetrations for the passage of piping through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor slabs and floor/ceiling assemblies), and vertical service shafts.
2. Locations shown specifically on the drawings or where specified in other sections of these specifications.

2.6 MATERIALS

- A. Firestopping materials/systems shall be flexible to allow for normal movement of building structure and penetrating item(s) without affecting the adhesion or integrity of the system.
- B. Firestopping materials shall not require hazardous waste disposal of used containers/packages.
- C. Provide firestopping materials free of solvents which will not experience shrinkage while curing.
- D. Firestopping materials shall be unaffected by moisture.

2.7 ACCEPTABLE MANUFACTURERS

- A. Specified Technologies, Inc.
- B. Dow Corning
- C. Flamesafe
- D. International Protective Coatings

PART 3 - EXECUTION

- 3.1 Deliver materials to site in original unopened containers or packages bearing the manufacturer's name, brand designation, product description and U.L. Classification mark.
- 3.2 Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job site.
- 3.3 Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements.
- 3.4 Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.

3.5 EXAMINATION

- A. Examine areas and conditions under which work is to be performed and notify the Contractor in writing of conditions detrimental to proper and timely completion of the work.
- B. Verify that openings are properly sized and in suitable condition to receive the work of this section.
- C. Verify manufacturer's printed instructions for installation and when applicable, curing in accordance with temperature and humidity. Conform to ventilation and safety requirements.
- D. Verify the condition of the substrates before starting work.

- E. Verify Weather Conditions. Do not proceed with installation of firestop materials when temperatures fall outside the manufacturer's suggested limits.
- F. Verify that firestopping materials are installed so as not to contaminate adjacent surfaces.
- G. Schedule firestopping after installation of penetrants but prior to concealing the openings.
- H. Where firestopping is installed at locations which will remain exposed in the completed work, provide protection as necessary to prevent damage to adjacent surfaces and finishes, and protect as necessary against damage from other construction activities.
- I. Verify that all pipe, conduit, ducting which penetrate fire-rated construction have been permanently installed prior to installation of firestop.

3.6 PREPARATION

- A. Clean substrate of dirt, dust, grease, oil, loose materials, rust or other matter that may affect the proper fitting or adhesion of the firestopping materials.
- B. Clean metal and glass surfaces with a non-alcohol solvent.

3.7 INSTALLATION

- A. Installation of firestops shall be performed by an applicator/installer qualified and trained by the manufacturer. Installation shall be performed in strict accordance with manufacturer's details installation procedures.
- B. Apply firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, and manufacturer's recommendations.
- C. Unless specified and approved, all insulation used in conjunction with through-penetrations shall remain intact and undamaged and may not be removed.
- D. Seal holes and penetrations to ensure an effective smoke seal.
- E. In areas of high traffic, protect firestopping materials from damage. If the opening is large, install firestopping materials capable of supporting the weight of a human.
- F. Insulation types specified in other sections shall not be installed in lieu of firestopping material specified herein.
- G. All combustible penetrants (e.g. non-metallic pipes or insulated metallic pipes) shall be firestopped using products and systems tested in a configuration representative of the field condition.
- H. Dam Construction
 - 1. When required to properly contain firestopping materials within openings, damming or packing materials may be utilized. Combustible damming material must be removed after appropriate curing. Noncombustible damming materials may be left as a permanent component of the firestop system.

- 3.8 Firestopping may be required by other Subcontractors under related sections of the project specifications. Identify all locations requiring firestopping and coordinate the work of this section with work performed under other sections of the project to provide a uniform system of firestopping.
- 3.9 Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.
- 3.10 Do not proceed with installation of firestop materials when temperatures exceed the manufacturer's recommended limitations for installation.
- 3.11 Firestop systems do not re-establish the structural integrity of load bearing partitions. Contractor shall consult the structural engineer prior to penetrating any load bearing assembly.
- 3.12 Firestop systems are not intended to support live loads or traffic. Contractor shall consult the structural engineer if he has reason to believe these limitations may be violated.
- 3.13 The installation of firestop materials shall be inspected on site by a representative of the firestopping manufacturer and verified in writing that the installation is in accordance with the manufacturer's requirements. This shall be done for each firestop penetration installed on this project.
- 3.14 FIRESTOPPING
 - A. Un-Insulated Cold Pipes
 - 1. Install a pipe sleeve through the wall or slab to be penetrated with an inside diameter large enough to include the specified pipe & firestopping.
 - 2. Install firestop material at each end of sleeve to form a U.L. approved system.
 - 3. Mark penetration in an approved manner to verify manufacturer's inspection.
 - 4. Cover firestopping with escutcheon cover.
 - B. Insulated Cold Pipes
 - 1. Install a pipe sleeve through the wall or slab to be penetrated with an inside diameter large enough to include the specified thickness of insulation.
 - 2. Pipe insulation should be continuous through sleeve. Insulation should be covered with a vapor barrier. For depth of wall plus 1" on either side of wall or slab, vapor barrier shall be wrapped with a 26 gauge sheetmetal inner sleeve. Firestop shall be applied between wall sleeve and pipe protection sleeve.
 - 3. Install firestop material at each end of sleeve to form a U.L. approved system.
 - 4. Mark penetration in an approved manner to verify manufacturer's inspection.
 - 5. Cover firestopping with escutcheon cover.
 - C. Hot Pipes (Up to 220°F)
 - 1. Install a pipe sleeve through the wall or slab to be penetrated with an inside diameter large enough to include the specified thickness of insulation.
 - 2. Pipe insulation should be continuous through sleeve. Insulation should be covered with a vapor barrier. For depth of wall plus 1" on either side of wall or slab, vapor barrier shall be wrapped with a 26 gauge sheetmetal inner sleeve. Firestop shall be applied between wall sleeve and pipe protection sleeve.
 - 3. Insulate pipe on each of wall and caulk all around insulation at joint of wall and insulation.
 - 4. Mark penetration in an approved manner to verify manufacturer's inspection.
 - 5. Cover firestopping with escutcheon cover.

3.15 FIELD QUALITY CONTROL

- A. Prepare and install firestopping systems in accordance with manufacturer's printed instruction and recommendations.
- B. Follow safety procedures recommended in the Material Safety Data Sheets.
- C. Finish surfaces of firestopping which are to remain exposed in the completed work to a uniform and level condition.
- D. All areas of work must be accessible until inspection by the applicable Code Authorities.
- E. Correct unacceptable firestops and provide additional inspection to verify compliance with this specification.

3.16 CLEANING

- A. Remove spilled and excess materials adjacent to firestopping without damaging adjacent surface.
- B. Leave finished work in neat, clean condition with no evidence of spill overs or damage to adjacent surfaces.

END OF SECTION

SECTION 220518

ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide complete plumbing systems in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Escutcheons

1.3 SUBMITTALS

- A. Provide the following Manufacturer's Specifications and Engineering Data:
 - 1. Materials
 - 2. Parts
 - 3. Devices
 - 4. Finish
 - 5. Performance Data
 - 6. Area of Use
- B. Provide samples as follows: Where manufacturer's catalog information does not satisfactorily indicate materials, engineering design, quality of construction or aesthetics of proposed equipment, samples shall be submitted as requested with no additional cost to the Owner.

1.4 QUALITY ASSURANCE

- A. Local Codes.
- B. Plumbing and Drainage Institute (PDI).
- C. ANSI.
- D. National Sanitary Foundation (NSF).
- E. ASTM.
- F. Underwriters Laboratories (UL).

PART 2 - PRODUCTS

2.1 GENERAL

- A. The following specifications represent desired design, material, and construction standards for the various items of work. Manufacturer names and model numbers are used to describe specific types, styles and quality.

2.2 ESCUTCHEONS

- A. Provide escutcheons on all exposed piping through walls, floors, partitions and ceilings.
- B. Provide escutcheons on all piping passing through fire rated walls.
- C. Escutcheons shall be held in place by set screws.
- D. Escutcheon Application

Location	
Finished Spaces	Chrome plated brass
Unfinished spaces: including mechanical equipment rooms.	Cast iron

- E. Two-piece or hinged escutcheons will not be permitted.
- F. Escutcheons shall be installed on both sides of pipe penetrations.

PART 3 - EXECUTION

3.1 NOT USED.

END OF SECTION

SECTION 220519

METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide water meters and accessories in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Water Meters.
- B. Gauges.

1.3 SUBMITTALS

- A. Manufacturer's Specifications and Engineering Data
 - 1. Each type of meter.
 - 2. Materials for all parts.
 - 3. Manufacturer's accuracy and pressure drop curves.

1.4 QUALITY ASSURANCE

- A. Name of manufacturer stamped on meter body.
- B. Reference Standards
 - 1. AWWA-C700
 - 2. AWWA-C701
 - 3. AWWA-702

PART 2 - PRODUCTS

2.1 COMPOUND TYPE (DOMESTIC WATER)

- A. Full-flow compound type of combined disc and turbine design capable of accurately measuring both large and small flows.
- B. Single body, all bronze casing containing a straight-through turbine mounted horizontally and a sensitive disc meter to measure low flows.
- C. Meters shall be full line size with flanged inlet and outlet connections.
- D. Hermetically sealed register and gear train compartments with remote reader.
- E. Meters shall be approved.

2.2 DETECTOR CHECK FIRE METER

- A. Provide a detector check meter for all fire protection water service to building.

- B. Detector check shall be approved by local authorities.

2.3 DISC METERS

- A. Cold water, magnetic modular disc type.
- B. Remote Meter Reading: Self-contained remote reading option shall be included with meter. This Contractor to furnish all required wiring.

2.4 REMOTE READERS

- A. Provide remote readers as required.

2.5 GAUGES

- A. Provide pressure gauges where indicated on the Drawings and in accordance with the schedule given below. All gauges shall be provided with snubbers. Gauges shall have 4" diameter dial, white coated with black figures and graduations. Gauges shall be H.O. Trerice Co. Shutoff cock shall be provided between gauge and piping to permit gauge removal while system is under pressure.
- B. Gauges shall have graduations such that at normal working pressure the needle is in the center of the field.
- C. Gauge Location Schedule
 - 1. Gauge Location
 - 2. Inlet to Water Heaters
 - 3. Inlet and Outlet of Water Service PRV Stations
 - 4. Inlet and Outlet of Pumps
 - 5. Inlet and Outlet of Strainers
 - 6. Inlet and Outlet of Gas Boosters
 - 7. Inlet and Outlet of Hot Water Circulator
 - 8. THERMOMETERS
- D. Provide thermometers where indicated on the drawings and in accordance with the schedule given below. Thermometers shall be 6" dial type, mercury actuated, with adjustable angle face, immersion bulb, and separate socket, cast aluminum case, white background, black markings face, as made by H. O. Trerice. Install in oversize pipe tee and nipple.
- E. Thermometer Schedule

Thermometer Location	Temperature Range
Inlet of water heaters	0-160
Inlet and outlet of circulating pumps	0-160
Outlet of water heaters	0-240

2.6 ACCEPTABLE MANUFACTURERS

A. Water Meters

1. Hersey
2. Neptune

B. Gauges

1. H.O. Trerice
2. Wekslor Instruments
3. Taylor Sybron

C. Thermometers

1. H.O. Trerice
2. Wekslor Instruments
3. Taylor Sybron

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation to be performed under regulations of the Department of Environmental Protection of the City of New York.
- B. Meter assemblies to be properly supported to permanent construction. All meters shall be supported with concrete pads or piers and as per manufacturer recommendations.
- C. Meters to be set in horizontal position, with dials facing upward and no higher than 3'-0" above finished floor.

END OF SECTION

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SECTION 220523

VALVES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide valves in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Gate Valves.
- B. Globe Valves.
- C. Check Valves.
- D. Pressure Reducing Valves.
- E. Ball Valves.
- F. Plug Valves.
- G. Drain Valves.
- H. Butterfly Valves.
- I. Excess Pressure Shutoff Valve

1.3 SUBMITTALS

- A. Manufacturers' Specifications and Engineering Data
 - 1. Each type valve.
 - 2. Materials of all parts.
 - 3. Pressure ratings.
 - 4. Schedule of valves, locations, application and pressure rating.
 - 5. Certificates: Manufacturers' certification that valves and accessories meet or exceed specification requirements.

1.4 QUALITY ASSURANCE

- A. Each valve shall have the manufacturer's name, size, direction of flow arrow and pressure rating cast or stamped on body.
- B. Listed below are references to the specification, standards or recognized authorities to which valves must conform to be acceptable. All references shall be the latest edition in effect at the time of opening of Bids. Local codes must be complied with, such as New York City Board of Standards and Appeals.

ITEM	STANDARDS NUMBER
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ITEM	STANDARDS NUMBER
Valve Identification	MSS-SP-25
Cast-Iron Valves	MSS-SP-70, 71
Bronze Valves	MSS-SP-80
Globe Valves	MSS-SP-85
Ball Valves	MSS-SP-110
Butterfly Valves	MSS-SP-67
Swing Check Valves	ANSI/ASTM B-62 ANSI/ASTM A-126 Grade B

PART 2 - PRODUCTS

2.1 GENERAL

- A. All domestic water control valves within the building shall be gate, ball, globe or butterfly valves. All valves shall have the name of the manufacturer and working pressure cast or stamped thereon.
- B. All valves shall be with threaded or flanged ends as required by the piping system in which they are installed. In order to prevent dezincification no forged or yellow brass bodies or stems shall be accepted on ball, gate, globe and check valve.
- C. Valves shall be selected for the maximum working pressure to which the valve may be subject.
- D. All domestic water balancing valves shall be circuit setter type.
- E. Adapters shall be provided on all threaded valves installed in the copper water piping system.
- F. Where a manufacturer produces all types of valves, all valves shall be of the same manufacturer.
- G. All valves of the same type shall be supplied by one manufacturer.

2.2 VALVE SCHEDULE

- A. Unless otherwise indicated, the valves tabulated on the Valve Schedule on drawings have been selected from the catalog of The Nibco Valve Co., and are representative of the design, materials and working features desired.

1. Domestic Water System

a. Gate Valves:

Size	End	Figure No.	PSIG W.O.G.	Material	Spindle
2½" & Smaller	Thread	T-111	200	Bronze	Rising Stem
2½" &	Thread	T-154-A	400	Bronze	Non-Rising Stem

Size	End	Figure No.	PSIG W.O.G.	Material	Spindle
Smaller					
3" & Larger	Flange	F-619	200	IBBM	Non-Rising Stem
3" & Larger	Flange	F-617-0	200	IBBM	OS&Y
3" & Larger	Flange	F667-O	500	IBBM	OS&Y

b. Ball Valves:

Size	End	Figure No.	PSIG W.O.G.	Material	Spindle
2" & Smaller	Thread	0860	600	Bronze	Full Post-

c. Balancing Globe Valves:

Size	End	Figure No.	PSIG W.O.G.	Material	Spindle
1/2" - 3/4"	Solder	S-1709*	125	Brass	Non-Rising Stem
1" - 2"	Solder	S1710*	240	Brass	Non-Rising Stem

* Based on NIBCO

d. Butterfly Valves:

Size	End	Figure No.	PSIG W.O.G.	Disc Material	Actuator
2" - 6"	Lug Style	LD-2000-3	200	Bronze	Lever Operated
8"-12"	Lug Style	LD-2000-5	200	Bronze	Gear Operated
14" - 20"	Lug Style	LD-1000-5	150	Bronze	Gear Operated
2" - 6"	Lug Style	LD-3022-3	250	Stainless Steel	Lever
8"-12"	Lug Style	LD-3022-5	250	Stainless Steel	Gear Operated
2 1/2" - 6"	Grooved	GD-47565-3	300	EPDM	Gear Operated

*Victaulic Co.

e. Check Valves:

Size	End	Figure No.	PSIG W.O.G.	Material
2 1/2" & Smaller	Thread	T-413	200	Bronze
3" & Larger	Flange	F-918-B	200	IBBM
3" & Larger	Flange	F-968-B	500	IBBM

2. Gas System (Rockwell-Nordstrom Fig. Numbers)

Size	End	Figure No.	PSIG W.O.G.	Material
2 ½ " & Smaller	Thread	142	175	Semi-Steel
3" & Larger	Flange	143	175	Semi-Steel

Notes:

1. Provide operating wrenches for all size valves. Attach wrench to each valve on sizes up through 1".
2. ½" and ¾" A.G.A. approved ball valves with square nut head may be used.

B. Shut-Off Valves

1. Underground Valves:

- a. 3 Inches and Larger: AWWA hub and IBBM double disc gate type with square spindle nut, 200 psi wwp.
- b. Similar to Kennedy No. 571X (mechanical joint).
- c. 4 Inches and Larger: Tight closing, rubber (Buna-N) seated cast iron or ductile iron mechanical bell end body AWWA butterfly valves, 200 wwp, with lifetime bearings, ductile iron disc, stainless steel shaft, nut actuated gear or slotted lever operator; similar to Kennedy.
- d. 2 Inches and Smaller: Bronze non-rising stem gate type, 125 psi wsp.
 - 1) Threaded ends, similar to NIBCO T-113.
 - 2) Wheel handle and extension rod or 1¼" operating nut.
- e. 2 Inches and Smaller: Brass plug type, Teflon coated plug and top and bottom "O" rings, 175 psi wwp.
 - 1) Similar to Mueller No. H-15201 or No. H-10291.
 - 2) Provide extension rod.
- f. 3 Inches and Smaller on PVC Piping: PVC double union full port ball valves with socket or threaded ends, Teflon seats, "O" ring seals, and tee handles, 150 wwp.
 - 1) Similar to Chemtrol Series TU and DE.

2. Curb Box:

- a. Provide with adjustable tar coated cast iron extension shaft and flush box with lock type extra heavy cast iron cover marked WATER.
- b. Provide with adjustable plastic extension shaft and flush box with locked type extra heavy cover marked WATER.
 - 1) Provide two (2) operating wrenches.

C. Pressure Reducing Valves

1. 2½" and Smaller:

- a. Valve shall maintain a constant downstream pressure regardless of varying inlet pressures and/or changing flow rates.
- b. Valve shall be capable of reducing a maximum inlet water pressure of 430 psi to a lower desired pressure.

- c. The valve shall close drip-tight when the downstream pressure rises above the spring setting.
 - d. Valve shall be of the balanced single seat design and shall contain an integral strainer constructed of chrome-nickel stainless steel.
 - e. All necessary repairs shall be possible without removing the valve from the line.
 - f. The pressure reducing unit shall be replaceable without the requirement of a new pressure adjustment.
 - g. The diaphragm assembly shall be fully guided at both the top and the bottom.
 - h. All trim shall be chrome-nickel stainless steel throughout.
 - i. Valve shall be constructed with union ends at the inlet and the outlet.
 - j. Provide a pressure gauge on the downstream side of the valve, installed in a threaded tapping on either side of the valve.
 - k. The body and the cover shall be constructed of heavy-duty bronze.
 - l. For upstream and downstream pressures, and model number, refer to the Schedule as indicated on the Drawings.
2. 3" and Larger:
- a. This valve shall maintain a constant downstream pressure regardless of fluctuations in demand, or varying inlet pressures.
 - b. Valve shall be a hydraulically operated pilot controlled valve.
 - c. No external packing glands shall be permitted, and there shall be no pistons operating the main valve or any pilot controls.
 - d. The pilot control shall be a direct-acting, adjustable, spring-loaded, normally open diaphragm valve, designed to permit flow when controlled pressure is less than the spring setting.
3. Entire installation shall be assembled as shown on drawings.
- D. Butterfly Valves
- 1. Use for throttling and shut-off control in lieu of ball, globe and gate valves.
 - 2. Valves shall be lug style.
 - 3. Body shall be ductile iron with extended neck. The liner is to be molded-in or captive boot design.
- E. Hose Bibb Valves
- 1. Drain valves on street pressure piping:
 - a. Heavy, rough cast brass faucets with composition washer and 3/4" hose end.
 - 2. Drain valves on higher pressure piping:
 - a. Bronze, angle valves with composition washer and 3/4" hose end, 300 psig wsp.
- F. Excess Pressure Shutoff Valve (Domestic Water PRV Stations)
- 1. The valve shall close drip tight if the pressure at the valve inlet rises above the setpoint of the pilot control and shall remain closed until the inlet pressure drops below the setpoint.
 - 2. The valve shall be hydraulically operated, pilot controlled, diaphragm type globe pattern valve.
 - 3. The valve shall have a single removable seat and resilient disk.
 - 4. The stem shall be guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat.
 - 5. No external packing glands will be permitted.
 - 6. The valve shall be cast iron body with bronze trim and all cast iron wetted parts shall be epoxy-coated by the fusion process.

7. The pilot control shall be a direct-acting adjustable, spring-loaded and normally open diaphragm valves designed to permit flow when inlet controlling pressure is less than the spring setting.
8. The control system shall incorporate a manual locking valve designed to keep the valve in the close position when it has once been actuated to the close position.
9. The valve shall be mounted so that if the main valve diaphragm ruptures, the valve will close.
10. Acceptable Manufacturer: Cla-Val #50G-33HI.

2.3 MODULATING FLOAT VALVE (SUCTION TANKS AND FIRE STORAGE TANK)

- A. The Modulating Float Valve shall modulate to maintain a constant water level in the suction tank by compensating for variation in supply and or demand. It shall be capable of controlling the flow into the tank in direct relation to the flow that is being withdrawn from the tank. The valve shall close on rising level.
- B. The main valve shall be a hydraulically operated, pilot controlled, diaphragm type, globe pattern valve. The main valve shall have a resilient disc, having a rectangular cross section, contained on three and one half sides by a disc retainer and forming a tight seal against a single renewable seat; quad rings and "O" rings are not acceptable. The diaphragm assembly containing a valve stem shall be fully guided at both ends by a threaded removable T303 stainless steel bearing in the valve cover and by an integral bearing in the threaded removable T303 stainless steel valve seat. This diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure. The diaphragm shall consist of nylon fabric bonded with synthetic rubber and shall not be used as a seating surface. All necessary repairs shall be possible without removing the main valve from the line.
- C. The valve shall be constructed of all bronze (ASTM B-62) with stainless steel trim, Type 303. The valve shall have 150ASA class flanged connections conforming to ANSI B16.42. All necessary repairs shall be possible without removing the valve from the line.
- D. The float control pilot shall be a rotary disc type pilot to insure long term, reliable, low maintenance service. The pilot valve shall include a lapped Monel multi-port disc with a matching stainless steel port plate and a cast bronze housing. The float rod linkage assembly shall convert tank level changes into gradual rotation of the internal disc. The float control shall be equipped with stainless steel rod and float.
- E. The control system shall include a variable orifice proportioning valve, which will insure a smooth valve opening and closing stroke. The pilot system shall also include a self-cleaning strainer to keep foreign particles from entering the pilot system.
- F. The valve shall be similar to the No. 428-01HI Modulating Float Valve, manufactured by Cla-Val Co.

2.4 PRESSURE REDUCING VALVE (HIGH FLOW PRV)

- A. The valve shall be capable of keeping the low zone outlet pressure constant from zero flow to maximum flow (infinite rangeability). No low flow chatter or hunting will be acceptable. This shall be accomplished by a special pilot control system configuration.
- B. The valves shall be cast bronze (ASTM B62) and shall have all stainless steel trim (303). They shall have 300 ASA Flanged ends that conform to ANSI B16.24 and shall have a maximum working pressure of 400 PSI.

- C. The main valve shall be a hydraulically operated, pilot controlled, diaphragm type, globe pattern valve. The main valve shall have a resilient disc, having a rectangular cross section, contained on three and one half sides by a disc retainer and forming a tight seal against a single renewable seat; quad rings and "O" rings are not acceptable. The diaphragm assembly containing a valve stem shall be fully guided at both ends by a threaded removable T303 stainless steel bearing in the valve cover and by an integral bearing in the threaded removable T303 stainless steel valve seat. This diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure. The diaphragm shall consist of nylon fabric bonded with synthetic rubber and shall not be used as a seating surface. All necessary repairs shall be possible without removing the main valve from the line.
- D. The pilot control shall be a direct acting, spring loaded, diaphragm valve adjustable from 30-300 psi and set as indicated on the drawings. The control system shall also include a fixed orifice, a flow clean strainer, a field adjustable opening speed control.
- E. The valves shall be similar to the Model No. 90-01KxHI Pressure Reducing Valve, manufactured by the Cla-Val Co.

2.5 PRESSURE REDUCING VALVE (LEAD PRV & BRANCH PRV)

- A. The pressure-reducing valve shall maintain a constant downstream pressure (± 3 PSI) regardless of changing inlet pressure. All flow conditions from zero flow to full flow shall be handled in a stable manner. The valve shall be factory certified to withstand a maximum working inlet pressure of 350 PSI. The reduced pressure spring range shall be either 28-85 or 80-140 psi, as indicated on the drawings.
- B. The valve shall close drop tight when the downstream pressure rises to the set point of the springs setting. No pressure "creep" or leakage will be tolerated. Valve shall be of the high capacity, balanced, single seat design. The valve body and cover shall be constructed of all virgin bronze (ASTM B-62) material; lower grades of bronze and recycled brass are not acceptable. Valve trim shall be of type 416 stainless steel.
- C. A self-contained pressure-reducing valve shall include a permaphragm assembly, all internal seals, spring, spring guide, adjustment nut, stem, and a floating stainless steel seat. The permaphragm assembly shall be fully guided above and below molded, reinforced synthetic rubber permaphragm. The design of the permaphragm shall be such that any stem travel will not cause any stretching or fatigue. The perimeter of the permaphragm shall be molded to form a bead ring, which will enable highly reliable attachment between the cover and the permaphragm retainer without the requirement of high compression of the bead ring (outer perimeter) of the permaphragm. Flat, die-cut diaphragms will not be permitted.
- D. Valve shall be constructed with union tailpieces at both the inlet and the outlet ends. Dual body tappings shall make it possible to install a pressure gauge on either side of the valve to monitor the downstream pressure.
- E. The valve shall have been in standard production and have a proven history of reliable and satisfactory performance in similar applications for a period no less than ten (10) years.
- F. The valve shall be model No. 1338xHI as manufactured by JR Gunzenhauser.

2.6 PRESSURE RELIEVE VALVE (MASTER PRV RIGS)

- A. The pressure relief valve shall open quickly when the system pressure exceeds the setting of the excess pressure safety valves and permit flow to drain line. The valve automatically close at an adjustable rate after line pressure is returned to a normal level.
- B. The valve body and cover shall be cast bronze ASTM B-62, and stainless steel trim, T303. The main valve body shall have 300 ASA class screwed ends, ANSI B16.42, with a working pressure of 400 psi.
- C. The valve shall be sized and installed as shown on the drawings. The main valve shall be a hydraulically operated, diaphragm actuated, globe pattern valve. It shall contain a resilient, synthetic rubber disc, having a rectangular cross section, contained on three and one half sides by a disc retainer and forming a tight seal against a single, removable stainless steel seat insert. The diaphragm shall consist of nylon fabric bonded with synthetic buna rubber. The diaphragm assembly containing the valve stem shall be guided at both ends by a bearing in the cover and by an integral bearing in the valve seat. Packing glands and/or stuffing boxes are not permitted and there shall be no pistons operating the valve or pilot controls. All necessary repairs shall be possible without removing the main valve from the line.
- D. The valve shall be supplied with a control that can be field adjusted from 0-75 or 20-200 psi. The pilot control shall be a direct acting, adjustable, spring loaded, diaphragm type valve, designed to permit flow when controlling pressure exceeds the spring setting. The pilot system shall also include a Y-strainer with an adjustable closing speed control. A limit switch (SPDT) shall be provided, and the contacts will indicate when the valve is in the open position.
- E. The valve shall be similar to the No. 50-01CkxHI Pressure Relief Valve, manufactured by Cla-Val Co.

2.7 SOLENOID SAFETY SHUT-OFF VALVE (SUCTION TANKS & FIRE TANK)

- A. The safety shut-off valve is normally open and allows the modulating float valve to control the water level in the suction tank. If the water level rises to an undesirable level, a high level probe shall signal the emergency shut-off valve to close drip-tight to prevent the tank from overfilling.
- B. The main valve body, cover shall be cast ASTM B-62 bronze. The valve trim shall be ASTM B62 bronze. The connections shall be 150ASA flanged ends than conform to ANSI B16.24 and shall have a maximum working pressure of 225 psi.
- C. The main valve shall be a hydraulically operated, pilot controlled, diaphragm type, globe pattern valve. The main valve shall have a resilient disc, having a rectangular cross section, contained on three and one half sides by a disc retainer and forming a tight seal against a single renewable seat; quad rings and "O" rings are not acceptable. The diaphragm assembly containing a valve stem shall be fully guided at both ends by a threaded removable T303 stainless steel bearing in the valve cover and by an integral bearing in the threaded removable T303 stainless steel valve seat. This diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure. The diaphragm shall consist of nylon fabric bonded with synthetic rubber and shall not be used as a seating surface. All necessary repairs shall be possible without removing the main valve from the line.
- D. The pilot system shall contain self-cleaning strainer to prevent debris from entering the pilot control system and a three-way solenoid valve. When the solenoid pilot valve is energized, the main valve will close drip-tight. When de-energized, the valve will remain open wide.

- E. The solenoid safety shut off valve shall be similar to the Model No. 136 01KxIH as manufactured by Cla-Val Company.

2.8 EXCESS PRESSURE SAFETY SHUT-OFF VALVE (MASTER PRV RIGS):

- A. During conditions when the PRV outlet pressure is normal, the Excess Pressure Safety Valve remains open. If the PRV outlet pressure rises to an unacceptably high level, the Excess Pressure Safety Valve automatically closes to protect the downstream system. If the high-pressure event is just momentary, the Excess Pressure Safety Valve automatically re-opens, allowing flow.
- B. The valve body and cover shall be cast bronze ASTM B-62. The valve trim shall be ASTM B-62 bronze. The valve shall have 300 ASA screwed or flanged ends that conform to ANSI B16.24 and shall have a maximum working pressure of 400 PSI.
- C. The main valve shall be a hydraulically operated, and diaphragm actuated, and shall contain a resilient, synthetic rubber disc, having a rectangular cross-section, contained on three sides by a disc retainer and forming a tight seal against a single removable seat insert. The diaphragm assembly containing a valve stem shall be fully guided at both ends by a bearing in the cover and an integral bearing in the valve seat. This diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure. The diaphragm shall consist of nylon fabric bonded with synthetic rubber. All necessary repairs shall be possible without removing the main valve body from the line.
- D. The pilot control shall be a direct-acting, adjustable, spring loaded, diaphragm valve, designed to permit flow when controlling pressure exceeds the spring setting. It shall be field adjustable, but factory set as outline on the valve schedule. Where indicated, an F61 fail switch shall be included for field installation & wiring.
- E. The valve shall be similar model number 50-33KxDD-HI Excess Pressure Safety Valve manufactured by Cla-Val Co.

2.9 FLOAT CONTROL VALVE (ROOF TANKS & FIRE TANK)

- A. The roof tank float control valve normally allows water flow into the house tank. If the water level in the tank rises above the normal high level, the float control valve shall close, to prevent overflow. The float valve is intended for use as a safety backup to the automatic house pump control system. When the level in the tank returns to an acceptable level, the float valve automatically re-opens, allowing flow into the tank.
- B. The main valve body, cover shall be cast ASTM B-62 bronze. The valve trim shall be ASTM B62 bronze. The connections shall be 150ASA flanged ends that conform to ANSI B16.24 and shall have a maximum working pressure of 225 psi.
- C. The main valve shall be a hydraulically operated, pilot controlled, diaphragm type, globe pattern valve. The main valve shall have a resilient disc, having a rectangular cross section, contained on three and one half sides by a disc retainer and forming a tight seal against a single renewable seat; quad rings and "O" rings are not acceptable. The diaphragm assembly containing a valve stem shall be fully guided at both ends by a threaded removable T303 stainless steel bearing in the valve cover and by an integral bearing in the threaded removable T303 stainless steel valve seat. This diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure. The diaphragm shall consist of nylon fabric bonded with synthetic rubber and shall not be used as a

seating surface. All necessary repairs shall be possible without removing the main valve from the line.

- D. The pilot control shall be a rotary disc plate type valve which, when the tank level rises, diverts line pressure into the main valve cover chamber, forcing it slowly closed. When the tank level recedes, the cover chamber pressure shall be vented, thereby permitting line pressure to open the main valve. The vertical rod and ball shall be all stainless steel. The pilot control shall be bronze with monel & stainless steel trim. The pilot system shall contain a self cleaning strainer to insure that debris will not enter the pilot control system.
- E. The Roof Tank Float Control Valve shall be similar to model no. 124G-22ACKxHI, manufactured by Cla-Val, and represented by Haper International, Inc., Tel. 800-551-2733.

2.10 ACCEPTABLE MANUFACTURERS

A. Gate Valves, Globe Valves & Check Valves

- 1. Milwaukee
- 2. Stockham
- 3. Nibco
- 4. Kennedy

B. Pressure Reducing Valves

- 1. J.R. Gunzenhauser
- 2. Cla-Val
- 3. Bailey

C. Ball Valves

- 1. Milwaukee
- 2. Stockham
- 3. Apollo
- 4. Nibco
- 5. Kennedy

D. Butterfly Valves

- 1. Nibco
- 2. Stockham
- 3. Milwaukee

E. Plug Valves

- 1. Rockwell-Nordstrom
- 2. Walworth
- 3. Stockham

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All valves shall be installed only in the upright vertical or horizontal positions unless specifically otherwise required by the drawings.
- B. All valves shall be installed in accessible locations to facilitate easy removal for repair or replacement.

- C. All valves with pilot control systems shall have drains piped to floor drains.
- D. When using circuit setter valves the contractor shall provide to the Owner a differential pressure test kit for measuring flow across the valves.

END OF SECTION

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SECTION 220525

PLASTIC PIPING AND FITTING MATERIALS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide piping and fitting materials in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Piping.
B. Fittings.
C. Related Accessories.

1.3 SUBMITTALS

- A. Submit a list of all proposed piping materials including system/material (use schedule).
B. Submit complete back-up material where proposed materials differ from those specified.

1.4 QUALITY ASSURANCE

- A. The following are references to the specifications standards of recognized authorities to which pipe and fitting materials must conform to be acceptable. All references shall be the latest edition in force at the time of bidding.

MATERIAL	AUTHORITY SPEC. NO.
Polyethylene Pipe and Fittings (PE)	ASTM D-2239, 2447, 2737, CS-197, 255
Polyvinyl Chloride Pipe and Fittings (PVC)	ASTM D-2241, 1785, CS-256, 272, 207, 237
Chlorinated Polyvinyl Chloride Pipe and Fittings (CPVC)	ASTM F-440, 441, 442, 937, D-2846
Acrylonitrile-Butadiene-Styrene Pipe and Fittings (ABS)	ASTM D-1527, 1788, 2661, 2751, 2680, 2282, CS-218, 254, 255, 270
Polypropylene Pipe and Fittings (PP)	ASTM D-2146
Polyvinylidene Fluoride (PVDF)	Kynar
Polybutylene Pipe and Fittings (PB)	ASTM D-3309, 2662, 2666

PART 2 - PRODUCTS

2.1 SCHEDULE OF PLASTIC PIPE AND FITTINGS

Material	Schedule	Sizes (inches)	Joining Methods
PVC Drain Pipe	40, 80	1½ - 48	Solvent weld, thread, flange, push-on, heat fusion
PVC Pressure Pipe	40, 80	¼ - 30	Solvent weld, thread, flange, push-on, heat fusion
PVC Perforated	40, 80	4 - 12	Solvent weld, push-on
PVC Clear	40	2 - 8	Split pipe, injectable bonding
PP	40, 80	½ - 8	Solvent weld, thread, flange, push-on, heat fusion
CPVC	40, 80	½ - 8	Solvent weld, thread, flange, push-on, compression
PE	40, 80	½ - 48	Clamp, insert, heat fusion
ABS	40, 80	— - 12	Solvent weld, thread
PB	SDR	¼ - 6	Compression, flare, thread, heat fusion
PVDF	40, 80	½ - 4	Flanged, solvent weld, thread, heat fusion

2.2 PIPE AND FITTINGS APPLICATION SCHEDULE

Material	System	Joints
PVC DWV	Storm; Drainage and Vent	S,T,P
PVC Pressure	Class 100 - Water mains only (100 psi)	S,T,F,P
PVC Pressure	Class 150, 200 - Fire and water mains	S,T,F,P
PVC CTS	Copper tube size - domestic cold water	T,F
PVC Perforated	Underdrain - subsurface drainage	S,P
PVC Clear	Secondary containment	B,P
PP	Acid drain; deionized and distilled water; chemical	S,T,F,HF,P

Material	System	Joints
CPVC	Domestic hot and cold water	S,T,F,P,C
PE	Water mains; gas; acid drain; irrigation	HF,I,CL
ABS	Storm and sanitary sewers; DWV; chemical	S,T
PB	Water mains; domestic hot and cold water	HF,T,C,FR
PVDF	Domestic hot water; deionized and distilled water	F,S,T,HF
S = Solvent Weld; T = Threaded; P = Push-on; HF = Heat Fusion; C = Compression; FR = Flare; F = Flanged		

PART 3 - EXECUTION

3.1 JOINTS

- A. Solvent Weld: Dissolve inside socket surface by brushing primer onto the pipe end and inside the fitting socket with a brush or applicator. Next, dissolve surface of male end of pipe, to be inserted into socket, to depth of fitting socket by brushing on a liberal coat of primer. Be sure entire surface is well dissolved. Again, brush inside socket surface with primer, then, without delay, apply proper cement liberally to male end of pipe. The amount should be more than sufficient to fill any gap. Also apply the same proper cement lightly to inside of socket. Keep excess cement out of socket to prevent solvent damage to pipe. Time is important. Apply a second coat of cement to the pipe end. Cement should be applied deliberately but without delay. While both the inside socket surface and the outside surface of the male end of the pipe are soft and wet with cement, forcefully bottom the male end of the pipe in the socket, giving the male end a one quarter turn if possible. Hold the joint together (for about 30 seconds) until the joint is firmly gripped. Allow the joint to cure for an adequate time before pressure testing.
- B. Threaded Joints: Do not damage fitting surface, remove burrs and ream smooth. Apply Teflon tape to male threads only.
- C. Flanged Joints: Use matched flange faces and 1/16" thick compressed gaskets.
- D. Push-on Joints: Do not lubricate rubber rings or the ring groove. Lubricate the spigot end of the pipe. Do not use non-approved lubricant. Insert the spigot end into the bell and brace the bell while the spigot end is pushed into the bell until the assembly mark on the pipe barrel is flush with the end of the bell.
- E. Heat Fusion: Fusion joints shall be made using the Fuseal power unit to electrically fuse the two pipes together. Follow the manufacturer's instructions.
- F. Injection Bonding: Prior to injection bonding, the fittings shall be held together by the clips provided. The clips shall be affixed over the integral fitting clip locators. The pipe and fitting joint shall be welded together by injecting the bonding media.
- G. Mechanical Joint: Mechanical (grooved) joints shall be made with neoprene or synthetic rubber gaskets. For non-pressure applications, slide the nut, grab ring and seal ring on the pipe. Insert

the pipe into socket and tighten one half turn past hand tight. As the nut is tightened, the grab ring grips and cuts a retaining groove in the pipe. Further tightening seals the polypropylene ring to ensure a leakproof joint.

END OF SECTION

SECTION 220529

HANGERS, SUPPORTS, ANCHORS, GUIDES AND SEISMIC RESTRAINT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work of this Section shall conform to the requirements of the Contract Documents.

1.2 WORK INCLUDED

- A. Hangers equipment.
- B. Supports
- C. Provide engineered seismic restraint systems for suspended Plumbing Piping compliant with the currently adopted version of the International Building Code (IBC) with local building code amendments.
- D. At seismic restraint installations, provide vertical support systems engineered to accommodate dead load plus seismic force restrictions.

1.3 SUBMITTALS

- A. Manufacturer's literature, catalog data and illustrations.
- B. Shop Drawings indicating:
 - 1. Dimensions
 - 2. Construction details of hangers, inserts, anchors and guides
 - 3. Materials
 - 4. Maximum Load
 - 5. Locations
 - 6. Recommended installation procedures
- C. Provide Seismic Design Force calculations per ASCE 7-05, Formulas 13.3-1 thru 13.3-3 stamped by a registered design professional licensed to practice in the State where project is located. For multi-story projects, provide calculated Seismic Design Force for each floor.
- D. Submit seismic restraint layouts stamped by a registered design professional licensed to practice in the State where project is located. Seismic restraint layouts to show:
 - 1. All vertical support and seismic brace locations.
 - 2. All anchorage connections to structure. Anchor brand, type, quantity and size.
 - 3. Vertical support and brace reaction point load at all connections to structure. For review by engineer of record in checking suitability of the building structure to accommodate imposed loads.
 - 4. Plan set sheets showing appropriate installation details reflecting actual job site conditions.
- E. Include cover sheet with Seismic Restraint Bracing Legend delineating:
 - 1. Maximum Allowable Size or Utility Weight (Lbs/Lf).

2. Minimum Vertical Support Rod Diameter.
3. Support Rod Total Vertical Load.
4. Maximum Allowable Transverse Brace Spacing.
5. Transverse Brace Reaction
6. Maximum Allowable Longitudinal Brace Spacing.
7. Longitudinal Brace Reaction
8. Minimum Required Seismic Restraint Brace Arm Assembly.
9. Minimum Required Seismic Restraint Anchorage to Overhead Structure.
10. Installation Detail Drawing References.

1.4 QUALITY ASSURANCE

A. Codes and Authorities

1. Federal Specification WW-H171b
2. ASA Code for Pressure Piping
3. ASTM A-575-73
4. MSS SP-58-67
5. MSS SP-69-66
6. Underwriters Laboratories
7. Local Plumbing Code

B. References

1. Publications, codes and standards listed below form a part of this specification to the extent referenced.
 - a. Applications, Design and Inspection Manual – Engineered Seismic Bracing of Suspended Utilities, 2006 International Building Code Edition.
International Seismic Application Technology (ISAT)
Vol. 2 – HVAC Duct, Mechanical Piping, Plumbing, Process Piping and Equipment
 - b. International Building Code (IBC)
Chapter 16 – Structural Design
Chapter 17 – Structural Tests and Special Inspections
 - c. ASCE 7-05, Chapter 13, Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineers (ASCE).
 - d. ACI 318, Building Code Requirements for Structural Concrete, American Concrete Institute (ACI).

PART 2 - PRODUCTS

2.1 HANGERS

- A. All bracket, clamp and rod sizes indicated in this specification are minimum sizes only. All structural hanging materials shall have a built-in safety factor of 5.
- B. Provide pipe roller support where longitudinal movement due to expansion and contraction may occur.

C. Pipe Hanger Schedule

	Carpenter & Patterson 'Witch'	Grinnell	I. R. Rauch's & Sons
C-Clamp with Retaining Clip and Locknut (pipe sizes 2" & smaller)	47 with 22	86 with 89	47 with 22
Beam Clamp	293	228	82
Multi-J Hook	---	---	228
J Hook	---	---	221
Clevis Hanger	100	260	100
Clevis Hanger w/Saddle	100SH	---	100SH
180° Shield	265P	168	265P
Single Rod Roll Hanger	140	181	140
Double Rod Roll Hanger	142	171	142
Trapeze	---	46	1600-1700
U-bolt Adjustable Pipe	283	137C	283
Stanchion Saddle	247	259	247
Welded Steel Bracket	84 or 139	199 or 195	84 or 139
Riser clamp	126	261	126
Welded Beam Attachment	113A	66	---
Welded Beam Attachment w/bolt & nut	113B	66	113A
Concrete Insert	108	282	180 or 181
Phillips Inserts	513	Phillips Insert	1000

D. Hanger Rod Schedule

Pipe Size	Rod Diameter
2" and smaller	3/8"
2-1/2" - 3-1/2"	1/2"
4" - 5"	5/8"
6"	3/4"
8" - 12"	7/8"

- E. Acceptable Manufacturers
 - 1. I. R. Rauch's & Sons
 - 2. Grinnell Company, Inc.
 - 3. Carpenter & Patterson

2.2 FOUNDATIONS

- A. All equipment, piping, etc., shall be mounted on approved foundations, all as specified herein, or as shown on the drawings.
- B. All floor-mounted equipment shall be erected on 4" high concrete pads, provided under a separate section of the specifications, over the complete floor area of the equipment, unless specified to the contrary herein. Hereinafter, wherever vibration eliminating devices and/or concrete inertia blocks are specified, these items shall in turn be mounted upon aforementioned pads unless specified to the contrary herein.
- C. All floor-mounted equipment shall be erected on 4" high concrete pads, over the complete floor area of the equipment, unless specified to the contrary herein. Hereinafter, wherever vibration eliminating devices and/or concrete inertia blocks are specified, these items shall in turn be mounted upon aforementioned pads unless specified to the contrary herein. Refer to Section 22 05 48 for Vibration Isolation.
- D. All concrete foundations and supports (and required reinforcing thereof) will be furnished and installed under this Section of the Specification. Furnish templates for all concrete foundations and supports, and all required hanger bolts and other appurtenances necessary for the proper installation of equipment. Submit shop drawings showing the complete details of all foundation bases including necessary concrete and steel work.

2.3 SEISMIC RESTRAINTS

- A. Component Importance Factor
 - 1. In order to identify systems requiring seismic restraint and to define those from which restraints may be excluded, utility components are assigned an ASCE 7 Importance Factor (I_p) on the basis of the following:
 - $I_p = 1.5$ Life-Safety component which is required to function after a seismic event including fire protection sprinkler systems
 - Components that contain hazardous or flammable materials.
 - $I_p = 1.0$ All other Components
- B. Structural Attachments
 - 1. Seismic restraint hardware and engineering by International Seismic Application Technology (ISAT) or approved equal.
 - 2. Vertical support and seismic restraint anchorages to utilize ISAT Blue Banger Hanger Cast-In Place Dec Inserts unless noted otherwise. Post installed anchors are an acceptable alternate provided the anchors are those pre-engineered within the *ISAT Applications, Design and Inspection Manual*.
 - 3. Vertical support and seismic restraint connections to structural steel are to utilize ISAT BC-4 Beam Clamp connections unless noted otherwise. Welded or bolted connections

are an acceptable alternate provided the details employed are those pre-engineered within the *ISAT Applications, Design and Inspection Manual*.

PART 3 - EXECUTION

3.1 INSTALLATION

A.

Hanger Spacing Schedule			
Piping Material	Pipe Size	Maximum Hanger Spacing	Remarks
Cast iron (hub and spigot)	All sizes	5 feet	Provide hanger behind each hub.
Cast iron (hubless)	All sizes	5 feet	Provide hanger at each side of every joint.
Copper	1¼" and less	6 feet	
Copper	1½" and larger	10 feet	
Steel	All	10 feet	Provide hanger at each mechanical joint.
Note: Restraint assemblies consisting of pipe clamps, rods and nuts shall be fitted to each hubless vertical to horizontal fitting. Sway bracing must be provided for above ground piping 6" or larger.			

- B. For flat slab construction only, support hangers from concrete inserts. Furnish, locate and set such inserts and make sure that such inserts are in place when the concrete is poured. Construct inserts of malleable iron or pressed steel with space for rods of all sizes. Install all inserts for pipes 3" and larger in size with a reinforcing rod ½" in diameter run through a slot in the insert specifically provided for this purpose.
- C. For flat slab construction only, if any pipe is to be hung in a space where no inserts have been provided, drill holes in the slab (subject to the Structural Engineer's prior approval) and provide rods and hanger attached to an approved fishplate or install double expansion shields connected by a 2" x 2" angle from which the hanger rod is to be suspended. For pipe size 2" and under, use single shields but the hanger spacing defined hereinbefore to be reduced to 5 feet. The carrying capacity and size of each shield to be calculated on the basis of the spacing indicated above but the minimum size to be _". Install additional shields of the same size so that the number of hangers are of adequate size to support the loads which they carry. Shields may be used in flat concrete slabs only.
- D. Regardless of the type of construction (i.e., concrete, concrete-deck-steel or other variations) take particular care to support all main lines and all large and heavy pipes in an approved manner, including the furnishing and installation of supplementary steel, if required. Supplementary steel sections are to be mill-rolled. Submit shop drawings, indicating support methods, point loadings to the building structure and hanger locations for review sufficiently in advance of concrete pouring schedules to permit evaluation, critique and any necessary changes to handling and support methods.

- E. Set all inserts for all pipes in ample time to allow concrete work to be performed on scheduled time.
- F. Hangers may be directly attached to steel beams of building construction, where they occur, if approved by Structural Engineer. Smaller pipes may be suspended from crosspieces of pipe or steel angles, which in turn are to be securely fastened to building beams. The intention is to provide supports which, in each case, will be amply strong and rigid for the load, but which will not weaken or unduly stress the building construction.
- G. Provide approved roller support, floor stands, wall brackets, etc., for all lines running near the floor or near walls, which can be properly supported or suspended by the floors or walls. Pipelines near walls may also be hung by hangers carried from approved wall brackets at a level higher than the pipe.
- H. Do not hang piping from other piping. Support of hangers by means of vertical expansion bolts is not permitted.
- I. Support Locations for Vertical Piping
 - 1. Cast Iron Soil Piping: At every floor and at its base, but in no case greater than 20-foot intervals.
 - 2. Copper Tubing and Steel Pipe: At every floor but no more than 20-foot intervals.
- J. Hangers shall be installed outside of piping insulation with a semi-cylindrical galvanized shield set between the hanger and insulation.
- K. Trapeze hangers may be used instead of separate clevis hangers with suspension rods having double nuts and securely attached to the construction.
- L. All beam attachments shall be installed on clean, smooth, and non-fireproofed sections of the beam.
- M. All hangers, anchors, rods and supports shall be galvanized or painted.

END OF SECTION

SECTION 220530
DISINFECTING OF WATER SUPPLY SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Disinfect the water supply piping system in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Disinfection of potable water piping system.

1.3 SUBMITTALS

- A. Test results.
- B. Guarantees.
- C. Necessary approvals.

1.4 QUALITY ASSURANCE

- A. Flush all lines before chlorination.
- B. Chlorinate all domestic water lines including tanks.
- C. Comply with National Standard Plumbing Code requirements for disinfection of potable water systems.
- D. Sterilize after all pressure tests have been completed.

PART 2 - PRODUCTS

- 2.1 Liquid Chlorine Fed. Spec. BB-C-12OB or hypochlorite Fed. Spec. O-C-114(4), Type II, Grade B or Fed. Spec. O-S-602D, Grade A or B.

PART 3 - EXECUTION

- 3.1 The pipe system shall be flushed with clean, potable water until no dirty water appears at the outlets.
- 3.2 The system or part thereof shall be filled with a water-chlorine solution containing at least 50 parts per million of chlorine and the system or part thereof shall be valved off and allowed to stand for 24 hr. or the system or part thereof shall be filled with a water-chlorine solution containing at least 200 parts per million of chlorine and allow to stand for 3 hours.
- 3.3 Test for residual chlorine at the extreme end of system from the point where chlorine was introduced. If less than 10 ppm, repeat chlorination procedure.
- 3.4 Flush system with clean water until chlorine is reduced to less than 1 ppm. Open and close each valve and faucet at least four times during flushing procedure.
 - A. Obtain the services of an independent laboratory to have samples taken and tested. The system must be free of bacteriological contamination. If the system is contaminated, rechlorinate until satisfactory. Submit test results to the Architect/Engineer.

END OF SECTION

SECTION 220533

HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide electric heat tracing in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Electric heat tracing to prevent pipes from freezing.
- B. Electric heat tracing for grease flow maintenance.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.
 - 1. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
- B. Shop Drawings: For electric heating cable. Include plans, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.
- E. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

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

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Furnish and Install a complete UL Listed, system of heating cables, components, and controls to <choose one or both> [prevent pipes from freezing] [provide flow maintenance of grease lines].
- B. Provide a complete system from a single manufacturer. The system shall be complete with all required cable, splice kits, tape, thermostat, power distribution/control panel with GFI protection, end seal kits, etc., as required for a complete installation.
- C. Unless indicated otherwise on the drawings, the contractor is required to design the heat tracing cable lengths, circuit start point and end points, as appropriate for the circuit limitations and provide the correct number of circuits and properly sized control panel for the intended application.
- D. The installation shall comply with the manufacturer's instructions.
- E. Component enclosures shall be rated NEMA 4X to prevent water ingress and corrosion. Installation shall not require the installing contractor to cut into the heating-cable core to expose the bus wires. Connection systems that require the installing contractor to strip the bus wires or that use crimps or terminal blocks, shall not be acceptable. All components that make an electrical connection shall be reenterable for servicing. No component shall use silicone to seal the electrical connections. An exception will be made in areas where a conduit transition is required.

2.2 HEAT TRACING CABLE

- A. The self-regulating heating cable shall consist of two (2) 16 AWG nickel-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heating cable to be cut to length in the field. The heating cable shall be covered by a radiation-crosslinked, modified polyolefin dielectric jacket. To provide a ground path and to enhance the heating cable's ruggedness, the heating cable shall have a braid of tinned copper and an outer jacket of fluoropolymer, as required per section 427-23 of the NEC-1996.
- B. In order to conserve energy and to prevent overheating, the heating cable shall have a self-regulating factor of at least 90 percent. The self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heating cable output going from 40°F pipe temperature operation to 150°F pipe temperature operation.
- C. The heating cable shall operate on line voltages of <choose one> [120] [208] [220] [240] or [277] volts without the use of transformers.
- D. The heating cable for freeze protection shall be sized 8 watts per foot at 50°F. Piping 8" and larger shall have 2 strips of heat trace cable per foot.

- E. For grease waste flow maintenance the heating cable shall be installed in accordance with the following schedule:

Pipe Size	Indoors	Outdoors/Parking Garages	Buried
4" and below	5 watts per foot – Single run	8 watts per foot – Double run	8 watts per foot – Single run
5", 6" and 8"	8 watts per foot – Single run	12 watts per foot – Double run	8 watts per foot – Double run
10" – 12"	12 watts per foot – Single run	12 watts per foot – Triple run	12 watts per foot – Double run

- F. Power connection, end seal, splice, and tee kit components shall be applied in the field.
- G. Heating cable circuit shall be protected by a ground-fault device for equipment protection.
- H. The heating cable shall be similar to XL-Trace cable as manufactured by Raychem Corporation.

2.3 LABELING

- A. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
- Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
 - Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.4 CONTROL PANEL (SMALLER SYSTEMS)

- A. The control equipment shall provide the required GFI protection for the heat tracing system. The system shall be modular for ease of expansion and shall provide complete system status and parameters locally, and remote alarm and data communication to the BMS.
- B. The system shall be field-mounted and shall have FM or CSA approval for Class I, Division 2, Groups A, B, C, D when using a solid-state switching device.
- C. The system shall provide the user with the option of line-sensing control with a user-selectable dead band, ambient sensing, proportional ambient sensing (PASC), and powerlimiting control modes.
- D. Enclosure type shall be NEMA 4X fiberglass reinforced plastic (FRP)
- E. Each heater cable shall be individually controlled by a Resistance Temperature Detector (RTD) device. The RTD shall be located on each pipe. The RTD shall be provided with armored lead wires to prevent damage. Failure of a temperature sensor shall be indicated at the system monitor panel and shall result in activation of the heater cable. Mechanical thermostats shall not be used.

- F. The monitor system shall provide UL Listed GFI protection for all branch heater cable circuits per NEC 1996 Section 423-22. GFI shall have a 30 mA trip level. Monitor system shall provide High GFI Current warning at 20mA.
- G. Each heater cable including all tees shall be monitored and provide alarms for high and low current.
- H. The freeze protection control systems shall energize each heater cable independently when the pipe temperature drops to 40 degrees F. The system shall indicate an alarm condition when the pipe temperature drops to 35 degrees F.
- I. For grease waste flow maintenance the control system shall energize each heater cable independently when the pipe temperature drops to 115oF. The system shall indicate an alarm condition when the pipe temperature drops below 70oF.
- J. Each monitor channel shall have a separate microprocessor and alarm group. Each monitor panel shall be NEMA 4X, UL approved. The panel shall operate off of the heater cable power supply, at that voltage.
- K. Each monitor channel shall have autocycling capability for monitoring cable during the entire year. All setpoints and diagnostics shall be stored in non-volatile memory. Alarms shall be provided for memory and SCR failures.
- L. The control system shall provide as standard the following alarm outputs:
 - 1. Dry contact to BMS for common alarm (Low Pipe Temperature, Ground Fault Alarm/Trip, and Loss of Power).
 - 2. DigiTrace units shall be network-ready to provide communication to a host PC running Windows™-based Supervisor software for central programming, status review, and alarm annunciation. DigiTrace units shall support the Modbus™ RTU or ASCII/HTCBus communications protocol and be supplied complete with RS-485 communications interface capability.

2.5 CONTROLS FOR DISTRIBUTED SYSTEMS

- A. The control system shall be of distributed control design, comprised of a user interface display connected to smart contactors located as indicated on the drawings and as associated with the specified heating cable applications.
- B. The distributed system shall provide for independent control functions at each smart contactor allowing for maximum system reliability and redundancy.
- C. The user interface shall allow parameters and algorithms to be selected for any or all of the following applications. Refer to contract drawings for indication:
 - 1. Freeze Protection:
 - a. Each heater cable shall be individually controlled by a line temperature sensing device. The RTD shall be located on each pipe as indicated on the contract drawings. The RTD shall be provided with armored lead wires to prevent damage. Failure of a temperature sensor shall be indicated at the system monitor panel and shall result in activation of the heater cable. Mechanical thermostats shall not be used.

- b. The control system shall energize each heater cable independently when the pipe temperature drops to 40 degrees F. The system shall indicate an alarm condition when the pipe temperature drops to 35 degrees F.
- 2. Grease Flow Maintenance
 - a. Each heater cable shall be individually controlled by a line temperature sensing device. The RTD shall be located on each pipe as indicated on the contract drawings. The RTD shall be provided with armored lead wires to prevent damage. Failure of a temperature sensor shall be indicated at the system monitor panel and shall result in activation of the heater cable. Mechanical thermostats shall not be used.
 - b. The control system shall energize each heater cable independently when the pipe temperature drops to 115 degrees F. The system shall indicate an alarm condition when the pipe temperature drops to 70 degrees F.
- D. The system shall be field-mounted and shall have FM or CSA approval for Class I, Division 2, Groups A, B, C, D when using a solid-state switching device.
- E. The system shall provide the user with the option of line-sensing control with a user-selectable dead band, ambient sensing, proportional ambient sensing (PASC), and power limiting control modes.
- F. Enclosure type shall be NEMA 4X fiberglass reinforced plastic (FRP) stainless steel for corrosion resistance and protection from moisture.
- G. The monitor system shall provide UL Listed GFI protection for all branch heater cable circuits per NEC 1996 Section 423-22. GFI shall have a 30 mA trip level. Monitor system shall provide High GFI Current warning at 20 mA.
- H. Each heater cable including all tees shall be monitored and provide alarms for high and low current.
- I. The system shall have autocycling capability for monitoring cable during the entire year. All setpoints and diagnostics shall be stored in non-volatile memory. Alarms shall be provided for memory and SCR failures.
- J. The system shall provide ground-fault monitoring, trip alarm and fault protection for every heat-tracing circuit and fulfills the requirements of agency certifications and the National Electrical Code.
- K. The user interface terminal shall be a LCD color display with touch screen technology. The UIT shall display and allow programming of all settings and be password protected to prevent unauthorized access to the system. The system shall be capable of controlling all heating applications independently by circuit.
- L. The control system shall be capable of setting different temperatures based on user defined input with 24 hour, 7 day/week programmable options.
- M. The control system shall have a user selectable option to save energy by lowering floor temperature during low use periods.
- N. The control system shall provide as standard the following alarm outputs:
 - 1. Dry contact to BMS for common alarm (Low Pipe Temperature, Ground Fault Alarm/Trip, and Loss of Power);

2. DigiTrace units shall be network-ready to provide communication to a host PC running Windows™-based Supervisor software for central programming, status review, and alarm annunciation. DigiTrace units shall support the Modbus™ RTU or ASCII/HTCBus communications protocol and be supplied complete with RS-485 communications interface capability.
 - a. The controller shall provide the following alarms: high/low temperature or RTD failure, high ground-fault current, ground-fault trip, high/low current fault, circuit relay failure, communication failure and loss of power.

2.6 ACCEPTABLE MANUFACTURERS

- A. Raychem Corporation
- B. Nelson
- C. Thermon

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
 1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written recommendations using cable protection conduit and slack cable to allow movement without damage to cable.
- B. Install electric heating cables after piping has been tested and before insulation is installed.
- C. Install electric heating cables according to IEEE 515.1.
- D. Install insulation over piping with electric cables according to Division 22 Section "Plumbing Insulation."
- E. Install warning tape on piping insulation where piping is equipped with electric heating cables.
- F. Set field-adjustable switches and circuit-breaker trip ranges.
- G. Protect installed heating cables, including non-heating leads, from damage.

3.3 FIELD QUALITY CONTROL

- A. Testing: Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
 1. Test cables for electrical continuity and insulation integrity according to manufacturer's instructions before energizing.

2. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
 - B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounting cables.
 - C. Remove and replace malfunctioning units and retest as specified above.
- 3.4 BURIED PIPING
- A. Buried splices or terminations will not be permitted. All splices or terminations in buried piping shall be extended above grade for access. Additional cable length required to accommodate the above grade splices shall be included.
- 3.5 TEMPERATURE SENSORS (RTD)
- A. Install temperature sensors at worst case locations.
- 3.6 AMBIENT TEMPERATURE SENSORS
- A. For all freeze protection systems provide an ambient temperature sensor to shut off the freeze protection system when the ambient temperature exceeds 50°F.

END OF SECTION

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SECTION 220534

TEMPERATURE MAINTENANCE CABLE FOR
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide electric heat tracing in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Provide a UL-listed system of electric self-regulating heating cable and components for maintaining the water temperature in the hot water lines as indicated on the drawings. The cable shall utilize a radiation-crosslinked conductive polymer as the heating element, and the cable shall be specifically designed, manufactured, and UL listed for domestic hot water temperature maintenance.

1.3 SUBMITTALS

- A. Shop Drawings: Equipment sizes, locations, performance data, installation details, wiring diagrams, and controls.
- B. Product Data: Manufacturer's latest published data for materials, equipment and installation.
- C. Copy of UL file indicating the heating cable is specifically listed to provide supplementary heating to hot water service supply systems utilizing thermally insulated metal or plastic pipe.
- D. Project list of at least 20 projects, installed for at least 5 years, with at least 2000 feet of self-regulating heating cable in each project.

1.4 QUALITY ASSURANCE

- A. U.L.
- B. National Electric Code.

PART 2 - PRODUCTS

2.1 CONSTRUCTION

- A. Hot Water Heating Cable
 - 1. The self-regulating heating cable shall consist of two (2) 16-AWG nickel-coated copper bus wires embedded in a radiation-crosslinked conductive polymer core. It shall be covered by a radiation-crosslinked, polyolefin, dielectric jacket surrounded by a polymer-coated aluminum wrap, and enclosed in a tinned copper braid of 14 AWG equivalent wire size. The braid shall be covered with a 40-mil polyolefin outer jacket, color coded for easy identification.
 - 2. The heating cable shall operate on voltage shown on drawings.

- B. The cable shall have a minimum cut-through resistance of 600 lb. per CSA 22.2 0.3 Cutting Test 4.14. The cable shall have a minimum impact resistance of 25 ft.lb. per UL 1588.11. The cable shall withstand a glancing impact of 22.ft.lb. per UL 1581.590. The cable shall have a minimum abrasion resistance of 7000 cycles per UL 719.19. The cable shall withstand a crush resistance of 4500 N per IEEE 515 Deformation Test 5.1.5.

2.2 PERFORMANCE

A. Hot Water Heating Cable

1. Operating temperatures: The system shall maintain a nominal temperature of 105°F 115°F 125°F 140°F. Exact temperature requirements shall be noted on the drawings. The system shall operate at voltage shown on drawings.
2. Each hot water system temperature shall be maintained using only one product. Temperatures shall be maintained with straight runs of heating cable on the pipe.
3. The slope of the power/temperature curve shall be such that the power of the heating cable shall increase with decreasing temperature at a rate of at least 0.028 W/ft.°F from 50°F to 100°F.
4. The power retention of the heating cable shall be at least 90% after 300 cycles between 50°F and 212°F.
5. The heater shall not decrease in resistance, overheat, or burn when powered at 208 V and exposed to 400°F for 30 minutes.

2.3 ACCEPTABLE MANUFACTURERS

- A. Raychem Corporation
- B. Nelson

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The system shall be installed according to the drawings and the manufacturer's instructions. The installer shall be responsible for providing a functional system, installed in accordance with applicable national and local code requirements. Each circuit shall be protected with a 30-mA ground-fault protection device. Apply "electric traced" signs to the outside of insulation. Signs shall be located where they can be easily read.
- B. Hot Water Heating Cable
 1. The quantity of heating cable furnished shall trace all hot water mains and risers completely and branch piping to within 10 feet of the fixture in compliance with the manufacturer's recommendations and the plumbing contract drawings.
 2. The plumbing contractor shall cooperate with the electrical contractor to coordinate the installation and testing of this system, including identification of all piping to be traced. Piping to be heat traced shall be marked by the plumber in the field.
 3. Furnish a UL-listed hot water temperature maintenance system for installation by the Electrical Contractor, consisting of self-regulating heating cable for the voltage shown on drawings. The self-regulating heating cable shall consist of a flat flexible low heat density electric heating strip of parallel circuit construction covered with a flexible tinned copper braid. The self-regulating conductive polymer core and the polyolefin outer insulating jacket shall both be radiation cross-linked to stability of long term performance.

Accessories to include power connection kits with end seals, fiberglass tape, electric traced labels, splice and tee kits, as required.

3.2 TESTING

- A. Measure the heater circuit continuity and the insulation resistance between the braid and bus wires with a 2500-Vdc megohmmeter (megger). Minimum insulation resistance shall be ten (10) mega-ohms regardless of length.
- B. The tests should be performed after the pipe insulation has been installed and prior to installation of wall or ceiling panels, and shall be witnessed by the Owner's Representative and the manufacturer or the manufacturer's representative.
- C. The heater circuit shall be continuous and megger readings shall be at least 20 megohms regardless of heater length. Circuits yielding unacceptable readings must be repaired or replaced.
- D. Submit records of the test data to the Engineer.

END OF SECTION

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SECTION 220535
BACKFLOW PREVENTION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide backflow preventer assemblies in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Backflow Prevention Devices.

1.3 SUBMITTALS

- A. Manufacturer's Specifications and Engineering Data
 - 1. Materials
 - 2. Parts
 - 3. Devices
 - 4. Finish
 - 5. Performance Data

1.4 QUALITY ASSURANCE

- A. ASSE No. 1013
- B. ASSE No. 1012
- C. ASSE No. 1001
- D. AWWA C506
- E. U.L.
- F. Factory Mutual

PART 2 - PRODUCTS

2.1 REDUCED PRESSURE ZONE BACKFLOW PREVENTER ASSEMBLY 3/4"-2"

- A. The reduced pressure backflow preventer shall consist of two (2) independently operating, spring loaded, "Y" pattern check valves and one (1) hydraulically dependent differential relief valve. The device shall automatically reduce the pressure in the "zone" between the check valves to at least 5 PSI lower than inlet pressure. Should the differential between the upstream and the zone of the unit drop to 2 PSI, the differential relief valve shall open and maintain the proper differential.
- B. Mainline valve body and caps including relief valve body and cover shall be bronze. Check valve moving member shall be center stem guided. All hydraulic sensing passages shall be internally located within the mainline and relief valve bodies and relief valve cover. Diaphragm to seat area ratio shall be 10:1 minimum. Check valve and relief valve components shall be constructed so

they may be serviced without removing the valve body from the line. All seat discs shall be reversible. Shutoff valves shall be full ported.

- C. The device shall be rated to 175 PSI water working pressure and water temperature range from 32°F to 180°F.
- D. The device shall be similar to Conbraco 40-200.

2.2 REDUCED PRESSURE ZONE BACKFLOW PREVENTER ASSEMBLY, 2½"-10"

- A. The reduced pressure backflow preventer shall consist of two (2) separate spring loaded, "Y" type check valves and one (1) differential relief valve having two (2) diaphragms separated by a spacer. This device shall automatically reduce the pressure in the "zone" between the check valves. Should the differential between the upstream and the zone to the unit drop to 2 PSI, the differential relief valve shall open and maintain the proper differential.
- B. Both check valve and the differential relief valve shall be constructed so they may be serviced without removing the device from the line.
- C. Backflow preventers shall have cast iron bodies and covers with internal epoxy coating and bronze trim. Sizes 2½" and 3" shall have bronze and stainless steel internal check assembly. Sizes 4"-10" shall have stainless steel internal check assembly. The device shall be rated to 175 PSI working pressure and water temperature from 32°F to 140°F.
- D. Device shall be similar to Conbraco 40-200 backflow preventer.

2.3 DOUBLE CHECK WITH ATMOSPHERIC PORT

- A. The double check backflow preventer with atmospheric port shall consist of two (2) independently operating check valves with an intermediate atmospheric port. The device shall have a cast bronze body and union nuts, stainless steel springs, precision machined internal brass parts, and molded parts of plastics specially selected for high temperature use, resiliency, positive sealing, and long life.
- B. The device shall be similar to Febco 815DCAP.

2.4 VACUUM BREAKERS

- A. Atmospheric vacuum breakers shall have all bronze bodies and bonnets and shall be of the non-spilling type. Vacuum breaker shall be rated to 150 PSI working pressure and shall withstand water temperatures of 32°F to 110°F.
- B. Devices shall be similar to Febco Model 710/715.

2.5 ACCEPTABLE MANUFACTURERS

A. Backflow Preventers

- 1. Watts
- 2. Febco
- 3. Hersey
- 4. Conbraco

B. Vacuum Breakers

- 1. Watts

2. Febco

PART 3 - EXECUTION

3.1 APPLICATION

A.

	Location	Device
	All incoming domestic service	Reduced pressure zone backflow preventer
	Connections to all HVAC equipment	Reduced pressure zone backflow preventer
	Connections to all Kitchen and Concession equipment	Double check with atmospheric port
	All submerged inlet	Vacuum breaker and check valve
	All hose bibb connections	Vacuum breaker

3.2 GENERAL

- A. Pipe all relief ports to nearest floor drain.
- B. Provide 4" concrete pad for all backflow preventers larger than 1½" unless otherwise noted.
- C. Provide valves on inlet and outlet of all reduced pressure backflow preventers.
- D. Install all backflow preventers according to manufacturer's recommendations.

END OF SECTION

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SECTION 220548
VIBRATION ISOLATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide vibration isolation in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Vibration isolation elements for piping and equipment.
- B. Equipment isolation bases.

1.3 SUBMITTALS

- A. Manufacturer's Data
 - 1. Catalog cuts and data sheets on specific vibration isolators to be utilized showing compliance with the specifications.
 - 2. An itemized list showing the items of equipment or piping to be isolated, the isolator type of model number selected, isolator loading and deflection, and reference to specific drawings.
 - 3. Written approval of the base design to be obtained from the equipment manufacturer.
- B. Shop Drawings
 - 1. Drawings showing equipment base constructions for each piece of equipment, including dimensions, structural member sizes and support point locations.
 - 2. Drawings showing methods of suspension and support guides for piping.
 - 3. Drawings showing methods for isolation of pipes piercing walls and floor slabs.
 - 4. Concrete and steel details for bases including anchor bolt locations.
 - 5. Provide installation instructions, drawings and field supervision to assure proper installation and performance.

1.4 QUALITY ASSURANCE

- A. Provide control of excessive noise and vibration in the buildings due to the operation of pumps or equipment, and/or due to interconnected piping. Installation of vibration isolation units, and associated hangers and bases, shall be under the direct supervision of the vibration isolation manufacturer's representative.
 - 1. All vibration isolators shall have either known undeflected heights or calibration markings so that, after adjustment, when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.
 - 2. All isolators shall operate in the linear portion of their load versus deflection curve. Furnish load versus deflection curves linear over a deflection range of not less than 50% above the design deflection.
 - 3. The ratio of lateral to vertical stiffness to be not less than 0.9 nor greater than 1.5.
 - 4. The theoretical vertical natural frequency for each support point, based upon load per isolator and isolator stiffness shall not differ from the design objectives for the equipment as a whole by more than $\pm 10\%$.

5. All neoprene mountings shall have a Shore hardness of 40 to 65, after minimum aging of 20 days or corresponding oven-aging.
- B. Adhere to SMACNA Guidelines for Restraints of Mechanical Systems.
- C. Manufacturer of vibration isolation equipment has the following responsibilities:
 1. Determine vibration isolation and seismic restraint sizes and locations.
 2. Guarantee specified isolation system deflection.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All vibration isolation devices to be the product of a single manufacturer.
- B. Where exposed to the atmosphere all steel to be hot dipped galvanized; hardware to be cadmium plated; springs to be neoprene coated.
- C. Initials used in this specification are as follows: MII-Mason Industries, Inc.; VMCI - Vibration Mountings and Controls, Inc.; PE - Peabody Engineering; KDC - Korfund Dynamics Corp.; AB - Amber Booth; VEC - Vibration Eliminator Co.

2.2 VIBRATION ISOLATORS

- A. Refer to schedule sheets for vibration isolator types to be used.
 1. Type A: Spring isolators to incorporate the following:
 - a. Minimum diameter of 0.8 of the loaded operating height and horizontal spring stiffness 1.1 times rated vertical spring stiffness.
 - b. Reserve deflection, from loaded to solid height, of 50% of rated deflection with leveling device.
 - c. Minimum ¼ inch thick neoprene acoustical base pad on underside, unless designated otherwise.
 - d. Designed and installed so that ends of springs remain parallel.
 - e. Non-resonant with equipment forcing frequencies or support structure natural frequencies.
 - 1) Type SLF MII
 - 2) Type OSKVEC
 - 3) Type AN VMCI
 2. Type B: Spring isolators to be same as Type A, except:
 - a. Provide built-in resilient vertical limit stops.
 - b. Tapped holes in top plate for bolting to equipment.
 - c. Capable of supporting equipment at a fixed elevation during equipment erection.
 - 1) Type SLR MII
 - 2) Type KW VEC
 - 3) Type AWR VMCI
 3. Type C: Spring hanger rod isolators to incorporate the following:
 - a. Spring element seated on a steel washer within a neoprene washer.
 - b. Steel retainer box encasing the spring and neoprene washer.
 - c. Minimum ½ inch clearance between retainer box and spring hanger rod.
 - d. Maximum 30 degree allowable rod misalignment from centerline axis.

- 1) Type 30 MII
- e. Where operating weight differs from installed weight provide built-in adjustable limit stops to prevent equipment rising when weight is removed. Stops shall not be in contact during normal operation.
4. Type D: Elastomer isolators to incorporate the following:
 - a. Bolt holes for bolting to equipment base.
 - b. Bottom steel plates for bolting to sub-base as required.
 - c. Unit type design molded in oil-resistant neoprene.
 - d. Neoprene to be compounded to meet the following:
 - 1) Not greater than 70 durometer.
 - 2) Minimum tensile strength 2000 psi.
 - 3) Minimum elongation 300%.
 - 4) Maximum compression set at 25% of the original deflection

a)	Type ND	MI
b)	Type 368 SD	VEC
c)	Type RD	VMCI
5. Type E: Elastomer hanger rod isolators to incorporate the following:
 - a. Molded unit type neoprene element.
 - b. Compounding described in Type D above.
 - c. Steel retainer box encasing neoprene mounting.
 - d. Clearance between mounting hanger rod and steel retainer box.

1)	Type HD	MI
2)	Type CD	VEC
3)	Type RHD	VMCI
6. Type F: Pad type elastomer mountings to incorporate the following:
 - a. 5/16 inch minimum thickness.
 - b. 50 psi maximum loading.
 - c. Ribbed or waffled design.
 - d. 1/16 inch deflection per pad thickness.
 - e. 1/16 inch galvanized steel plate between multiple layers of pad thickness.
 - f. Suitable bearing plate to distribute load.

1)	Type W	MI
2)	Type 200N	VEC
3)	Type Shearflex	VMCI
7. Type G: Pad type elastomer mountings to incorporate the following:
 - a. Laminated canvas duck material and neoprene.
 - b. Maximum loading 1000 psi.
 - c. Suitable bearing plate to distribute load.
 - d. Minimum thickness, 2 inch.

1)	Type HL	MI
2)	Type Fabriflex	VMCI
8. Type H: Combination spring/elastomer hanger rod isolators to incorporate the following:
 - a. Spring and neoprene isolator elements in a steel box retainer.
 - b. Characteristics of spring and neoprene as described in Type C and Type D hanger isolators.

1)	Type 30N	MI
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- 2) Type SNRC VEC
- 3) Type RSH-30A VMCI

2.3 EQUIPMENT BASES

A. Integral Structural Steel Base, Type B-1

1. Reinforced as required to prevent base flexure at start-up and misalignment of drive and driven units. Drilled for drive and driven unit mounting template.
 - a. Type WF MII

B. Concrete Inertia Base, Type B-2

1. Concrete inertia bases to be formed in a structural steel perimeter base, reinforced as required to prevent flexure, misalignment of drive and driven unit or stress transferral into equipment. The base to be complete with motor slide rails, pump base elbow supports and complete with height saving brackets, reinforcing, equipment bolting provisions and isolators.
2. Minimum thickness of the inertia base to be according to the following tabulation:

Motor Size-(HP)	Min. Thickness-Inches
5-15	6
20-50	8
60-75	10
100-250	12
Type K (MII)	

2.4 FLEXIBLE CONNECTORS

A. Neoprene Type FC-1

1. Manufactured of nylon tire cord and neoprene both molded and cured with hydraulic presses.
2. Straight connectors to have two spheres.
3. Elbow to have single sphere forming the corner of joint.
4. Rated 150 psi at 220°F.
5. Size 12 inch and larger to employ control cables with end fittings isolated from anchor plates by means of ½ inch bridge bearing.
6. Neoprene washer bushings.
 - a. Type MFNEC, MFTFU or MFTNC MII

B. Flexible Stainless Hose, Type FC-2

1. Braided flexible metal hose.
2. 2 inch pipe size and smaller with male nipple fittings.
3. 2½ inch and larger pipe size with fixed steel flanges.
4. Suitable for operating pressure with 4:1 minimum safety factor.
5. Length as shown on Drawings.
 - a. Type BSS MII
 - b. Type MFP VMCI

2.5 SEISMIC RESTRAINTS

A. General

1. Provide restraints capable of safely accepting one half "G" external forces without failure, or one "G" for life safety equipment to maintain equipment and piping in a captive position. Restraints must not short circuit vibration isolation systems or transmit objectionable vibration or noise. Submit calculations by registered Civil or Structural Engineer to verify snubber capacities.
 - a. Spring Seismic Restraint, Type I: Comply with general characteristics of spring isolators. Incorporate snubbing restraint in all directions. Restraint shall be capable of supporting equipment at a fixed elevation during equipment erection.
 - 1) Type SSLFH MII
 - b. Seismic Restraint, Type II: Each corner or side seismic restraint to incorporate minimum 5/8 inch thick resilient pad limit stops. Restraints shall be made of plate, structural members or square metal tubing in a welded assembly incorporating resilient pads.
 - 1) Type Z-1255 MII
 - c. Seismic Restraint, Type III: Metal cable type with approved end fastening devices to equipment and structure. See details on Drawings.
2. Provide diagonal thrust restraint consisting of Type C Hanger with the same deflection as specified for the spring mountings. Design the spring element so it can be preset for thrust and adjusted to allow for a maximum of ¼ inch movement at start and stop. Attach diagonal restraints at the centerline of thrust restraint.
 - a. Type WV MII

2.6 ACCEPTABLE MANUFACTURERS

- A. Mason Industries, Inc. (MII)
- B. Vibration Mountings & Controls, Inc. (VMCI)
- C. Peabody Engineering (PE)
- D. Korfund Dynamics Corp. (KDC)
- E. Amber-Booth (AB)
- F. Vibration Eliminator Co. (VEC)

PART 3 - EXECUTION

3.1 GENERAL

- A. Install in accordance with manufacturer's written instructions. Vibration isolators must not cause any change of position of equipment or piping resulting in piping stresses or misalignment.
- B. Isolate mechanical equipment from the building structure by means of noise and vibration isolators as scheduled on the Drawings.

- C. Piping to be isolated must pass freely through walls and floors without rigid connections. Maintain 3/4 inch to 1 1/4 inch clearance around outside surfaces of piping at penetration points. Pack this clearance space tightly with fiberglass, and caulk airtight after installation of piping.
- D. Make no rigid connections between equipment and building structure that degrades the noise and vibration isolation system specified herein.
- E. Bring to the Engineer's attention, prior to installation, any conflicts with other trades which will result in unavoidable rigid contact with equipment or piping as described herein, due to inadequate space or other unforeseen conditions. Corrective work necessitated by conflicts after installation will be at the responsible contractor's expense.
- F. Support vertical piping loads, including water strainers, and valves between pump base elbow supports and the suction and discharge header piping by means of the pump base spring isolators without stress or strain to the pump housing.

3.2 EQUIPMENT ISOLATORS

- A. Mount vibration isolating devices and related inertia blocks on the housekeeping concrete pad.
- B. Support each pump and motor assembly on a single structural steel frame.
- C. Additional Requirements
 - 1. Provide brackets to accommodate the isolator. Manufacturer to specify the vertical position and size of the bracket.
 - 2. Maintain a minimum operating clearance between the equipment frame on rigid steel base frame and the housekeeping pad of 1 inch. Maintain a minimum operating clearance of 2 inches between concrete inertia and base and housekeeping pad or floor.
 - 3. Temporarily support the structural steel or concrete inertia base with blocks or shims, as appropriate, prior to the installation of the machine or isolators.
 - 4. Install the isolators without raising the machine and frame assembly.
 - 5. Adjust the isolator after the entire installation is complete and under full operational load so that the load is transferred from the blocks to the isolator. When all isolators are properly adjusted, the blocks or shims will be barely free and shall be removed.
 - 6. Verify that all insulated isolator and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to flexibly limit equipment start-up lateral motion to 1/2 inch.
 - 7. Prior to start-up, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base or isolators.

3.3 PIPING ISOLATORS

- A. Isolate piping outside the shafts as follows:
 - 1. All water piping in machine rooms.
 - 2. Piping where exposed on roof.
 - 3. Water piping within 50 feet (or 100 diameters if greater) from connected rotating equipment and pressure reducing stations.
- B. Install isolators with the isolator hanger box attached to, or hung as close as possible to, the structure.
- C. Suspend isolators from substantial structural members, not from slab unless specifically permitted.

- D. Align hanger rods to clear the hanger box.
- E. Suspend horizontal pipe 2 inches and smaller by means of Type E isolator with a minimum 0.25 inch deflection. Support pipe larger than 2 inches by isolator Type C with a minimum 1½ inch static deflection.
- F. Mount floor supported horizontal pipe at slab using Type A isolator with a minimum static deflection of 1 inch or same deflection as isolated equipment to which pipe connects, whichever is greater.
- G. Utilize Type G isolator for vertical riser pipe supports.
- H. Utilize resilient pipe anchors, where required, similar to Mason Industries Type ADA, to avoid direct contact of piping with building.
- I. Utilize two neoprene elements for pipe sway braces, where required, Type F or G isolator, to accommodate tension and compression forces.
- J. Position all isolators close to building structure.
- K. Mount all isolators between building structure and supplementary steel.
- L. Suspend isolators from rigid and massive support points.
- M. Supplementary steel to be sized for a maximum deflection of 0.08 inches at center span.
- N. Support water piping in shafts and floor supports entering shaft with Type F isolators (2 layers) or Type G pad depending on piping loads and support point space conditions within shafts.
- O. Guide and anchor piping in shafts as required with approved mounting designs incorporating Type G pad to prevent direct contact of piping with building structure.

3.4 INSPECTION

- A. On completion of installation of all vibration isolation devices specified herein, the local representative of the isolation materials manufacturer is to inspect the completed system and to submit a report to the Engineer indicating the adequacy of the installation and listing any corrective action required.

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SECTION 220553

IDENTIFICATION OF PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide information of plumbing systems in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Pipe Labeling
- B. Valve and Equipment Tagging

1.3 SUBMITTALS

- A. Provide the following Manufacturer's Specifications and Engineering Data:
 - 1. Materials
 - 2. Parts
 - 3. Devices
 - 4. Finish
 - 5. Area of Use
- B. Provide samples as follows: Where manufacturer's catalog information does not satisfactorily indicate materials, engineering design, quality of construction or aesthetics of proposed equipment, samples shall be submitted as requested with no additional cost to the Owner.

1.4 QUALITY ASSURANCE

- A. Local Codes.
- B. Plumbing and Drainage Institute (PDI).
- C. ANSI.
- D. National Sanitary Foundation (NSF).
- E. ASTM.
- F. Underwriters Laboratories (UL).

PART 2 - PRODUCTS

2.1 GENERAL

- A. The following specifications represent desired design, material, and construction standards for the various items of work. Manufacturer names and model numbers are used to describe specific types, styles and quality.

2.2 PIPE LABELING

- A. All piping shall be identified by stenciled lettering, or self-adhesive pipe markers which legend conforms to OSHA/ANSI standards including but not limited to the identification of flow direction, pressure, supply/return, pump discharge, cold water, hot water, hot water return, etc.
- B. There shall be at least one lettering identification for each pipe in each space and at all valve locations.
- C. For painted identification use color sharply contrasting with background. If necessary, paint a strip background of black or white to obtain contrast.
- D. Vertical piping shall be labeled at each floor. Horizontal piping shall be labeled every 10', both sides of partitions, before and after turns, and close to valves and flanges.
- E. Each set consisting of one (1) band on which the name of the service is printed in black letters not less than 1½ inches high, and one (1) band on which is printed a black directional arrow. Apply bands where they can be easily read and with their long dimension parallel to the axis of the pipe. Provide bands with backgrounds of different colors from the various service groups.
- F. Adhesive Bands: "Quick-Label B-350 Perma-Code Film Markers" (W.H. Brady Company).

2.3 VALVE & EQUIPMENT TAGGING

- A. Tag valves with identifying number and system. Number valves by floor level.
- B. For valves, etc., use metal tags 2" minimum in diameter with 1" painted letters fabricated of brass, stainless steel or aluminum. Attach tags with chain of same material.
- C. Prepare lists of all tagged valves showing location, floor level, tag number and use. Prepare separate lists for each system. Mount lists under a sheet of clear acrylic in Equipment Room. Include copies in each maintenance manual.
- D. Provide charts showing equipment lubrication points, lubrication required and frequency, and columns for date and initials.
- E. Stencil equipment with identifying letters and numbers as used on drawings. Where space is available use full name of equipment.
- F. Identify all controls such as motor starters not in motor control centers, float switches and alarms.

PART 3 - EXECUTION

3.1 NOT USED

END OF SECTION

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SECTION 220580

ACCESS DOORS IN GENERAL CONSTRUCTION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Furnish access doors located in general construction in accordance with the Contract Documents for setting under general construction work.

1.2 WORK INCLUDED

- A. Access Doors in Drywall.
- B. Access Doors in Ceilings.
- C. Access Doors in Masonry.
- D. Fire Rated Access Doors.
- E. Color Coded Buttons.

1.3 SUBMITTALS

- A. Provide manufacturer's data on access doors to be furnished in each type of general construction, by location, within the project.

PART 2 - PRODUCTS

- 2.1 Wherever access is required through walls or ceilings, to valves, gauges, alarm devices, or other concealed equipment installed under this division, furnish a hinged access door with flush screwdriver operated cam locks and frame as follows:

- A. Drywall construction--Milcor Style DW.
- B. Finished acoustical tile ceiling--Milcor Style AT.
- C. Finished plaster ceiling--Milcor Style AP.
- D. Finished plaster walls or ceramic tile--similar to doors required for finished acoustical tile ceiling.
- E. Plaster or masonry walls and ceilings outside offices and in other finished areas exposed to view--Milcor Style K or M.
- F. Provide access doors in rated construction with "B" label fire construction. Furnish a U.L. label on each access door.
- G. Access doors will be installed under another Division. Coordinate all sizes and locations with General Contractor.
- H. No access door shall be installed until location and type have been approved by the Architect.

- 2.2 Furnish color coded buttons or tabs to indicate location of valves or other equipment located above removable type ceilings where access doors are not required.
- 2.3 Make access door size a minimum of 18" x 18".

PART 3 - EXECUTION

3.1 GENERAL

- A. Coordinate sizes and location of all access doors with General Contractor.
- B. Direct location and setting of access doors in hung ceilings, furred spaces, walls, etc., to provide access to all concealed work items requiring maintenance and/or adjustment and as directed by the Architect/Engineer. Obtain acceptance of the Architect/Engineer for the locations and sizes of such access doors.
- C. Locate and group equipment requiring access doors so that access door locations are aesthetically acceptable. Coordinate location of equipment requiring access with other trades to minimize number of access doors in one area. Prepare drawings of valve locations indicating proposed access door locations for review by the Architect/Engineer prior to installation of valves, etc. Include equipment of other trades on the Drawing.

END OF SECTION

SECTION 220590

TESTING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide testing for all plumbing systems in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Test all new systems.

1.3 SUBMITTALS

- A. Provide all test certifications.
- B. Approvals.

1.4 QUALITY ASSURANCE

- A. AWWA
- B. New York City Building Code
- C. 2015 NYS Uniform Code
- D. International Fuel Gas Code
- E. International Plumbing Code
- F. NFPA-54
- G. Utility Requirements

PART 2 - PRODUCTS

2.1 NOT USED.

PART 3 - EXECUTION

3.1 DOMESTIC WATER SYSTEM

- A. Upon completion of a section of a water system or of the entire water system, the completed section or system shall be verified as to materials, and shall be tested and proven tight under a water pressure of at least 1½ times the working pressure, but not less than 200 psig, for one (1) hour, with no loss in pressure. Testing of sections shall be done in order to permit general construction and other work to proceed. Such tests shall be made in the presence of the Building Department Inspectors, Owner's representative and any other authorities having jurisdiction.

- B. Provide all apparatus and temporary work for tests. Take all precaution necessary to prevent damage to the building or its contents as a result of such tests. The water used for tests shall be obtained from a potable source of supply.
- C. Any defects or deficiencies discovered as a result of tests shall be immediately repaired and tests shall be repeated until the test requirements are fully complied with.
- D. Caulking of pipe joints to remedy leaks will not be permitted.

3.2 SOIL, WASTE, VENT AND STORM WATER SYSTEMS

- A. Except for outside leaders and perforated or open jointed drain tile (subsoil drains), the piping of sanitary and storm drainage and vent systems shall be verified as to materials and shall be tested upon completion of the rough piping installation and prove to be water tight. The removal of cleanout plugs may be required to ascertain that the prescribed pressure has been reached in all parts of the system. Testing of sections shall be done in order to permit general construction and other work to proceed. Such tests shall be made in the presence of the Building Department Inspectors, Owner's representative and any other authorities having jurisdiction.
- B. Water Test. A water test shall be applied to the drainage system either in its entirety or in sections after rough piping has been installed. If applied to the entire system, all openings in the piping, except the highest opening, shall be tightly closed and the system filled with water to the point of overflow. If the system is tested in sections, each opening, except the highest opening of the section under test, shall be tightly plugged and each section filled with water. No section shall be tested with less than a ten foot head of water. In testing successive sections, at least the upper ten feet of the following section shall be tested, so that no joint or pipe in the building (except the uppermost ten feet of the system) shall have been submitted to a test of less than ten foot head of water. The water shall be kept in the system or in the portion under test for at least four (4) hours before inspection starts; the system shall then be tight at all points.
- C. Air Test. An air test may be used only when permission for this type of test is obtained from the Engineer. The air test shall be made by attaching an air compressor testing apparatus to any suitable opening and, after closing all other inlets and outlets of the system, forcing air into the system until there is a uniform gauge pressure of five psi or sufficient pressure to balance a column of mercury ten inches in height. This pressure shall be held, without introducing additional air, for a period of at least thirty minutes.
- D. Buried Piping
 - 1. In addition to the hydrostatic testing indicated above all buried piping shall be videotaped twice. Once after backfilling is complete and a second time after the slabs have been poured. A report and videotape shall be given to the owner's representative after each test.

3.3 NATURAL GAS SYSTEMS

- A. Upon completion of a section of a gas system or of the entire gas system and before appliances are connected thereto, the completed section or system shall be verified as to materials, and tested and proven tight as described hereafter.
- B. Gas Distributing Piping
 - 1. Piping shall be tested in accordance with the following criteria:

Operating Pressure	Test Pressure	Duration	X-Ray Testing Required
Less than ½ psig	3 psig	1 hour	No
½ psig to 3 psig	50 psig	1 hour	No
3 psig to 15 psig	100 psig	1 hour	Yes
15 psig and above	100 psi or 2 times operating pressure whichever is greater	2 hour	Yes
Operating Pressure	Test Pressure	Duration	X-Ray Testing Required
Less than 3 psig	90 psig	30 minute	No
3 psig to 125 psig	90 psig or 1 ½ times working pressure whichever is greater	1 hour	Yes
125 psig or greater	1 ½ times working pressure	2 hour	Yes

Operating Pressure	Test Pressure	Duration	X-Ray Testing Required
Less than 3 psig	3 psig or 1 ½ times working pressure whichever is greater	30 minutes for each 500 ft³ of pipe volume not to exceed 24 hours	No
3 psig above	1 ½ times working pressure	30 minutes for each 500 ft³ of pipe volume not to exceed 24 hours	Yes

C. Meter Piping

1. Meter piping shall be pressure tested in accordance with the requirements of the serving utility. These requirements shall be either the same as those for testing distribution piping in paragraph B, or if different, the piping shall be certified by the local utility as being tested in compliance with their requirements.
2. Notwithstanding the above, all coated or wrapped pipe shall be pressure tested at a minimum of ninety psig.

D. Testing Procedure

1. For testing, the piping shall be filled with air or an inert gas, and the source of pressure shall be isolated before the pressure readings are made. All test duration time periods are to be measured after stabilization of testing medium. Fresh water may be used as the test medium only where the required test pressure exceeds one hundred psig.

END OF SECTION

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SECTION 220719

INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide insulation in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Equipment Insulation.
- B. Piping Insulation.

1.3 SUBMITTALS

- A. Shop Drawings: Submit insulation shop drawings for each service.
- B. Product Data: Manufacturer's latest published data for materials, equipment, and installation.

1.4 QUALITY ASSURANCE

- A. ASTM C335.
- B. ASTM C356.
- C. ASTM C411.
- D. ASTM C547.
- E. ASTM 84.
- F. ASTM 225.
- G. U.L.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Conform to application schedule specified herein for types and thicknesses of insulation.
- B. Provide insulation (including insulation jacket or facing and adhesives used to adhere the facing or jacket to the insulation) with noncombustible material meeting all Code requirements and fire and smoke hazard ratings as tested by procedure ASTM E-84, National Fire Protection Association 225, and UL 723, not exceeding flame spread 25 and smoke developed 50.

2.2 PIPE INSULATION

A. Materials

1. Fiberglass Density: All Fiberglass pipe insulation in equipment rooms and/or where exposed, to be of the sectional type having 6 lbs./cu. ft. density. All other fiberglass insulation to be of the 1-piece type having 4 lb. density.
2. Thermal conductivity of fiberglass to be .23 BTU/hr/inch/sq. ft./°F at a mean temperature of 75°F.
3. Thermal conductivity of calcium silicate to be .32 BTU/hr/inch/sq. ft./°F at a mean temperature of 100°F.

B. Insulation Jackets

1. Hot Pipes Concealed: Factory applied white fire retardant jacket, (ASJ), taped and banded. Pipes banded with not less than 3 bands per section.
2. Hot Pipes Exposed: Factory applied white fire retardant jacket, (ASJ), with butt strips taped and banded. Pipes banded with not less than 3 bands per section.
3. Cold Pipes Concealed and Exposed: Factory applied white fire retardant jacket with self-sealing lap (ASJ) and butt strip. Ends of pipe insulation sealed off at valves, fittings and flanges with I.C. 301 or FB 30-35).
4. Finish calcium silicate with glass cloth adhered with I.C. 501 or BF 30-36.
5. Vapor jacket permeability to be 0.02 perms.
6. Jacket Puncture Resistance to be 50 units (Beach).
7. Piping Exposed to Outdoors: Cover piping and fittings which is exposed to weather or called for to be weatherproof, in addition to insulation and finishes specified for piping exposed to outdoors, with a polished aluminum jacket similar to Johns-Manville "Metal-Lok" or approved equal.

C. Application Schedules

1. Schedule

<u>Service</u>	<u>Material</u>	Insulation Thickness in Inches for Pipe Sizes				
		<u>1" and less</u>	<u>1¼" to 2"</u>	<u>2½" to 4"</u>	<u>5" to 6"</u>	<u>8" and larger</u>
Horizontal Storm Drains and Drain Bodies	Glass Fiber	---	1"	1"	1"	1"
Hot Water and Hot Water Circulation	Glass Fiber	1"	1"	1"	--	--
Domestic Cold Water	Glass Fiber	1"	1"	1"	1"	1"
Drains and Drain Bodies Receiving Condensate	Glass Fiber	--	1"	1"	1"	--"
Drain Traps at Handicapped Sinks	Glass Fiber	--	1/2"	--	--	--

2. Piping Exposed to Outdoors and Pipes Subject to Freezing: Cover any piping subject to freezing with an additional layer of 2" glass fiber insulation of the same finish as specified for the particular service when not subject to freezing, but not less than 3" total thickness.
 3. For heat-traced piping, insulation must be sized to accommodate electric cable. Cover with an aluminum jacket, as specified for piping exposed to the weather.
- D. Fittings, Valves and Flanges
1. Where manufactured, use factory premolded fittings (of the same material and thickness as the pipe insulation) for all fittings, flanges and valves.
 2. Where premolded insulation fittings are not manufactured, insulate all fittings, flanges and valves with mitered segments of the same density as the adjoining pipe covering. Finish hot service applications with open weave glass mesh adhered with I.C. 501 (or BF 30-35). Vaporseal for cold applications with I.C. 501 (or BF 30-35) adhesive with open weave glass mesh laid in while wet with final coat with I.C. 501 (or BF 30-35) adhesive. Overlap glass mesh and outer coat adjacent covering by at least 2". Do not insulate flanges until systems are operational.
 3. Provide insulation for removable flanges of pipe strainers on cold services with built-up sections of glass fiber pipe covering, arranged to facilitate servicing of the strainer. Complete applications with vaporseals. All vapor barriers to be sealed and continuous through hangers, walls, sleeves, etc. All adhesives and coatings to be as noted herein.
 4. Insulate fittings, flanges, valves, etc. for services where calcium silicate insulation is specified as a pipe insulation with mineral wool cement of equal thickness to the pipe insulation and finished with glass cloth.
 5. PVC molding pipe fitting covers as manufactured by Zeston are acceptable.
 6. Insulate water supply lines inside chases and up to the plumbing fixture supply stop.

2.3 ACCEPTABLE MANUFACTURERS

- A. Insulation
1. Owings Corning Fiberglas
 2. Johns Manville
 3. Certain-Teed
 4. Pittsburgh Corning
- B. Adhesives and Sealers
1. Benjamin Foster (B-F)
 2. Insul-Coustic (I-C)
 3. Minnesota Mining and Mfg. Co. (3M)

PART 3 - EXECUTION

3.1 INSTALLATION OF INSULATION

- A. Perform all work in strict accordance with the manufacturer's recommendation and the best practice of the trade and the intent of this specification.
- B. Apply all insulation over clean dry surface, butting all sections or surfaces firmly together and finishing as hereinafter specified.
- C. Seal all vapor barriers continuous and throughout against moisture penetration.

3.2 PROTECTION OF INSULATION

- A. Protect pipe insulation at hangers, guides, and rollers by 16 gauge galvanized metal shields (at least 3 times the insulation diameter in length and 1/3 the insulation circumference in width) on the outside of the insulation and vapor barrier. Hold shields in place by straps. Do not pierce the insulation with hangers. Where glass fiber insulation is used on piping 3" and larger, provide half-section of calcium silicate covering of equal thickness at metal shields.
- B. Do not use staples.

END OF SECTION

SECTION 220800

COMMISSIONING OF PLUMBING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General

1. Work under this contract shall conform under requirements of Division 1, General Requirements, Conditions of the Contract, and Supplementary Conditions. This specification covers commissioning of the Plumbing systems for the entire facility.
2. Furnish labor and material to accomplish complete Plumbing commissioning as specified herein.

B. Commissioning work shall be a team effort to ensure that all Plumbing equipment and systems have been completely and properly installed, function together correctly to meet the design intent, and document system performance parameters for fine tuning of control sequences and operational procedures. Commissioning shall coordinate system documentation, equipment start-up, control system calibration, testing and balancing, and verification and performance testing.

C. The commissioning team shall be made up of representatives from the Owner, design professionals, major equipment suppliers, and construction trades. The trades represented on the commissioning team shall include, but not be limited to, piping and fitting, BMCS Division 25, equipment test and balance and electrical. The lead person for each trade who will actually perform or supervise the work is to be designated as the representative to the commissioning team. Responsibility for various steps of the commissioning process shall be divided among the members of the commissioning team, as described in this section.

D. The Commissioning Authority, shall have responsibility for coordinating and directing each step of the commissioning process.

E. Plumbing system installation, start-up, testing, balancing, preparation of O&M manuals, and operator training are the responsibility of the Division 22 Plumbing Contractors, with coordination, observation, verification and commissioning the responsibility of the Commissioning Authority. The commissioning process does not relieve Division 22 (Plumbing) from the obligations to complete all portion of work in a satisfactory and fully operational manner.

F. Definitions

1. Commissioning: the process of ensuring that systems are designed, installed functionally tested and capable of being operated and maintained to perform in conformity with the design intent. For this project, the commissioning includes construction, start-up, acceptance, and training.
2. Commissioning authority: the designated person, company, or agent, who implements the overall commissioning process.
3. Commissioning Plan: A document defining the commissioning process, which is developed by the commissioning authority.
4. Commissioning report: the document that records the results of the commissioning process, including the as-built performance of the Plumbing system and documents all sign-offs.

5. Commissioning specification: the contract document that details the objective, scope, and implementation of the construction and acceptance phases of the commissioning process as developed in the Commissioning Plan.
6. Commissioning team: those people responsible for working together in carrying out the commissioning process.
7. Functional performance testing (FPT): the process of determining the ability of the Plumbing system to deliver domestic water natural gas and sanitary storm and any other plumbing system in accordance with the final design intent.
8. User: The authorized Representative of the Owner.
9. Design Professional: the Landlord's Architectural, Engineering and Other Consultants who prepared Construction Documents.
10. Verification: that full range of checks and tests carried out to determine if all components, subsystems, systems, and interfaces between systems operate in accordance with the contract documents. In this context, "operate" includes all modes and sequences of control operation, interlocks and conditional control responses, and specified responses to abnormal or emergency conditions.

G. Purpose

The commissioning is a process and its purpose is:

1. to clearly document the design intent
2. to verify that the systems installation and performance is in accordance with the plans, specifications and design intent.
3. to train the user's operators so that they fully understand the design intent and the operation and maintenance requirements of the equipment.

1.2 SCOPE OF WORK

A. Commissioning work of Division 22 shall include, but not be limited to:

1. Testing and start-up of the equipment.
2. Testing, adjusting and balancing of domestic water system.
3. Cooperation with the Commissioning Authority.
4. Providing qualified personnel for participation in commissioning tests, including seasonal testing required after the initial testing.
5. Providing equipment, materials, and labor as necessary to correct construction and/or equipment deficiencies found during the commissioning process.
6. Providing operation and maintenance manuals, and as-built drawings to the Commissioning Authority for verification.
7. Providing training and demonstrations for the systems specified in this Division.

B. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems, and sub-systems. The following equipment and systems shall be evaluated:

1. Domestic water systems
2. House pumps & controls
3. Sanitary drainage and vent systems
4. Plumbing systems
5. Domestic hot water heaters
6. Natural gas systems.
7. PRV stations
8. Starters furnished by Plumbing Division 22.
9. Automatic temperature controls integrated with the Plumbing Systems.
10. Coordination with the BMCS (Division 25).

- C. Timely and accurate documentation is essential for the commissioning process to be effective. Documentation required as part of the commissioning process shall include but not be limited to:
 - 1. Progress and status reports, including deficiencies noted.
 - 2. Minutes from all meetings.
 - 3. Pre-start, and start-up procedures.
 - 4. Training agenda and materials.
 - 5. As-built records.
 - 6. Commissioning report.
 - 7. Operational and maintenance (O&M) manuals.
- D. Detailed testing shall be performed on all installed equipment and systems to ensure that operation and performance conform to contract documents. All tests shall be witnessed by the Commissioning Authority. The following testing is required as part of the commissioning process:
 - 1. Verification tests are comprised of a full range of checks and tests to determine that all components, equipment, systems, and interfaces between systems operate in accordance with contract documents. This includes all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions.
 - 2. Functional performance tests (FPT) shall determine if the Plumbing system is providing the required capacity of the various services in accordance with the finalized design intent.
- E. Comprehensive training of O&M personnel shall be performed by the Plumbing Contractor, and where appropriate by other sub-contractors, and vendors prior to turnover of building to the User. The training shall include classroom instruction, along with hands-on instruction on the installed equipment and systems. All training sessions shall be videotaped or recorded on alternative audiovisual media.

1.3 QUALITY ASSURANCE

- A. Commissioning Authority shall meet the following qualifications:
 - 1. Have a minimum of five (5) years of demonstrated commissioning authority experience in the commissioning of HVAC Systems similar in size and complexity to this Project.
 - 2. Commissioning Authority shall hold a Certified Commissioning Professional (CCP) designation from the Building Commissioning Association.
- B. The following reference is a guideline to the Commissioning process and shall be applied as appropriate.
- C. Reference:
 - 1. ASHRAE Guideline 1-1996: The Plumbing Commissioning Process
 - 2. ASHRAE Application Handbook – 1995: Chapter 39 – Building Commissioning.
 - 3. ASHRAE Guideline 4-1993: Preparation of Operating and Maintenance Documentation for Building Systems.

1.4 ROLES AND RESPONSIBILITIES

- A. User
 - 1. User will advise Commissioning Authority regarding changes in building occupancy and/or usage.
 - 2. Assign maintenance personnel and schedule them to participate in meetings, training session as follows:

- a. Construction Phase coordination meeting.
 - b. Initial User training session at initial placement of major equipment.
 - c. Maintenance orientation and inspection
 - d. Piping test and flushing verification meetings.
 - e. Procedures meeting for Testing, Adjusting sequencing and Balancing.
 - f. Users training session.
 - g. Verification demonstrations.
 - h. Final review at acceptance meeting.
3. Provide qualified personnel for videotaping and editing of training sessions.
 4. Video tape construction process, hidden shafts, etc.
 5. Provide any utilities required for the commissioning process.
 6. Provide detailed program clearly stating the User's objectives, parameters, budgets, etc. for this facility.

B. Commissioning Authority

1. Develop the commissioning requirements and all related testing, verification and quality control sections.
2. Prepare the commissioning program required as part of the Commissioning Specification. Include lists of all contractors for commissioning events by name, firm, and trade specialty.
3. Develop detailed pretest and final test reports forms, to be used by the Commissioning Authority for data recording purposes throughout the testing process. The Commissioning Authority shall specifically develop forms for each system and piece of equipment installed on the project. All forms to be submitted for approval a minimum of one hundred and twenty (120) days prior to initial testing.
4. Execute the commissioning program, through organization of all tests, meetings, demonstrations, training events and performance verifications described in the Contract Documents and the approved commissioning program. Organizational Responsibilities include preparation of agendas, attendance lists; arrangements for facilities and timely notification to participants for each commissioning event. The Commissioning Authority shall act as chairman at all commissioning events and assure the execution of all agenda items. The Commissioning Authority shall prepare minutes of every commissioning event and send copies to all those in attendance and the User within 5 workdays of the event.
5. Review the Construction Documents which define the scope of the commissioning process and the final performance of the system. This include verification that appropriate commissioning guidelines have been followed, and to document the performance of each piece of equipment and each system.
6. Review all approved submittals for coordination with the commissioning process and the performance testing of the Systems.
7. Schedule regular Construction Phase coordination meetings to include User, Landlord and Contractor. This meeting shall be for the purpose of reviewing the complete commissioning program and establishing tentative schedules for plumbing system orientation and inspections, O&M submittals, training sessions, system flushing and testing, job completion, test, adjust and balance (TAB) work and verification and functional performance testing.
8. Schedule User training sessions so that they will be held at an appropriate timeframe relative to the turnover of the Systems to the User. These sessions shall be attended by the User's O&M personnel, the Contractor, and the Commissioning Authority.
9. The Commissioning Authority shall be solely responsible for conducting and recording the results of periodic inspections, undertaken by the Commissioning Authority, of work in progress to ensure that all systems are installed according to specifications. The Commissioning Authority shall note any deficiencies discovered in writing. Once the deficiencies have been corrected, as reported by the Contractor, the Commissioning Authority shall re-inspect the report that the corrections have been made.

10. The Commissioning Authority shall assist the contractor in recommending solutions to minor deficiencies.
11. Receive and review the Operation and Maintenance (O&M) manuals as submitted by the contractor, and reviewed and approved by the Design Professional.
12. Witness equipment and system start-up and testing. Ensure the results are documented (including a summary of deficiencies), and incorporated in the O&M manuals. The Commissioning Authority shall record all test results on pre-test and final test forms for each piece of equipment.
13. Prior to initiating the TAB work, the Commissioning Authority shall meet with the User, Contractor, and TAB Contractor. The TAB Contractor shall outline TAB procedures and get concurrence from the Design Professional and Commissioning Authority. Ensure that the TAB Contractor has all forms required for the job database and understands their importance and use.
14. Schedule the O&M training sessions. All training sessions shall be on-site, except where otherwise specified. These training sessions are to be attended by the User, Commissioning Authority, Contractors and equipment suppliers as required by Lease Construction Documents. The format shall follow the outline in manuals. This mechanical system orientation and inspection should include hands on training. The Commissioning Authority shall be solely responsible for recording all demonstration and training sessions on videotape, or alternative approved media, and furnish two (2) copies of the recording media to the User. Each session shall clearly reflect the content of each training session. Video Tapes or other approved media and enclosures shall be neatly labeled.
15. Provide detailed FPT procedures for review and acceptance by the Design Professional.
16. Upon receipt of notification from the Contractor that the systems have been completed and are operational, the Commissioning Authority shall proceed to verify the TAB report and operation of the control systems in accordance with the Commissioning Specification.
17. Conduct Verification tests.
18. Record verification test data.
19. Provide detailed checklists data sheets to document verification tests.
20. Provide and install calibrated test instrumentation to monitor and record data as necessary.
21. The Commissioning Authority shall document the results of all Functional Performance Testing.
22. Observe and record Functional Performance Tests.
23. Submit functional performance test report.
24. Participate in re-testing, if necessary, if performance deficiencies are found, corrected and additional testing is requested.
25. Review as-built drawings for accuracy with respect to installed systems. Review revisions to achieve accuracy.
26. Ensure that the O&M manuals and all other as-built records have been updated to include all modifications made during the construction phase.
27. Observe and record repeated Functional Performance Tests to accommodate seasonal tests and correct any performance deficiencies. Revise and re-submit the commissioning report.
28. Prepare the final commissioning report.
29. Assemble the final project documentation, which shall include the commissioning report and all as-built records. Submit this documentation to the User for review and acceptance.
30. The CA shall verify that all O and M manuals; "as-built" documentation and training manuals and training sessions are complete in every aspect and in accordance with the project specifications. The CA shall supplement the above documentation, as required, to make them complete.

C. Architect

1. Provide support to the Design Professional who must provide a service as a part of the commissioning process. This shall include providing adequate space for equipment installation and maintenance.
2. Conduct periodic inspections of work in progress to ensure that all systems and equipment are installed according to specifications.
3. Provide data on structure, building materials, interior finishes, and furnishings for their effect on the Plumbing System.

D. Plumbing Design Professional

1. Provide Construction Documents.
2. The Design Professional retains responsibility for the system evaluation, adequacy of the system to meet design intent, capacity of the system, quality control check or any of the other elements of the system design.
3. Participate in inspection at the final construction stage.
4. Review verification and functional performance testing procedures submitted by the Commissioning Authority, for conformance with Lease Construction Documents.
5. Review TAB report and verification data sheets for system conformance to contract documents. Issue a report noting deficiencies requiring correction to the Commissioning Authority.
6. Review functional performance testing report for deficiencies in meeting the finalized design intent.
7. Review as-built records as required by contract documents and turn them over to the Commissioning Authority for inclusion in final project documentation.
8. Review and comment on the final commissioning report.

E. Electrical Design Professional

1. Provide documentation or design narratives for electrical services to be provided for specific Plumbing equipment requirements.
2. Provide electrical system information confirming compatibility with electrical service requirements specified by the plumbing design professional for all Plumbing equipment and systems. Provide information necessary for the basis of design.
3. Prepare contract documents that coordinate interfaces between life safety systems, BMCS and Plumbing systems including commissioning specifications.
4. Attend construction-phase coordination meeting scheduled by the commissioning authority.
5. Participate in the start-up of Plumbing equipment and systems.
6. Participate in the Plumbing training sessions as required.
7. Participate in review of shop drawings for Plumbing equipment.
8. Prepare electrical ladder wiring diagrams indicating power source connections to Plumbing equipment and systems.
9. Prepare as-built electrical service record drawings as required by contract documents.
10. Verify that any space requirements for electrical equipment are in accordance with relevant code requirements.
11. Participate in O&M personnel orientation and inspection sessions.

F. General Contractor

1. Include cost for commissioning requirements in the contract price
2. General contractor shall coordinate construction progress with the commissioning schedule to assure that the building envelope and systems that affect proper operation and control of Plumbing equipment and systems being tested are completed prior to testing.

3. Include commissioning requirements in the Plumbing, electrical, and Division 25 (BMCS) contracts, as well as all other sub-contractors, to ensure cooperation of all parties in the Plumbing commissioning program.
4. Ensure acceptable representation, with the means and authority to prepare and coordinate execution of the Plumbing commissioning program as described in the contract documents.
5. Issue a statement that TAB work has been completed, and submit the final TAB reports for review.
6. Issue a statement that control systems have been calibrated.
7. Remedy deficiencies identified in verification tests.
8. Evaluate any performance deficiencies identified in the FPT report for non-performance with contract documents.
9. The equipment supplier shall document the performance of his equipment. Performance testing shall be witnessed by the commissioning authority.

G. Plumbing Contractor

1. Include cost of commissioning requirements in the contract price.
2. Include requirements for submittal data, O&M data, and training in each purchase order or sub-contract written.
3. Ensure cooperation and participation of specialty sub-contractors such as testing, adjusting and balance.
4. Ensure participation of major equipment manufacturers in appropriate training and testing activities.
5. Attend Construction Phase coordination meeting scheduled by the Commissioning Authority.
6. Assist the Commissioning Authority in all verification and functional performance tests.
7. Prepare preliminary schedule for Plumbing system orientations and inspections, O&M manual submissions, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up, TAB and task completion for use by the Commissioning Authority. Update schedule as appropriate throughout the construction period.
8. Attend initial training session.
9. Conduct Plumbing system orientation and inspection at the equipment placement completion stage.
10. Update drawings to the record condition to date, and review with the Commissioning Authority.
11. Gather O&M data on all equipment, and assemble in binders as required by the Commissioning Specification. Submit to Commissioning Authority prior to the completion of construction.
12. Coordinate with the Commissioning Authority to provide sufficient advance notice so that the witnessing equipment and system start-up and testing can begin.
13. Notify the Commissioning Authority a minimum of two weeks in advance of the time for start of the TAB work. Attend the initial TAB meeting for review of the official TAB procedures.
14. Participate in, and schedule vendors and Contractors to participate in the training sessions as set up by the Commissioning Authority.
15. Provide written notification to the General Contractor and Commissioning Authority that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.
 - a. Plumbing equipment including all controls, pumps, PRV valves, water heaters, and all other equipment furnished under this Division.
 - b. Domestic water systems, sanitary & storm drainage system, gas system.
 - c. Fire stopping in the fire rated construction, including, caulking, gasketing and sealing of smoke barriers.
 - d. Installation of plumbing fixtures.

- e. Pipe hangers.
- 16. The equipment supplier shall document the performance of his equipment. Performance testing shall be witnessed by the commissioning authority.
- 17. Provide a complete set of as-built records to the Commissioning Authority.
- H. Test, Adjust, and Balance Contractor
 - 1. Include cost for commissioning requirements in the contract price.
 - 2. Attend initial commissioning coordination meeting scheduled by the Commissioning Authority.
 - 3. Submit the TAB procedures to the Commissioning Authority and Design Professional for review and acceptance.
 - 4. Attend the TAB review meeting scheduled by the Commissioning Authority. Be prepared to discuss the procedures that shall be followed in testing, adjusting, and balancing the Plumbing system.
 - 5. At the completion of the TAB work, and the submittal of the final TAB report, notify the Plumbing Contractor and the General Contractor.
 - 6. Participate in training sessions as scheduled by the Commissioning Authority.
 - 7. At the completion of TAB work, and the submittal of the final TAB report, notify the Plumbing Contractor and the General Contractor.
 - 8. Participate in verification of the TAB report, which will consist of repeating any selected measurement contained in the TAB where required by the Commissioning Authority for verification or diagnostic purposes.
 - 9. The equipment supplier shall document the performance of his equipment. Performance testing shall be witnessed by the commissioning authority.
- I. Equipment Suppliers and Miscellaneous Contractors.
 - 1. Include cost for commissioning requirements in the contract price.
 - 2. Provide submittals, and appropriate O&M manual section(s).
 - 3. Attend initial commissioning coordination meeting scheduled by the Commissioning Authority.
 - 4. Participate in training sessions as scheduled by the Commissioning Authority.
 - 5. Demonstrate performance of equipment as applicable.
- J. Electrical Contractor
 - 1. Include costs for commissioning requirements in the contract price.
 - 2. Ensure participation in testing equipment.
 - 3. Ensure coordination, installation, and operation interfaces between heating, cable and plumbing systems.

1.5 DOCUMENTATION

- A. The Commissioning Authority shall oversee and maintain the development of commissioning documentation. The commissioning documentation shall be kept in three ring binders, and organized by system and sub-system when practical. All pages shall be numbered, and a table of contents page(s) shall be provided. The commissioning documentation shall include, but not be limited to, the following:
 - 1. Approved test and balance report for domestic hot water return systems being commissioned.
 - 2. All accepted shop drawings of Plumbing equipment. Shop drawings shall be full size sheets folded as required to fit in binders.
 - 3. All pre-functional performance test checklists, signed by indicating personnel, organized by system and sub-system.

4. All verification and functional performance test checklists/results, signed by indicated personnel, organized by system and sub-system.
5. Three copies of the operation and maintenance (O&M) manuals specified in other sections of these specifications shall be included with the commissioning documentation. The manuals shall be incorporated in the commissioning documentation prior to commencement of O&M training required in this and other sections of the specification. Preparation of O&M manuals shall be as specified in section 3.07 of these specifications.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. The appropriate Contractor(s) shall furnish all special tools and equipment required during the commissioning process. A list of all tools and equipment to be used during commissioning shall be submitted to the Commissioning Authority for approval. The user shall furnish necessary utilities for the commissioning process.

2.2 TEST EQUIPMENT – PROPRIETARY

- A. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the user upon completion of the commissioning process.

PART 3 - EXECUTION

3.1 GENERAL

- A. A pre-construction meeting of all commissioning team members shall be held at a time and place designated by the user. The purpose shall be to familiarize all parties with the commissioning process, and to ensure that the responsibilities of each party are clearly understood.
- B. The Contractor shall complete all phases of work so the systems can be started, tested, balanced, and acceptance procedures undertaken. This includes the complete installation of all equipment, materials, pipe, duct, wire, insulation, controls, etc. per the contract documents and related directives, clarifications, and change orders.
- C. A Commissioning Plan shall be developed by the Commissioning Authority. The Contractor shall assist the Commissioning Authority in preparing the Commissioning Plan by providing all necessary information pertaining to the actual equipment and installation. If contractor initiated system changes have been made that alter the commissioning process, the commissioning authority shall notify the user.
- D. Acceptance procedures are normally intended to begin prior to completion of a system and/or sub-systems, and shall be coordinated with the Division 22 contractor. Start of acceptance procedures before system completion does not relieve the contractor from completing those systems as per the schedule.
- E. The commissioning authority shall develop a detailed schedule for acceptance procedures and training. The commissioning authority shall work in a cooperative manner with the Contractor to assure that the commissioning process does not interfere with the completion of work in accordance with the overall schedule.

3.2 PARTICIPATION IN ACCEPTANCE PROCEDURES

- A. The Contractor shall provide skilled technicians to start-up and debug all systems within Division 22. These same technicians shall be made available to assist the Commissioning Authority in completing the commissioning program. Work schedules, time required for testing, etc. shall be requested by the Commissioning Authority and coordinated by the contractor. Contractor shall ensure that the qualified technician(s) are available and present during the agreed upon schedules and of sufficient duration to complete the necessary tests, adjustments, and/or problem resolutions.
- B. System performance problems and discrepancies may require additional technician time, Commissioning Authority time, reconstruction of systems, and/or replacement of system components. The additional technician time shall be made available for subsequent commissioning periods until the required system performance is obtained.
- C. Qualifications of technicians shall include expert knowledge relative to the specific equipment involved and a willingness to work with the Commissioning Authority. Contractor shall provide adequate documentation and tools to start-up and test the equipment, system, and/or sub-system.

3.3 DEFICIENCY RESOLUTION

- A. In some systems, improper adjustments, misapplied equipment, and/or deficient performance under varying loads will result in additional work being required to commission the systems. This work shall be completed under the direction of the User, with input from the contractor, equipment supplier, and Commissioning Authority. Whereas all members shall have input and the opportunity to discuss, debate, and work out problems, the Design Professional shall have final jurisdiction over any additional work done to achieve performance.
- B. Corrective work shall be completed in a timely fashion to permit the completion of the commissioning process. Experimentation to demonstrate system performance may be permitted. If the Commissioning Authority deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the Commissioning Authority shall notify the User, indicating the nature of the problem, expected steps to be taken, and suggested deadline(s) for completion of activities. If the deadline(s) pass without resolution of the problem, the User reserves the right to obtain supplementary services and/or equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner shall be the contractor's responsibility.

3.4 ADDITIONAL COMMISSIONING

- A. Additional commissioning activities may be required after system adjustments, replacements, etc., are completed. The contractor(s) suppliers, and Commissioning Authority shall include a reasonable reserve to complete this work as part of their contractual obligations.

3.5 ACCEPTANCE PROCEDURES

- A. Verification Tests
 - 1. Scope of verification tests
 - a. Operating tests and checks to verify that all components, equipment, systems, sub-systems, and interfaces between systems, operate in accordance with contract documents. These tests are to include all operating modes, interlocks, specified control responses, specific responses to abnormal or emergency conditions and

- verifications of the proper response of the building automation system controllers and sensors.
 - b. Verify the validity of the TAB report.
2. Participants in verification tests
- a. The Commissioning Authority shall be responsible for preparing the scope of these tests. The Commissioning Authority shall schedule the tests and assemble the commissioning team members who shall be responsible for the tests. Participating contractors, manufacturers, suppliers, etc. shall include all costs to do the work involved in these tests in their proposals. Following is a list of tasks and supporting information that shall be required.
 - b. Plumbing contractor – provide the services of a technician(s) who is (are) familiar with the construction and operation of this system. Provide access to the contract plans, shop drawings, and equipment cut sheets of all installed equipment.
 - c. Electrical contractor – provide a foreman electrician familiar with the electrical interlocks, interfaces with emergency power supply, and interfaces with alarm and life-safety systems. Provide access to the contract plans, and all as-built schematics of sub-systems, interfaces, and interlocks.
3. Documentation and Reporting Requirements.
- a. Provide checklists for each component, piece of equipment, system, and sub-system, including all interfaces, interlocks, etc. Each item to be tested shall have a different entry line with space provided for comments. Separate checklists shall be prepared for each mode of operation. Provide space to indicate whether the mode under test responded as required or not. Also, provide space for all necessary parties to sign off on each checklist.
 - b. Data sheets used in verification of the proper operation of the control system shall include each controller to be verified, and its location. For each controller, provide space for recording the readout of the controller, the reading at the controller's sensor(s), and any comments. Also, provide space for all necessary parties to sign off on each checklist.
 - c. All test procedures and data sheets shall be submitted to the design professional for review and acceptance.
4. Instrumentation
- a. The Commissioning Authority shall furnish all measurement instrumentation for the verification tests. All instruments will have calibrated within the six-month period prior to these tests.
5. Verification Procedures
- a. The Commissioning Authority shall direct and witness the verification operating tests and checks for all equipment and systems.
 - 1) Set the system equipment (house pumps, booster pumps, water heaters) into the operating mode to be tested, i.e. normal shut down, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions.
 - 2) The Commissioning Authority shall inspect and verify the position of each device and interlock identified on the checklist. Each item shall be signed off as acceptable (yes), or failed (no).
 - 3) This test shall be repeated for each operating cycle that applies to the Plumbing system being tested.
 - 4) Operating checks shall include all safety cutouts, alarms and interlocks with tank filling systems during all modes of operation of the Plumbing system.
 - 5) If during a test an operating deficiency is observed, appropriate comments shall be added to the checklist data sheet.

- 6) Verification of the interface of the monitoring and control system, and the TAB criteria shall be included.
 - 7) Verification of the proper responses of monitoring and control system controllers and sensors shall be included.
 - b. The Commissioning Authority shall direct and witness the field verification of the final TAB report.
 - 1) The Commissioning Authority shall select, at random, 10 percent of the report data for verifications.
 - 2) The TAB contractor shall be given sufficient advance notice of the date of field verification. However, they shall not be informed in advance of the data points to be verified. The TAB contractor must use the same instruments (by model and serial number) that were used when the original data were collected.
 - 3) Failure of an item is defined as:
 - a) Pumps as per manufacturer's recommendation.
 - b) For pressure readings, a deviation of 8 pounds.
 - c) For temperature reading of 5°F.
 - 4) A failure of more than 10 percent of the selected items shall result in the rejections of the final TAB report.
 - c. If the deficiencies are identified during verification, the General Contractor must be notified, and action taken immediately to remedy the deficiency. The final tabulated checklist data sheets shall be reviewed by the Design Professional and the Commissioning Authority, to determine if verification is complete, and the operating system is functioning in accordance with the contract documents.
- B. Functional Performance Testing
1. Scope of Functional Performance Testing
 - a. Functional performance tests shall determine if the Plumbing system is providing the required capacity pressure and temperature services in accordance with the final design intent. They shall also determine the installed capacity of the heating plant, and heat transfer components. Following is a list of test examples:
 - 1) Determine the ability of the pumps & heaters to deliver the services to the distribution system, at the design water temperature and minimum pressure, required static pressure.
 2. Submittals
 - a. Detailed procedures for each series of tests shall be submitted to the Commissioning Authority for review and acceptance. The procedures shall include samples of the data sheets that will be part of the reports.
 3. Participants in Functional Performance Tests
 - a. Participants in the functional performance tests shall be the same as those listed in the verification tests.
 4. Instrumentation
 - a. In addition to the instrumentation requirements detailed under verification, the Commissioning Authority may need to provide data acquisition equipment to record data for the complete range of testing.
 5. Functional Performance Test Procedures

- a. The Commissioning Authority shall supervise and direct all functional performance tests.
 - b. For each test, the Commissioning Authority shall install the measuring instruments and logging devices to record test data for the required test period. The instrumentation shall monitor and record all operating conditions to allow for complete evaluation of the test results.
 - c. Measurement will be required to allow for calculation of total capacity of the system for each mode of operation under test.
6. Documentation and Reporting Requirements
- a. All measured data, data sheets, and a comprehensive summary, describing the operation of the Plumbing system at the time of testing shall be submitted to the Commissioning Authority.
 - b. A preliminary functional performance test report shall be prepared by the Commissioning Authority and submitted to the Design Professional or review. Any identified deficiencies need to be evaluated by the Design Professional and Construction Manager to determine if they are part of the contractor's contractual obligations. Construction deficiencies shall be corrected by the responsible contractor(s) and the specific functional performance test repeated.
 - c. If it is determined that the Plumbing system is constructed in accordance with the contract documents, and the performance deficiencies are not part of the contract documents, the User must decide whether any required modifications needed to bring the performance of the Plumbing system up to the finalized design intent shall be implemented, or if the test shall be accepted as submitted. If corrective work is performed, the User shall determine if a portion or all required functional performance tests should be repeated, and a revised report submitted.

3.6 OPERATING AND MAINTENANCE MANUAL:

- A. The operating and maintenance manual shall consist of a sturdy binder with 8-1/2" x 11" sheets in accordance with the Contract Documents.

3.7 OPERATING AND MAINTENANCE TRAINING

- A. The Plumbing Contractor, and appropriate sub-contractors, shall provide comprehensive operating and maintenance instruction on building systems in accordance with the Contract Documents prior to delivery. The instruction shall include classroom instruction deliver by competent instructors based upon the contents of the operating manual.
- B. Each classroom training period shall be followed by an inspection, explanation and demonstration of the system concerned by the instructors. All specified equipment shall be started up and shut down, with the exception of any connection to fire suppression system.
- C. The contractor shall be responsible for organizing, arranging, and delivering in a manner and on a schedule agreeable to the User.
- D. The contractor shall provide, at or before substantial completion, a proposed agenda and schedule of the above training for approval by the Commissioning Authority and the User.
- E. Each classroom training session and demonstration shall be recorded on videotape or alternative acceptable media and submitted to the User.

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SECTION 221116

DOMESTIC WATER PIPING AND FITTING MATERIALS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide piping and fitting materials in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Piping.
B. Fittings.
C. Related Accessories.
D. Testing.
E. Disinfection

1.3 SUBMITTALS

- A. Submit a list of all proposed piping materials including system/material (use schedule).
B. Submit complete back-up material where proposed materials differ from those specified.
C. Quality control submittals.
 1. Welder's Certification.
D. All final test results.

1.4 QUALITY ASSURANCE

- A. Local Plumbing Code.
B. Each pipe length shall have the manufacturer's name cast, stamped or rolled on.
C. Each fitting shall have the manufacturer's name cast, stamped or rolled on.
D. The following are references to the specifications standards of recognized authorities to which pipe and fitting materials must conform to be acceptable. All references shall be the latest edition in force at the time of bidding.

Material	Authority Spec. Numbers
Sleeve Pipe, Black and Galvanized	ANSI B36.20
Steel Pipe, Black and Galvanized	ANSI B36.20
Ductile Iron	ANSI A21.51

Material	Authority Spec. Numbers
Ductile Iron Fittings	ANSI A21.10, A21.11
Cast Iron Pressure Pipe	FS-WW-P360A
Malleable Iron Threaded Fittings - (Class 150 lbs. & 300 lbs.)	ANSI B16.3
Cast Iron Threaded Fittings (Class 125 lbs. & 250 lbs.)	ANSI B16.4
Cast Iron Pipe Flanges and Flanged Fittings (Class 25 lbs., 125 lbs., 250 lbs., & 800 lbs.)	ANSI B16.1
Seamless Copper Water Tube (Type "K" and "L") (Hard Temper)	ANSI H23.1
Brazing Filler Metal	ASTM B260-62T
Wrought Copper and Copper Alloy Solder Joint Pressure Fittings	ANSI H16.22
Brass Compression Fittings	ANSI A40.2
Bronze Pipe Flanges and Flanged Fittings (Class 150 lbs. & 300 lbs.)	ANSI B16.24
Cast Bronze Threaded Fittings - (Class 125 lbs. & 250 lbs.)	ANSI B16.15
Cast Copper Alloy Solder Joint Pressure Fittings	ANSI B16.18
Seamless Red Brass Pipe, Standard Sizes	ANSI H27.1

PART 2 - PRODUCTS

2.1 DUCTILE IRON WATER PIPE

- A. Pipe and Fittings: Centrifugally spun, Class 52 bell and spigot pipe, cement lined.
- B. Joints: "Tyton" rubber gasket, mechanical joint with grounding straps across joints.
- C. Restrained Joints: "Lok-Tyton" gasket used with a grooved spigot end pipe.
- D. Application: Underground water services from building to point of connection with the municipal water mains.

2.2 GALVANIZED STEEL PIPE

- A. Pipe: Galvanized steel pipe, Schedule 40 with maker's name rolled into each length.
- B. Fittings
 - 1. Threaded: Galvanized malleable iron with flat band steam pattern. Cast iron drainage pattern for waste piping.
 - 2. Mechanical Joint: Victaulic couplings Style 07 for grooved piping only, with gasket.
- C. Joints: Teflon tape for threaded, Victaulic couplings with gasket for mechanical joint.

D. Application

1. Schedule 40 steel for domestic water piping 8" and larger.

2.3 COPPER TUBING

A. Pipe: Copper tubing type 'L', seamless drawn extruded tubing hard temper. Pipe ends shall be plain, threaded or rolled groove as required for piping system.

B. Fittings

1. Brazed, Soldered or Threaded: Wrought or cast brass.
2. Mechanical Joint: Victaulic rolled groove fittings with gasket.

C. Joints:

1. Brazed Joints: Use brazing flux and brazing alloy.
2. Soldered Joints: Use 95-5 tin antimony solder (lead free).
3. Threaded Joints: Conform to American National Taper Thread. All burrs shall be removed. Teflon tape shall be used only on male threads.
4. Mechanical Joints: Grooved piping system for 2" through 6" sizes, with a pressure responsive synthetic rubber gasket, up to 300 psi working pressure, Victaulic Style 606, 610, 611, 620, 641.

D. Application: All hot, cold and hot water circulating piping less than 5" within building.

2.4 BRASS PIPE

A. Pipe: Seamless red brass, 85% copper, Schedule 40.

B. Fittings: Cast brass, 85% copper, Schedule 40.

C. Joints: Teflon tape.

D. Application:

1. All exposed fixture pipe, chrome plated.
2. Indirect waste pipe, chrome plated.

2.5 CHROMIUM PLATING

A. All exposed piping shall be chrome plated in accordance with U.S. Government Standards. Clean and polish materials before plating. Apply plating thoroughly and evenly to prevent stripping and peeling. Copper plate steel and cast iron pipe and nickel plate copper and brass pipe before applying chromium plating. Polished or satin finish as selected.

PART 3 - EXECUTION

3.1 JOINTS

A. Threaded Joints: Do not damage fitting surface, remove burrs and ream smooth. Apply Teflon tape to male threads only. Clean joint thoroughly of excess jointing material.

- B. Soldered Joints: Make all joints with wire solder. Remove burrs and ream smooth. Clean outside end of pipe and the inside cup of the fitting with sand cloth. Apply flux evenly and allow joint to cool. Clean joint of excess flux leaving a fillet around the cup of the fitting.
- C. Brazed Joints: Prepare surfaces the same as for soldering. Apply Harmon's "Handy Flux" evenly to tube end and fitting socket when wrought copper fittings (BCu Series) are used. Heat joint uniformly to temperature required (at least 1,000°F) and apply brazing alloy. Clean joint of excess brazing flux with wet brush or swab. Use lead-free brazing material only.
- D. Flanged Joints: Use matched flange faces and 1/16" thick compressed gaskets.
- E. Compression Joints: Lubricate neoprene gasket and slip into hub end of pipe. Draw spigot end of pipe into the gasketed hub. Provide restrained joints at all changes in pipe sizes, at all changes in direction of run and at all dead ends.
- F. Mechanical (Grooved) Joints: Joints shall be made with neoprene or synthetic rubber gaskets.
- G. Welded Joints
 - 1. All welded joints shall be butt welded in accordance with API 1104.1977 or ASME Section IX Boiler and Pressure Vessel Code 1980.
 - 2. Welders shall be qualified for all pipe sizes, wall thicknesses and all positions, in accordance with above standards, and requalified on an annual basis. Copies of the certified welder qualification reports shall be maintained by the responsible welding contractor and shall be made available upon request.
- H. Make joints between different piping materials with adaptor fittings of a type suitable for the purpose intended.
- I. Make joints between pipes of dissimilar metals with dielectric union or flanges.
- J. Exposed threads on exposed finished piping at plumbing fixtures and equipment will not be accepted.
- K. All mechanical joint fittings and couplings shall be made by the same manufacturer.

3.2 TESTING

- A. Upon completion of a section of a water system or of the entire water system, the completed section or system shall be verified as to materials, and shall be tested and proven tight under a water pressure of at least 1½ times the working pressure, but not less than 200 psig, for one (1) hour, with no loss in pressure. Testing of sections shall be done in order to permit general construction and other work to proceed. Such tests shall be made in the presence of the Building Department Inspectors, Owner's representative and any other authorities having jurisdiction.
- B. Provide all apparatus and temporary work for tests. Take all precaution necessary to prevent damage to the building or its contents as a result of such tests. The water used for tests shall be obtained from a potable source of supply.
- C. Any defects or deficiencies discovered as a result of tests shall be immediately repaired and tests shall be repeated until the test requirements are fully complied with.
- D. Caulking of pipe joints to remedy leaks will not be permitted.

- 3.3 The pipe system shall be flushed with clean, potable water until no dirty water appears at the outlets.
- 3.4 The system or part thereof shall be filled with a water-chlorine solution containing at least 50 parts per million of chlorine and the system or part thereof shall be valved off and allowed to stand for 24 hr. Or the system or part thereof shall be filled with a water-chlorine solution containing at least 200 parts per million of chlorine and allow to stand for 3 hours.
- 3.5 Test for residual chlorine at the extreme end of system from the point where chlorine was introduced. If less than 10 ppm, repeat chlorination procedure.
- 3.6 Flush system with clean water until chlorine is reduced to less than 1 ppm. Open and close each valve and faucet at least four times during flushing procedure.
- 3.7 Obtain the services of an independent laboratory to have samples taken and tested. The system must be free of bacteriological contamination. If the system is contaminated, rechlorinate until satisfactory. Submit test results to the architect/engineer.

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SECTION 221119
DOMESTIC WATER SPECIALTIES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide a complete domestic water system in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Potable cold water, hot water and hot water circulating piping to plumbing fixtures and equipment.
- B. Water Hammer Arrestors.
- C. Wall Hydrants and Hose Bibbs.
- D. Shock Absorbers
- E. Strainers
- F. Automatic Air Relief
- G. Dielectric Fittings
- H. Tank Level Control Panel

1.3 SUBMITTALS

- A. Shop Drawings: Submit details of piping supports, inserts, structural openings, including coordinates and elevation.
- B. Product Data: Manufacturer's latest published data for materials, equipment and installation.
- C. Indicated proposed changes in pipe sizes and basic system scheme.

1.4 QUALITY ASSURANCE

- A. Applicable Standards
 - 1. New York City Plumbing and Building Codes.
 - 2. 2016 NYS Uniform Code

PART 2 - PRODUCTS

2.1 WALL HYDRANTS (COLD WATER ONLY)

- A. Wall hydrants shall be similar to J.R. Smith Fig. 5709 bronze box, chrome plated face with integral vacuum breaker, cylinder lock, bronze casing and hose connection. Verify wall thickness at each location.

- B. Provide a ball or gate valve in the supply piping to each hydrant.

2.2 WALL HYDRANTS (HOT & COLD WATER)

- A. Wall hydrants shall be J.R. Smith hot and cold water Fig. 5760-VB with cylinder lock, chrome finish on brass castings, vacuum breakers. Verify wall thickness at each location.
- B. Provide a ball or gate valve in the supply piping to each hydrant.

2.3 NON-FREEZE WALL HYDRANT (COLD WATER ONLY)

- A. Wall hydrant shall be similar to J.R. Smith Fig. 5509, bronze box, chrome-plated face with integral vacuum breaker and cylinder lock. Verify wall thickness at each location.
- B. Provide a ball or gate valve in the supply piping to each hydrant.

2.4 NON-FREEZE WALL HYDRANT (HOT & COLD WATER)

- A. Wall hydrant shall be similar to J.R. Smith Fig. 5560, bronze box, chrome-plated face with integral vacuum breaker and cylinder lock. Verify wall thickness at each location.
- B. Provide a ball or gate valve in the supply piping to each hydrant.

2.5 HOSE BIBBS

- A. Provide, where indicated on the drawings, Woodford Mfg. Co. model 24P hose bibb. Finish shall be rough brass in mechanical or non-finished spaces, and polished chrome plated in all finished areas. Provide matching finish vacuum breakers at each hose bibb. Provide with loose tee key in finished areas.
- B. Provide a ball or gate valve in the supply piping to each hose bibb.

2.6 NON-FREEZE HOSE BIBBS

- A. Provide, where indicated on the drawings, Woodford Mfg. Co. model 21P-3/4 hose bibb. Finish shall be rough brass in mechanical or non-finished spaces, and polished chrome plated in all finished areas. Provide matching finish vacuum breakers at each hose bibb. Provide with loose tee key in finished areas.
- B. Provide a ball or gate valve in the supply piping to each hose bibb.

2.7 NON-FREEZE GROUND HYDRANTS

- A. Non-freeze ground hydrants shall be similar to J.R. Smith Fig. 5810-VB. Bronze hydrant with rough bronze box, bronze casing, loose 'T' handle, locking cover and vacuum breaker.
- B. Provide a ball or gate valve in the supply piping to each hydrant.

2.8 NON-FREEZE GROUND HYDRANT WITH INTEGRAL FLASHING FLANGE

- A. Non-freeze ground hydrants shall be similar to J.R. Smith Fig. 5810F-VB. Bronze hydrant with rough bronze box, bronze casing, flashing flange and flashing clamp, loose 'T' handle, locking cover and vacuum breaker.

- B. Provide a ball or gate valve in the supply piping to each hydrant.

2.9 NON-FREEZE POST HYDRANT

- A. Non-freeze post hydrant shall be similar to J.R. Smith Fig. 5910-VB, bronze post hydrant, bronze casing, cast iron casing guard, vacuum breaker and 'T' handle.

2.10 SHOCK ABSORBERS (WATER HAMMER ARRESTORS)

- A. Provide shock absorbers where indicated on Drawings and immediately adjacent to all flush valves and pieces of equipment wherein quick-closing or solenoid valves are installed. Shock absorbers shall be J.R. Smith Series 5000. Size of shock absorbers and installation procedure shall be as recommended in Plumbing and Drainage Institute Standard PDI-WH-201.

2.11 STRAINERS

- A. Provide strainers in inlet line to all temperature regulating, pressure regulating valves and automatic modulating valves.
- B. Strainers shall be "Y" type, full pipe size and fitted with blow-off gate valves, nipples and caps.
- C. Unless otherwise called for, basket screens shall be stainless steel with perforations suitable for the service intended.
- D. Unless otherwise indicated, the valves tabulated below have been selected from the catalog of Watts Industries and are representative of the design, materials and features desired.

Model	Size	Body	Working Pressure	Ends
777S	½"-4"	Bronze	400 psi	Threaded
77F-D-FDA-125	5"-12"	Cast Iron Epoxy Coated	500 psi	Flanged

2.12 AUTOMATIC AIR RELIEF VALVES

- A. Furnish and install a cast brass, stainless steel float automatic air relief valve at the high point of all hot water and hot water circulation piping.
- B. Valve shall be similar to Hoffman No. 78 (maximum 150 psi) or No. 79 (maximum 75 psi).
- C. Pipe drain to spill over nearest floor drain, mop receptor or slop sink.

2.13 DIELECTRIC FITTINGS

- A. Provide dielectric pipe or flange isolating joints on all connections between ferrous and non-ferrous pipe.
- B. Dielectric fitting shall be similar to Watts Series 3000.

2.14 TANK LEVEL CONTROL

- A. Furnish and install a Multi-Trode indicating level control system, as shown on the plans for the suction tanks and fire tank. Tanks shall have a multi-sensored probe type, extra low voltage level control system for: high level, high level reset, low level, low level reset and ground. The probe shall be a premium quality uPVC extruded tube with stainless steel sensors epoxy encapsulated in a rigid unit and suspended by a single multicolored cable from a stainless steel mounting bracket. Probes shall be wired to a local liquid level indicating and alarm relay panel mounted as close as possible to the tank. The panel shall be powered with 115 volt, single phase and be equipped with a circuit breaker disconnect switch, back-up float circuit and power failure relay. Upon loss of power, an auxiliary alarm contact shall close to activate a remote alarm. The panel shall also contain visual indication of water level and set point adjustment, alarm horn for high and low level indication with silencing push-button, indicating lights, (and) individual auxiliary alarm contacts (and tank compartment selector switch). The panel shall be prewired in a single NEMA-1 enclosure. All interconnecting wiring shall be made to a terminal strip.
- B. Furnish and install, a non-mercury, differential level sensor. This device shall provide a redundant low level alarm, in the event of a failure of the primary level system.
- C. These control shall be field interwired, by this contractor, with the low water cut-off of the Domestic Water Pumping System and Solenoid shut-off valves.

2.15 WATER TEMPERATURE VALVE (EMERGENCY SHOWER)

- A. Thermostatic Mixing Valve (TMV) of chrome-plated DZR brass construction with stainless steel internal operating mechanism and "Safety Yellow" control handle. TMV shall have 1" NPT inlets with fitted combination union/check stop/strainers and outlet stop valve and thermometer.
- B. TMV shall be supplied with all of the following capabilities:
 - 1. Maximum temperature limiting and single temperature locking.
 - 2. Control of mixed water temperature $\pm 2^{\circ}\text{F}$ at flow rates between 2 and 48 gpm.
 - 3. Complete shutoff of outlet flow prior to a 5°F temperature rise in the event of a failure of the inlet cold water supply.
 - 4. Constant cold water flow design capable of delivering up to 20 gpm directly from the cold water supply to the fixture in the event of a failure of the inlet hot supply.
 - 5. Designed so that with a 130°F inlet hot supply temperature and 60°F cold water supply, the range of mixed water temperature available from the TMV in misadjustment, product failure or product tampering mode is 60°F - 95°F .
- C. TMV shall be capable of meeting the requirements of ANSI Standard Z358.1-1998 sections 4.1, 4.6.6, 7.1.4, 7.4.6, 8.1, 8.4.4 and 9.4.5.
- D. TMV shall be supplied fully assembled and pressure-tested, with outlet stop valve enclosed in an 18"x24"x8" stainless steel recessed cabinet with a 2" flange. Cabinet shall have a polished stainless steel piano-hinged door with keyed cylinder lock.
 - 1. Cabinet shall be supplied with 1" NPT top inlets and a $\frac{3}{4}$ " NPT top outlet (standard).
 - 2. Valve shall be similar to Rada Z358-40-FMC.

2.16 ACCEPTABLE MANUFACTURERS

- A. Wall Hydrants

1. J.R. Smith
 2. Wade
 3. Woodford Manufacturing Company
 4. Ancon
- B. Hose Bibbs
1. Woodford Manufacturing Company
 2. Chicago Faucet
 3. Nibco
- C. Ground Hydrants
1. J.R. Smith
 2. Wade
 3. Woodford Manufacturing Company
 4. Ancon
- D. Post Hydrants
1. J.R. Smith
 2. Wade
 3. Zurn Industries
 4. Ancon
- E. Vacuum Breakers
1. Chicago Faucet
 2. Woodford Manufacturing Company
- F. Shock Absorbers (Water Hammer Arrestors)
1. J.R. Smith
 2. Wade
 3. Zurn Industries
- G. Strainers
1. Mueller Brass Co.
 2. Watts Regulator
 3. Hoffman Specialty
- H. Automatic Air Relief Valve
1. Hoffman Specialty
 2. Watts Regulator
- I. Dielectric Pipe Fittings
1. Watts Regulator
 2. Epco Sales Inc.
- J. Tempering Valves
1. Rada
 2. Armstrong
 3. Leonard

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All water piping shall be arranged to drain to low points and to provide for air elimination at high points. Provide plugged drain valves at all low points and automatic air relief valves at high points.
- B. Mains, risers and branch connections to same shall be arranged to permit expansion and contraction without strain by means of elbow swings and/or expansion joints.
- C. A riser control valve shall be provided on each water riser. Provide a drain valve on each riser located upstream of riser control valve.
- D. Provide a control valve in suction and discharge connections to each piece of equipment.
- E. All valves, check valves, pressure reducing valves, shock absorbers, tempering valves, etc., shall be easily accessible for maintenance and/or removal.
- F. All threaded joints shall be made with teflon tape or approved pipe compound, carefully placed on male threads only and not on the fittings.
- G. All cut and threaded pipe shall have the cutting burrs and sharp edges reamed out or filed off.
- H. In erecting chrome plated pipe, strap friction wrenches shall be used exclusively, and any pipe cut, dented or otherwise damaged shall be replaced.
- I. All ferrous to non-ferrous pipe connections shall be made with dielectric pipe or flange union isolating joints to prevent any electrolytic action between dissimilar metals.
- J. All copper tubing shall be cut square and reamed to remove all burrs. Outside and inside of the fittings and outside of the tubing at each end shall be well cleaned with sand cloth before soldering to remove all traces of oxidation regardless of how clean the surfaces of the pipe and fittings may appear.
- K. Provide unions at connections to each piece of equipment for each dismantling and at such other points to facilitate installation. Unions shall be of same strength and manufacture used in the respective piping systems and of ground joint type.
- L. Nipples: Any piece of pipe 8 inch in length and less shall be considered a nipple. All nipples with unthreaded portion 1½ inch and less shall be extra heavy. All other nipples shall be of weight corresponding to fitting connected. Only shoulder nipples shall be used, close nipples will not be acceptable.
- M. All fittings, unions and connections at pumps, tanks or other major equipment 3 inch and over in size shall be assembled with flanged joints and gaskets.

3.2 ADJUSTMENTS

- A. Hot Water Circulating System: Adjust hot water circulation balancing cocks to provide all circuits of the hot water system with minimum 110°F hot water during no-flow conditions.

3.3 OPERATING INSTRUCTIONS PERIOD

- A. Provide one day of instructions.

END OF SECTION

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SECTION 221316

SANITARY WASTE AND VENT PIPING AND FITTING MATERIALS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide piping and fitting materials in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Piping.
B. Fittings.
C. Related Accessories.

1.3 SUBMITTALS

- A. Submit a list of all proposed piping materials including system/material (use schedule).
B. Submit complete back-up material where proposed materials differ from those specified.

1.4 QUALITY ASSURANCE

- A. Local Plumbing Code.
B. Each pipe length shall have the manufacturer's name cast, stamped or rolled on.
C. Each fitting shall have the manufacturer's name cast, stamped or rolled on.
D. The following are references to the specifications standards of recognized authorities to which pipe and fitting materials must conform to be acceptable. All references shall be the latest edition in force at the time of bidding.

Material	Authority Spec. Numbers
Sleeve Pipe, Black and Galvanized	ANSI B36.20
Steel Pipe, Black and Galvanized	ANSI B36.20
Extra Heavy and Service Weight Cast Iron Soil Pipe and Fittings	CS188-66
Caulking Lead, Type I	FS-QQ-L156(1)
Neoprene or Rubber Gasket, Compression	CISPI HSN-75
Hubless Cast Iron Soil Pipe and Fittings	CISPI 301
Ductile Iron	ANSI A21.51
Ductile Iron Fittings	ANSI A21.10, A21.11

Material	Authority Spec. Numbers
Cast Iron Threaded Drainage Fittings	ANSI B16.12

PART 2 - PRODUCTS

2.1 CAST IRON SOIL PIPE (XH)

- A. Pipe: Uncoated extra heavy cast gray iron, hub and spigot type with weight per foot and maker's name clearly stamped or cast on each length.
- B. Fittings: Hub and spigot, extra heavy cast iron.
- C. Joints: Lead and oakum caulked.
- D. Application: Underground storm and sanitary piping inside and outside of building to point of connection with municipal sewers.

2.2 CAST IRON SOIL PIPE (SV)

- A. Pipe: Service weight centrifugally spun cast iron soil pipe hub and spigot type with weight per foot and maker's name clearly stamped or cast on each length.
- B. Fittings: Hub and spigot service weight cast iron.
- C. Joints: Oakum and lead, Neoprene or rubber gasket, compression.
- D. Application:
 - 1. Horizontal portions or offsets of sanitary stacks including one floor above and below the offset.

2.3 CAST IRON SOIL PIPE (HUBLESS)

- A. Pipe: Hubless cast iron soil pipe coated inside and out.
- B. Fittings: Hubless service weight, cast iron.
- C. Joints: Neoprene gasket and heavy duty type 304 stainless steel shield and four stainless steel bands for sizes 1½" through 4", six bands minimum for sizes 5" and larger. Clamps as manufactured by Clamp-All Corporation or Husky as manufactured by Anaheim Foundry Co. (ANACO).
- D. Application:
 - 1. Above ground branch sanitary and vent piping.
 - 2. Above ground sanitary stacks except all horizontal sanitary stacks and the 90° stack fittings shall be hub and spigot.

2.4 GALVANIZED STEEL PIPE

- A. Pipe: Galvanized steel pipe, Schedule 40 with maker's name rolled into each length.
- B. Fittings
 - 1. Threaded: Galvanized malleable iron with flat band steam pattern. Cast iron drainage pattern for waste piping.
 - 2. Mechanical Joint: Victaulic couplings Style 07 for grooved piping only, with gasket.
- C. Joints: Teflon tape for threaded, Victaulic couplings with gasket for mechanical joint.
- D. Application
 - 1. Schedule 40 steel for sewage ejector discharges.
 - 2. Schedule 40 steel for indirect waste piping.
 - 3. Schedule 40 steel for sanitary drainage greater than 15".

2.5 BRASS PIPE

- A. Pipe: Seamless red brass, 85% copper, Schedule 40.
- B. Fittings: Cast brass, 85% copper, Schedule 40.
- C. Joints: Teflon tape.
- D. Application:
 - 1. All exposed fixture pipe, chrome plated.
 - 2. Indirect waste pipe, chrome plated.

2.6 CHROMIUM PLATING

- A. All exposed piping shall be chrome plated in accordance with U.S. Government Standards. Clean and polish materials before plating. Apply plating thoroughly and evenly to prevent stripping and peeling. Copper plate steel and cast iron pipe and nickel plate copper and brass pipe before applying chromium plating. Polished or satin finish as selected.

PART 3 - EXECUTION

3.1 JOINTS

- A. Caulked Joints: Firmly pack joints with an oakum gasket and seal with molten virgin pig lead. Use twelve ounces of molten lead for each inch in diameter of pipe used at each joint. Run lead in one pouring and caulk tight. Seal and smoothly face the joints.
- B. Threaded Joints: Do not damage fitting surface, remove burrs and ream smooth. Apply Teflon tape to male threads only. Clean joint thoroughly of excess jointing material.
- C. Flanged Joints: Use matched flange faces and 1/16" thick compressed gaskets.
- D. Compression Joints: Lubricate neoprene gasket and slip into hub end of pipe. Draw spigot end of pipe into the gasketed hub. Provide restrained joints at all changes in pipe sizes, at all changes in direction of run and at all dead ends.

- E. Mechanical (Grooved) Joints: Joints shall be made with neoprene or synthetic rubber gaskets.
- F. Make joints between different piping materials with adaptor fittings of a type suitable for the purpose intended.
- G. Make joints between pipes of dissimilar metals with dielectric union or flanges.
- H. Exposed threads on exposed finished piping at plumbing fixtures and equipment will not be accepted.
- I. Graphite shall be used on all cleanout plugs or caps.
- J. All mechanical joint fittings and couplings shall be made by the same manufacturer.

3.2 BRACING

- A. Hubless cast iron pipe shall have bracing installed as required by CISPI and the manufacturer.

3.3 SOIL, WASTE AND VENT STORM WATER SYSTEMS

- A. Except for outside leaders and perforated or open jointed drain tile (subsoil drains), the piping of sanitary and storm drainage and vent systems shall be verified as to materials and shall be tested upon completion of the rough piping installation and prove to be water tight. The removal of cleanout plugs may be required to ascertain that the prescribed pressure has been reached in all parts of the system. Testing of sections shall be done in order to permit general construction and other work to proceed. Such tests shall be made in the presence of the Building Department Inspectors, Owner's representative and any other authorities having jurisdiction.
- B. Water Test. A water test shall be applied to the drainage system either in its entirety or in sections after rough piping has been installed. If applied to the entire system, all openings in the piping, except the highest opening, shall be tightly closed and the system filled with water to the point of overflow. If the system is tested in sections, each opening, except the highest opening of the section under test, shall be tightly plugged and each section filled with water. No section shall be tested with less than a ten foot head of water. In testing successive sections, at least the upper ten feet of the following section shall be tested, so that no joint or pipe in the building (except the uppermost ten feet of the system) shall have been submitted to a test of less than ten foot head of water. The water shall be kept in the system or in the portion under test for at least four (4) hours before inspection starts; the system shall then be tight at all points.
- C. Air Test. An air test may be used only when permission for this type of test is obtained from the Engineer. The air test shall be made by attaching an air compressor testing apparatus to any suitable opening and, after closing all other inlets and outlets of the system, forcing air into the system until there is a uniform gauge pressure of five psi or sufficient pressure to balance a column of mercury ten inches in height. This pressure shall be held, without introducing additional air, for a period of at least thirty minutes.
- D. Buried Piping
 - 1. In addition to the hydrostatic testing indicated above all buried piping shall be videotaped twice. Once after backfilling is complete and a second time after the slabs have been poured. A report and videotape shall be given to the owner's representative after each test.

3.4 INSTALLATION

- A. All materials shall be new and installed in a first class manner.
- B. All drainage piping, unless otherwise indicated, shall be pitched at a minimum rate of 1/8 inch per foot in direction of flow. Branch connections to stacks or main drains shall not be made in a manner which will permit backflow.
- C. All vent piping shall be arranged to drain any condensate back to waste piping.
- D. Nipples: Any piece of pipe 8 inch in length and less shall be considered a nipple. All nipples shall be of weight corresponding to fitting connected. Only shoulder nipples shall be used unless otherwise directed.
- E. Where indicated on the drawings, plugged outlets shall be left in drainage and vent piping for future fixtures.

END OF SECTION

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SECTION 221319

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide complete sanitary and storm drainage systems in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Traps.
- B. Cleanouts.
- C. Drains.
- D. Sovent System.
- E. Trap Primers.

1.3 SUBMITTALS

- A. Manufacturers Data Sheet.

1.4 QUALITY ASSURANCE

- A. Applicable Standards
 - 1. Local Plumbing Code.
 - 2. Local authorities having jurisdiction.
 - 3. PDI.

PART 2 - PRODUCTS

2.1 TRAPS

- A. All traps for showers and drains shall be brass or cast iron (threaded or caulked joint pattern) of approved types and water seal. Traps provided with cleanouts shall have heavy brass threaded plugs with solid brass heads.
- B. Fixture traps shall be as specified under Plumbing Fixtures.
- C. All traps shall be set as close to the fixtures as possible and in no event shall this distance exceed 2 feet horizontal and 4 feet vertical. All traps shall be set level with regard to their water line.

2.2 CLEANOUTS

- A. Provide cleanouts at the base of all soil, waste and leader stacks.
- B. Cast Iron Pipe Cleanouts: Tapped extra heavy cast iron ferrule, caulked into cast iron fittings, and extra heavy lead seal plug with solid hexagonal nut or countersunk plug to suit.
- C. No-Hub Cast Iron Pipe Cleanouts: No-Hub cast iron cleanout plug or extra heavy brass threaded plug in tapped cast iron fittings, with solid hexagonal nut or countersunk plug to suit.
- D. Steel Pipe Cleanouts: Extra heavy brass threaded plug in drainage fitting.
- E. Cleanout Plugs: Comply with the Plumbing Code; American Standard pipe threads with "Permacel" or approved Teflon tape applied to the male threads.
- F. Extend cleanouts to walls and floor with long sweep ells or "y" and 1/8 bends with plugs and face or deck plates to conform to the architectural finish in the room. Where no definite finish is indicated on the architectural and/or mechanical drawings, use stainless steel wall plates and floor plates of nickel bronze.
- G. Cleanouts shall be not more than 50 feet apart in horizontal drainage lines. Accessible cleanouts shall be installed at each change of direction greater than 45° on all horizontal drainage lines. All cleanouts shall be installed so that the cleanout opens in the direction of flow or at right angles thereto. Cleanouts shall be of same size as pipes up to 4 inches and not less than 4 inches for larger piping.
- H. Cleanouts and Plates: J.R. Smith models as indicated in the following tabulation:

Type	Location	Piping
4405-98		Exposed C.I. pipe
4472		Exposed steel pipe
4402-97	Wall	Concealed C.I. pipe
4472	Wall	Concealed steel pipe
4025	Concrete Floor	Steel or C.I.
4160FC	Waterproof Slab Floor	Steel or C.I.
4145	Asphalt Tile Floor	Steel or C.I.
4045	Ceramic Tile Floor	Steel or C.I.
4105	Heavy Duty Traffic Floor	Steel or C.I.
4020	Concrete Floor	No-Hub
4020FC	Waterproof Slab Floor	No-Hub
4140	Asphalt Tile Floor	No-Hub

Type	Location	Piping
4040	Ceramic Tile Floor	No-Hub
4100	Heavy Duty Traffic Floor	No-Hub

2.3 SOVENT SYSTEMS

- A. Provide cast iron Aerators, Deaerators and related components. Install system in compliance with the installation details and recommendations in the Sovent Design manual (or latest edition).
- B. Aerator and Deaerator fittings shall be made in compliance with standard ASME/ANSI B16.45. Fittings shall be manufactured with the "Disamatic" method of casting production. Fittings shall be gray cast iron of chemical composition in accord with ASTM-126 and CISPI 301-82 for hubless pipe and fittings.

2.4 DRAINS

- A. The drain schedule on the drawings indicates the particular drain desired at the various locations indicated on the Drawings.
- B. Locations of drains shown on the drawings shall be verified by this trade.
- C. All drains shall include adjustable clamping collars device where membrane or other waterproof floors or decks occur.
- D. All drains shall include extension collars as required to suit roof, floor or deck construction.
- E. Furnish caulk support strap, J.R. Smith Fig. No. 9329 for all drains requiring same.

2.5 TRAP PRIMER

- A. Pressure operated all brass trap seal primer with 1/2" inlet and outlet. Four hole view built-in air gap and removable filter screen.
- B. Provide trap seal distribution unit when more than one drain is being primed.

2.6 FRESH AIR INLET SECTION ONE [POLISHED BRONZE, CHROME PLATED, POLISHED NICKEL BRONZE] WITH VANDAL PROOF SCREWS SIMILAR TO J.R. SMITH 9005.

2.7 ACCEPTABLE MANUFACTURERS

- A. Cleanouts and Drains
 1. Wade
 2. Zurn
 3. J.R. Smith
 4. Ancon
- B. Trap Primers
 1. MIFAB
 2. Sioux Chief

- C. Fresh Air Inlet
 - 1. J.R. Smith
 - 2. Wade
 - 3. Zurn

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All materials shall be new and installed in a first class manner.

3.2 OPERATING INSTRUCTIONS PERIOD

- A. Provide one day of instructions.

END OF SECTION

SECTION 221323

SANITARY WASTE INTERCEPTORS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide complete interceptors in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Grease Interceptor.
- B. Oil Interceptor.
- C. Lint Interceptor.
- D. Trap Primers.

1.3 SUBMITTALS

- A. Manufacturer's Data Sheets.

1.4 QUALITY ASSURANCE

- A. Applicable Standards
 - 1. Local Plumbing Code.
 - 2. Local authorities having jurisdiction.
 - 3. PDI.

PART 2 - PRODUCTS

2.1 GREASE INTERCEPTORS (PASSIVE TYPE)

- A. Grease interceptors shall be powder epoxy coated inside and out, fabricated 10 gauge steel all welded construction with certification to the P.D.I. Standard #PDI-G101. Interceptor shall include removable baffle assembly and cross bar, integral deep seal trap covered by the lid, securing bolt(s), external vented flow control fitting, internal air relief by-pass, sewer gas stopper and non-skid neoprene gasketed lid.

2.2 GREASE INTERCEPTORS (AUTOMATIC RECOVERY TYPE)

- A. Automatic recovery grease interceptors shall have removable internal basket strainer. Construction to be 16 gauge type #304 stainless steel heli-arc welded, polished to a #4 finish and built to NSF Standard #2 with affixed seal. The interceptor shall: include a lid fastened down with stainless steel latches and catches welded in place; include an electric draw-off valve, electronic sensors, and an audible alarm with visible lights; be thermostatically controlled, maintaining the liquid at an average 120 degrees to prevent the grease from congealing and prewired to U.L. standards; include a heating element; have thermostat and electrical connections enclosed in a type 304 stainless steel housing box equipped with a gasketed removable stainless steel cover; include and external; vented flow control fitting and installed

between the inlet and the fixtures served; include an external clear plastic collection box for the recovered grease. The automatic recovery grease interceptor is to be tested and certified to the P.D.I. Standard PDI-G101.

2.3 OIL INTERCEPTORS

- A. Oil interceptor shall be powder epoxy coated inside and out and fabricated 10 gauge steel all welded construction. Interceptor shall include: removable baffle assembly and cross bar; sediment bucket with perforated baffle beside inlet; integral deep seal trap covered by the lid; securing bolt(s); internal calibrated stainless steel orifice plate; internal air relief by-pass; sewer gas stopper; adjustable draw off assembly; double vent connections on each side; and non-skid neoprene gasketed lid. Interceptor to be manufactured complete with an integral waste oil holding tank for additional waste oil storage.

2.4 LINT INTERCEPTORS

- A. Lint interceptors shall be powder epoxy coated inside and out, fabricated 10 gauge steel all welded construction. Interceptor shall include: ½" thick fixed primary straining baffle with 3/8" holes and a secondary ½" thick removable staining baffle with 3/8" holes; removable cross bar, integral deep seal trap covered by the lid, securing bolt(s), internal calibrated stainless steel orifice plate, internal air relief by-pass, sewer gas stopper and non-skid neoprene gasketed lid.

2.5 ACCEPTABLE MANUFACTURERS

- A. Grease Interceptors (passive type)
 - 1. MIFAB
 - 2. J.R. Smith
 - 3. Wade
- B. Grease Interceptors (automatic recovery type)
 - 1. MIFAB
 - 2. Thermaco
 - 3. Lowe Engineering
- C. Oil Interceptor
 - 1. MIFAB
 - 2. J.R. Smith
 - 3. Wade
- D. Lint Interceptor
 - 1. MIFAB
 - 2. J.R. Smith
 - 3. Wade

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All materials shall be new and installed in a first class manner.

3.2 OPERATING INSTRUCTIONS PERIOD

- A. Provide one day of instructions.

END OF SECTION

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SECTION 221413

STORM DRAIN PIPING AND FITTING MATERIALS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide piping and fitting materials in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Piping.
B. Fittings.
C. Related Accessories.

1.3 SUBMITTALS

- A. Submit a list of all proposed piping materials including system/material (use schedule).
B. Submit complete back-up material where proposed materials differ from those specified.

1.4 QUALITY ASSURANCE

- A. Each pipe length shall have the manufacturer's name cast, stamped or rolled on.
B. Each fitting shall have the manufacturer's name cast, stamped or rolled on.
C. The following are references to the specifications standards of recognized authorities to which pipe and fitting materials must conform to be acceptable. All references shall be the latest edition in force at the time of bidding.

Material	Authority Spec. Numbers
Sleeve Pipe, Black and Galvanized	ANSI B36.20
Steel Pipe, Black and Galvanized	ANSI B36.20
Extra Heavy and Service Weight Cast Iron Soil Pipe and Fittings	CS188-66
Caulking Lead, Type I	FS-QQ-L156(1)
Neoprene or Rubber Gasket, Compression	CISPI HSN-75
Hubless Cast Iron Soil Pipe and Fittings	CISPI 301
Cast Iron Threaded Drainage Fittings	ANSI B16.12

PART 2 - PRODUCTS

2.1 CAST IRON SOIL PIPE (XH)

- A. Pipe: Uncoated extra heavy cast gray iron, hub and spigot type with weight per foot and maker's name clearly stamped or cast on each length.
- B. Fittings: Hub and spigot, extra heavy cast iron.
- C. Joints: Lead and oakum caulked.
- D. Application: Underground storm piping inside and outside of building to point of connection with municipal sewers.

2.2 CAST IRON SOIL PIPE (SV)

- A. Pipe: Service weight centrifugally spun cast iron soil pipe hub and spigot type with weight per foot and maker's name clearly stamped or cast on each length.
- B. Fittings: Hub and spigot service weight cast iron.
- C. Joints: Oakum and lead, Neoprene or rubber gasket, compression.
- D. Application:
 - 1. All storm water except as noted under Hubless Cast Iron.

2.3 CAST IRON SOIL PIPE (HUBLESS)

- A. Pipe: Hubless cast iron soil pipe coated inside and out.
- B. Fittings: Hubless service weight, cast iron.
- C. Joints: Neoprene gasket and heavy duty type 304 stainless steel shield and four stainless steel bands for sizes 1½" through 4", six bands minimum for sizes 5" and larger. Clamps as manufactured by Clamp-All Corporation or Husky as manufactured by Anaheim Foundry Co. (ANACO).
- D. Application:
 - 1. Branch storm piping from drain to connections to stack.

2.4 GALVANIZED STEEL PIPE

- A. Pipe: Galvanized steel pipe, Schedule 40 with maker's name rolled into each length.
- B. Fittings
 - 1. Threaded: Galvanized malleable iron with flat band steam pattern. Cast iron drainage pattern for waste piping.
 - 2. Mechanical Joint: Victaulic couplings Style 07 for grooved piping only, with gasket.
- C. Joints: Teflon tape for threaded, Victaulic couplings with gasket for mechanical joint.

D. Application

1. Schedule 40 steel for sump pump discharges.
2. Schedule 40 steel for storm drainage greater than 15" ..

PART 3 - EXECUTION

3.1 JOINTS

- A. Caulked Joints: Firmly pack joints with an oakum gasket and seal with molten virgin pig lead. Use twelve ounces of molten lead for each inch in diameter of pipe used at each joint. Run lead in one pouring and caulk tight. Seal and smoothly face the joints.
- B. Threaded Joints: Do not damage fitting surface, remove burrs and ream smooth. Apply Teflon tape to male threads only. Clean joint thoroughly of excess jointing material.
- C. Flanged Joints: Use matched flange faces and 1/16" thick compressed gaskets.
- D. Compression Joints: Lubricate neoprene gasket and slip into hub end of pipe. Draw spigot end of pipe into the gasketed hub. Provide restrained joints at all changes in pipe sizes, at all changes in direction of run and at all dead ends.
- E. Mechanical (Grooved) Joints: Joints shall be made with neoprene or synthetic rubber gaskets.
- F. Make joints between different piping materials with adaptor fittings of a type suitable for the purpose intended.
- G. Make joints between pipes of dissimilar metals with dielectric union or flanges.
- H. Graphite shall be used on all cleanout plugs or caps.
- I. All mechanical joint fittings and couplings shall be made by the same manufacturer.

3.2 BRACING

- A. Hubless cast iron pipe shall have bracing installed as required by CISPI and the manufacturer.

3.3 INSTALLATION

- A. All materials shall be new and installed in a first class manner.
- B. All drainage piping, unless otherwise indicated, shall be pitched at a minimum rate of 1/8 inch per foot in direction of flow. Branch connections to stacks or main drains shall not be made in a manner which will permit backflow.
- C. Nipples: Any piece of pipe 8 inches in length and less shall be considered a nipple. All nipples shall be of weight corresponding to fitting connected. Only shoulder nipples shall be used unless otherwise directed.

3.4 OPERATING INSTRUCTIONS PERIOD

- A. Provide one day of instructions.

3.5 SOIL, WASTE, VENT AND STORM WATER SYSTEMS

- A. Except for outside leaders and perforated or open jointed drain tile (subsoil drains), the piping of sanitary and storm drainage and vent systems shall be verified as to materials and shall be tested upon completion of the rough piping installation and prove to be water tight. The removal of cleanout plugs may be required to ascertain that the prescribed pressure has been reached in all parts of the system. Testing of sections shall be done in order to permit general construction and other work to proceed. Such tests shall be made in the presence of the Building Department Inspectors, Owner's representative and any other authorities having jurisdiction.
- B. Water Test. A water test shall be applied to the drainage system either in its entirety or in sections after rough piping has been installed. If applied to the entire system, all openings in the piping, except the highest opening, shall be tightly closed and the system filled with water to the point of overflow. If the system is tested in sections, each opening, except the highest opening of the section under test, shall be tightly plugged and each section filled with water. No section shall be tested with less than a ten foot head of water. In testing successive sections, at least the upper ten feet of the following section shall be tested, so that no joint or pipe in the building (except the uppermost ten feet of the system) shall have been submitted to a test of less than ten foot head of water. The water shall be kept in the system or in the portion under test for at least four (4) hours before inspection starts; the system shall then be tight at all points.
- C. Air Test. An air test may be used only when permission for this type of test is obtained from the Engineer. The air test shall be made by attaching an air compressor testing apparatus to any suitable opening and, after closing all other inlets and outlets of the system, forcing air into the system until there is a uniform gauge pressure of five psi or sufficient pressure to balance a column of mercury ten inches in height. This pressure shall be held, without introducing additional air, for a period of at least thirty minutes.
- D. Buried Piping
 - 1. In addition to the hydrostatic testing indicated above all buried piping shall be videotaped twice. Once after backfilling is complete and a second time after the slabs have been poured. A report and videotape shall be given to the owner's representative after each test.

END OF SECTION

SECTION 221423
STORM DRAINAGE SPECIALTIES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide complete storm drainage systems in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Cleanouts.
- B. Drains.

1.3 SUBMITTALS

- A. Manufacturer's Data Sheet.

1.4 QUALITY ASSURANCE

- A. Applicable Standards
 - 1. Local Plumbing Code.
 - 2. Local authorities having jurisdiction.
 - 3. PDI.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Provide cleanouts at the base of all soil, waste and leader stacks.
- B. Cast Iron Pipe Cleanouts: Tapped extra heavy cast iron ferrule, caulked into cast iron fittings, and extra heavy lead seal plug with solid hexagonal nut or countersunk plug to suit.
- C. No-Hub Cast Iron Pipe Cleanouts: No-Hub cast iron cleanout plug or extra heavy brass threaded plug in tapped cast iron fittings, with solid hexagonal nut or countersunk plug to suit.
- D. Steel Pipe Cleanouts: Extra heavy brass threaded plug in drainage fitting.
- E. Cleanout Plugs: Comply with the Plumbing Code; American Standard pipe threads with "Permacel" or approved Teflon tape applied to the male threads.
- F. Extend cleanouts to walls and floor with long sweep ells or "y" and 1/8 bends with plugs and face or deck plates to conform to the architectural finish in the room. Where no definite finish is indicated on the architectural and/or mechanical drawings, use stainless steel wall plates and floor plates of nickel bronze.
- G. Cleanouts shall be not more than 50 feet apart in horizontal drainage lines. Accessible cleanouts shall be installed at each change of direction greater than 45° on all horizontal drainage lines. All cleanouts shall be installed so that the cleanout opens in the direction of flow

or at right angles thereto. Cleanouts shall be of same size as pipes up to 4 inches and not less than 4 inches for larger piping.

H. Cleanouts and Plates: J.R. Smith models as indicated in the following tabulation:

Type	Location	Piping
4405-98		Exposed C.I. pipe
4472		Exposed steel pipe
4402-97	Wall	Concealed C.I. pipe
4472	Wall	Concealed steel pipe
4025	Concrete Floor	Steel or C.I.
4160FC	Waterproof Slab Floor	Steel or C.I.
4145	Asphalt Tile Floor	Steel or C.I.
4045	Ceramic Tile Floor	Steel or C.I.
4105	Heavy Duty Traffic Floor	Steel or C.I.
4020	Concrete Floor	No-Hub
4020FC	Waterproof Slab Floor	No-Hub
4140	Asphalt Tile Floor	No-Hub
4040	Ceramic Tile Floor	No-Hub
4100	Heavy Duty Traffic Floor	No-Hub

2.2 DRAINS

- A. The drain schedule on the drawings indicates the particular drain desired at the various locations indicated on the Drawings.
- B. Locations of drains shown on the drawings shall be verified by this trade.
- C. All drains shall include adjustable clamping collars device where membrane or other waterproof floors or decks occur.
- D. All drains shall include extension collars as required to suit roof, floor or deck construction.
- E. Furnish caulk support strap, J.R. Smith Fig. No. 9329 for all drains requiring same.

2.3 FRESH AIR INLET SECTION ONE [POLISHED BRONZE, CHROME PLATED, POLISHED NICKEL BRONZE] WITH VANDAL PROOF SCREWS SIMILAR TO J.R. SMITH 9005.

2.4 ACCEPTABLE MANUFACTURERS

- A. Cleanouts and Drains
 - 1. Wade
 - 2. Zurn
 - 3. J.R. Smith

4. Ancon
- B. Fresh Air Inlet
1. J.R. Smith
 2. Wade
 3. Zurn

PART 3 - EXECUTION

3.1 OPERATING INSTRUCTIONS PERIOD

- A. Provide one day of instructions.

END OF SECTION

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SECTION 221429

SUMP PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide sump pumps in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Sump Pumps.
- B. Elevator Sump Pumps.

1.3 SUBMITTALS

- A. Catalog Data: Manufacturer's literature and illustrations.
- B. Shop Drawings
 - 1. Dimensions.
 - 2. Detail of valving and piping arrangements.
 - 3. Wiring diagram of prewired controllers required control wiring and power wiring diagrams.
 - 4. Written description of sequence of operation.
 - 5. Pump curves indicating service conditions.
- C. Installation: Manufacturer's installation instructions.
- D. Operating Instructions: Written operating instructions including startup and shutdown.
- E. Maintenance Data
 - 1. Written instructions on items requiring periodic maintenance.
 - 2. Parts List.
- F. Factory Tests and Certificates
 - 1. Pumps hydraulically tested for pressure/flow performances.
 - 2. Provide certified test data.
- G. Responsibility of Manufacturer
 - 1. The manufacturer shall be responsible for the complete pumping system and shall guarantee pumps, motors, controls and all components of the pumping system.

1.4 QUALITY ASSURANCE

- A. U.L.
- B. NEMA

PART 2 - PRODUCTS

2.1 GENERAL

- A. Pumping systems shall be complete with all necessary controls, starters, alarms, timers, wiring of factory-assembled components, etc.
- B. Construct all apparatus of materials and pressure ratings suitable for the conditions encountered during continuous operation.
- C. Select pumps so that when operating at rated RPM, the pump motor cannot be overloaded despite variations in pumping head.

2.2 SUMP PUMP

- A. Provide submersible duplex sump pump units of size and capacity indicated on the drawings. Pumps shall have cast iron casing with rubber asphalt painted external parts. Impeller shall be cast iron, epoxy coated. Provide mechanical seals, stainless steel shaft and flanged discharge connection.
- B. Motor
 - 1. Provide motor with voltage tolerance of 10% and capable of running dry continuously, non-overloading at all points.
 - 2. Provide terminal board connection for submersible motor cable entry.
- C. Guarantee
 - 1. One year guarantee for entire duplex system, commencing from startup of system.
- D. Control Panel
 - 1. The control panel shall consist of the following:
 - a. Across-the-line starter.
 - b. Ambient-compensated disconnect switches.
 - c. H.O.A. switches.
 - d. Automatic alternator.
 - e. Control transformer with fused primary and secondary.
 - f. Elapsed time meters.
 - 2. Panel shall provide the following alarms and indications:
 - a. Pump running lights one (1) per pump.
 - b. High water level alarm light one (1).
 - c. Power available light one (1).
 - d. Pump fail to run one (1) per pump.
- E. Level Sensors:
 - 1. Provide four sensors and ground. Sensors shall be Flygt Model ENH-10 or Peerless Series P Sealtrode Floatless Pump Controllers.
- F. General
 - 1. All wiring will be done provided by this Contractor who shall be responsible for the complete installation.

2. Alarms, alarm wiring and control wiring shall be provided by this trade.
3. The installation shall be complete with all accessories required.
4. Provide a horizontal swing check valve in the discharge from each pump. The valve shall be equipped with a lever weight for quick closure.
5. Sump pumps shall not be used during construction without written approval from the Engineer.

G. Concrete Pit

1. Concrete pit, specified in a separate section of the specification, shall be of size and capacity as shown on the drawings.

H. Cast Iron Basin

1. Provide one cast iron basin of size and capacity as shown on drawings. Centerline of lowest inlet to basin shall be located not less than 48" above bottom of basin.

I. Cover

1. Provide a cast iron frame and checkered steel plate cover with bolted down and gasketed cover plates, cord grip fittings for motor cables and two flexible connectors for pump discharges.

2.3 ACCEPTABLE MANUFACTURERS

A. Sump Pumps

1. Flygt Corporation
2. Weil Pumps
3. Gormann Rupp

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Completely align and level pumps, motors and bases. Where pumps and motor are shipped as a unit, realign them in the field.
- B. Grout base plates completely to provide a non-deflecting support.
- C. Secure pumps to bases with proper size anchor bolts.
- D. Install and align mechanical seals in accordance with the manufacturer's recommendation.
- E. Pump manufacturer to set packing, adjust impellers and check alignment prior to startup.
- F. Domestic water booster pumps to be installed with concrete inertia base.

END OF SECTION

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SECTION 221690
WATER DETECTION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide a complete electronic cable system that detects the presence of water at all points along the cables. The sensing cable shall be constructed such that no metallic parts are exposed to the environment. The installation kit shall include all system components required for a typical installation.
- B. The system shall be TraceTek TTC-ENC-9/TT1000 manufactured by Raychem Corporation in Menlo Park, California.

1.2 WORK INCLUDED

- A. Electronic cable driver modules.
- B. Water sensing cables.
- C. Interconnecting leader cables.
- D. Auxiliary equipment for leak detection.
- E. Each Water Detection System shall monitor areas shown for any leaks occurring at the piping risers.
- F. System alarm panel shall include space provisions for future addition of three (3) leak detection zones.
- G. System shall indicate alarm conditions locally and include discrete relay outputs for each monitored area.

1.3 SUBMITTALS

- A. Catalog Data: Manufacturer's literature and illustrations.
- B. Shop Drawings
 - 1. Wiring diagrams.
 - 2. Written description of sequence of operation.
 - 3. A graphic display map mounted near the module shall be prepared, after completion of installation, from "as-built" drawings furnished by the installer. The map shall indicate the location of the cables; connectors; landmarks such as columns and walls; and changes of cable direction.
- C. Installation: Manufacturer's installation instructions.
- D. Operating Instructions: Written operating instructions.
- E. Maintenance Data

1. Parts List.
 2. Written instructions on items requiring periodic maintenance.
- F. Responsibility of Manufacturer
1. The manufacturer shall be responsible for the complete water detection system.

1.4 QUALITY ASSURANCE

- A. The water detection system must comply with all codes having jurisdiction.

PART 2 - PRODUCTS

2.1 THE CABLE DRIVER MODULE

- A. The Cable Driver Modules (TTC-1) shall be able to monitor one length of TraceTek water sensing cable up to 300 feet long. The cable driver module shall indicate that water has been detected by activating an alarm LED and actuating the output signal. The "alarm" LED shall remain on as long as the sensing cable is wet. The module shall automatically reset when the cable is dried or replaced.
- B. The Cable Driver Modules shall monitor the cable for continuity. Damage to the sensing cable or leader cable shall cause the cable driver module to activate, a continuity LED, and actuate a separate output signal.
- C. The Cable Driver Modules shall have LED's indicating "power" (green), "alarm" (red), and "continuity" (yellow).
- D. The Cable Driver Modules shall be powered by 12 to 24 volts AC or 15 to 24 volts DC. The module shall have two (2) DPDT relays with 3 AMP rating for Leak Detection and 1 SPST relay with 3 AMP rating for loss of power or a break in the sensor cable.
- E. The Cable Driver Modules shall be supplied installed in a common enclosure Model TTC-ENC-9. The enclosure shall be a Hoffman Design-Line Type, NEMA-1 with a beige hammertone finish. The enclosure shall be supplied with 1 sensor cable driver module (Model No. TTC-1). The enclosure shall be supplied with terminal strips pre-wired from each cable driver module to include:
1. Incoming power (2 terminals).
 2. One common trouble alarm signal for the leak relay and trouble relay contacts of each module (2 terminals for connection to BMS or Remote Annunciator Panel).
 3. Sensor cable connections (4 terminals/module).
- F. The enclosure door shall be fitted with a Plexiglas window to permit inspection of the green, red and yellow LED's included with each cable driver module.
- G. This enclosure shall be mounted at the location shown on the drawing. Four conductor, 18-AWG, plenum rated jumper cable shall be installed from each cable driver module to each section of sensor cable as shown on the drawings.

2.2 THE WATER SENSING CABLE

- A. The water sensing cable (TT-1000-25FT) shall detect the presence of water and pinpoint its location. The cable shall consist of four wires: two sensor wires, a continuity wire, and a return wire. All four wires shall be coated or insulated with fluoropolymer and wound helically around a

central fluoropolymer core. Cables using exposed metal or non-fluoropolymer construction shall not be acceptable. The cable shall have a breaking strength including connectors of at least 70 pounds per ASTM D-638. The cable shall have an abrasion resistance of >65 cycles per UL 719. The sensing cables shall be capable of accommodating any number of branches using TraceTek Branch Connectors (TT-MBC).

- B. The sensing cable shall offer distributed sensing with the ability to detect the location of water at any point along the length of the cable. The cable shall be flexible, and carry less than 24 VDC under normal operating conditions. The sensing cable shall be available in modular lengths of 3, 10, 25, and 50 feet with factory installed male/female connectors.
- C. Contact by the sensing cable with any metallic equipment under the floor, such as drip pans, tile supports or conduit, will not alarm the system.
- D. The cable shall pass UL 910, Test Method for Fire and Smoke Characteristics of Electrical and Optical-Fiber Cables Used in Air Handling Spaces, and shall be plenum rated per NEC 725-2(b).

2.3 ACCESSORIES

- A. Standard accessories to include modular end terminations (TT-MET-PC), modular leader cables (TT-MLC-PC), caution tags (TT-TAG), and hold down clips (TT-HDC-1/4).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All TraceTek system components shall be installed in accordance with manufacturer's installation instructions. The installer shall be responsible for providing a clean and functional system. Supervision and training shall be available from a TraceTek distributor or other personnel authorized by TraceTek Group.
- B. The sensing cable shall be installed after all piping, air conditioning, raised flooring, and other mechanical work is completed. The subfloor shall be cleaned prior to installing the sensing cable. Care shall be taken during installation of the sensing cable to avoid contact with potential contaminants, such as puddles or solder flux. The cable shall be fastened securely to the surface of the floor slab with hold down clips together with construction mastic (3M Type 4975) plastic adhesive every 4 feet.
- C. The TraceTek system shall be commissioned upon completion of the installation by personnel authorized by the TraceTek Group in accordance with manufacturers' instructions.

3.2 GUARANTEE

- A. The Manufacturer of the water detection system shall guarantee for one year from the date the system is accepted by the owner. Contractor shall replace all equipment found to be defective during this period.

END OF SECTION

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SECTION 223300
ELECTRIC DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide a complete domestic water heater system in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Domestic Water Heaters.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's literature and illustrations.
- B. Shop Drawings
 - 1. Dimensions.
 - 2. Details of construction for heaters including control system, safety devices, and cathodic protection.
 - 3. Installation details, including supporting materials.
 - 4. Heater capacity and recovery rate (GPM, GPH temperature rise).
 - 5. ASME Code construction.
 - 6. Tank warranty.
 - 7. Energy module warranty and heater warranty.
- C. Manufacturer's installation instructions.
- D. Written operating instruction including start-up and shut-down.
- E. Maintenance Data
 - 1. Written instructions on items requiring periodic maintenance.
 - 2. Parts lists.
- F. Test Results: Certified copies of shop pressure tests.

1.4 QUALITY ASSURANCE

- A. Applicable Standards
 - 1. ASHRAE
 - 2. ASME
 - 3. ASTM
- B. Certifying Agencies
 - 1. ASME constructed and stamped.
 - 2. Underwriters Laboratories.
 - 3. Factory Mutual.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Furnish and install complete factory assembled packaged system, including auxiliary components and controls.
- B. Packaged heater shall include the following components:
 - 1. Water thermometer (3½" diameter dial minimum) direct mounted with separable thermowell.
 - 2. Thermostats in operating temperature range.
 - 3. Bronze pressure and temperature relief valve (ASME Certified) to comply with state and local codes.
 - 4. Pressure gauge (4½" diameter dial minimum).
 - 5. Heater shall be as scheduled on the drawings.

2.2 ELECTRIC DOMESTIC WATER HEATER

- A. The tank shall be constructed in accordance with ASME Code Section IV, stamped with the appropriate symbol, and hydrostatically tested at 180 PSI minimum. The tank shall be equipped with a removable modular energy package mounted on a flange with a minimum diameter of 23". Tank access may be gained by the removal of this energy package with ordinary hand tools. The tank shall also be equipped with an easily removable rear module access cover with a minimum diameter of 23" for simplicity of tank access and energy package cleaning and maintenance. The tank may be of modular design where more than one tank module will be required to meet the total gallon capacity. The total tank capacity shall be as scheduled on the drawings. The tank shall contain a strata-baffle to divert the incoming cold water to allow 80% of the total tank storage to be effective at a usable temperature of $\pm 5^{\circ}\text{F}$ from the setpoint of the operating thermostats. All fittings will be of type K heavy copper. No tank connections of other than non-ferrous alloys will be accepted.
- B. There shall be a minimum of two operating thermostats. These operating controls should be set at 120°F for the lower and 140°F for the upper. There shall be one temperature limiting device designed to prevent temperatures from exceeding a maximum of 200°F. There shall also be an ASME temperature and pressure relief valve. There shall also be installed, in the cold section of the tank as factory standard equipment, a thermal expansion control valve set to relieve pressure. Equipment submitted without these redundant controls, temperature limiting device and thermal expansion control valve will not be accepted.
- C. The tank shall be insulated with a heavy density fiberglass insulation and will be jacketed with segmented panels of 22 gauge steel with a factory baked enamel finish. The entire water heater shall rest on heavy duty skids for ease of movement.
- D. The tank shall be completely lined, inside and out, with 97% pure nickel. The method of applying the nickel shall be the electroless chemical deposition method, creating a holiday-free, non-ferrous layer of pure 97% nickel over the ASME code steel. The tank shall have an additional overcoat of an elastomeric, polymerized, hydrophobic cross-linked plastic to prevent any electrolysis that may develop within the plumbing system. Magnesium rods will not be installed. Cement lining or glass lining (porcelain enamel) with magnesium rods will not be accepted as an equal.
- E. The tank shall be covered under the manufacturer's ten year warranty, service policy and long life service policy. In the first year, the manufacturer will pay for all material, labor and freight

covering any part or parts of the water heater that should fail or not meet the Owner's satisfaction. For the next four years the manufacturer will pay for all material, labor and freight to repair or replace the tank should it leak or produce discolored water. During the last five years if the tank produces rusty water or leaks, the manufacturer will repair the tank so that it does not leak or produce rusty water and all repair costs will be totaled and shared between the manufacturer and the Owner. If, in the judgment of the manufacturer, the tank is not repairable, the manufacturer will offer to sell to the Owner a new tank of the then current equivalent model. With either repair or replacement, the cost to the Owner shall be equal to the number of months in service divided by the total number of months of the warranty, times the cost of repair or the current list price of the replacement tank. Less than the above described warranty will not be accepted.

- F. The energy package shall produce a minimum capacity as scheduled on the drawings and consist of an all-electric module guaranteed to produce a fuel-to-water operating efficiency of 83% minimum. This efficiency shall be certified by a nationally recognized certification agency
- G. The entire water heater shall meet U.L. and FM requirements, shall fit properly in the space provided and shall conform to drawing specifications. The complete installation shall be in accordance with all applicable codes.

2.3 ELECTRIC DOMESTIC WATER HEATERS

- A. The heater shall be glass-lined dura-power supreme commercial electric model as scheduled on drawings and as manufactured by A.O. Smith Corporation. Heater shall be constructed in accordance with ASME code shall bear appropriate symbol and listed with the National Board as required. Heater shall be listed with Underwriters Laboratories and approved by National Sanitation Foundation. All internal surfaces of the tank shall be glass-lined with an alkaline borosilicate composition that has been fused-to-steel by firing at a temperature of 1600°F. Tank shall be cathodically protected with adequate extruded magnesium anode. The entire vessel is to be enclosed in a round steel enclosure with baked enamel finish. Control compartment to be hinged and shall house 120 volt control circuit transformer, transformer fusing, magnetic contactors, immersion style operating thermostats, element fusing per N.E.C., and commercial grade incoloy sheathed flange mounted elements with prewired terminal leads. Temperature controls include limiting switch which will require resetting manually in the event the temperature reaches 190°F and low level shut-off. Foam insulation (R-16) shall exceed latest requirements of ASHRAE (currently 90A-1980) for heat loss efficiency. Heater shall include ASME T & P relief valve and drain valve.

2.4 ELECTRIC STORAGE WATER HEATERS

- A. The heater shall be glass-lined dura-power supreme commercial electric model as scheduled on drawings. Heater shall be constructed in accordance with ASME code shall bear appropriate symbol and listed with the National Board as required. Heater shall be listed with Underwriters Laboratories and approved by National Sanitation Foundation. Internal surfaces of the tank shall be glass-lined with an alkaline borosilicate composition that has been fused-to-steel by firing at a temperature of 1600°F. Tank shall be cathodically protected with adequate extruded magnesium anode. Entire vessel shall be enclosed in a round steel enclosure with baked enamel finish. Control compartment to be hinged and shall house 120 volt control circuit transformer, transformer fusing, magnetic contactors, immersion style operating thermostats, element fusing per N.E.C., and commercial grade incoloy sheathed flange mounted elements with prewired terminal leads. Temperature controls shall include limiting switch which will require resetting manually in the event the temperature reaches 190°F and low level shut-off. Foam insulation (R-16) shall exceed latest requirements of ASHRAE for heat loss efficiency. Heater shall include ASME T & P relief valve and drain valve.

2.5 ACCEPTABLE MANUFACTURERS

A. Electric Water Heaters

1. Hubbell
2. PVI
3. Patterson-Kelley
4. A.O. Smith
5. Lochinvar

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Pipe all relief valves indirectly to floor drains.

END OF SECTION

SECTION 224200
COMMERCIAL PLUMBING FIXTURES AND TRIM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide plumbing fixtures and accessories in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Carriers.
- B. Water Closets, Flush Valves and Seats.
- C. Urinals and Flush Valves.
- D. Lavatories, Faucets, Supplies and Traps.
- E. Sinks, Faucets, Supplies and Traps.
- F. Bathtubs, Shower Valves, Shower Heads and Accessories.
- G. Mop Receptors.
- H. Sinks.
- I. Drinking Fountains and Electric Water Coolers.
- J. Showers, Shower Valves, Shower Heads and Accessories.

1.3 SUBMITTALS

- A. Prior to purchase, submit manufacturers catalog data including illustrations, operating characteristics and details of construction for all plumbing fixtures and trim.
- B. Where manufacturer's catalog information does not clearly indicate construction details or aesthetics of fixtures, equipment samples shall be submitted before review.

1.4 QUALITY ASSURANCE

- A. Fixtures shall be free from imperfections, true as to line, angles, curves, and color. Fixtures shall be smooth, watertight, and practically noiseless in operation.
- B. If products of alternate manufacturers are selected, the alternate products shall have clearances, waterways, water use characteristics, and assembly equal to that of the plate number of the products specified.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Vitreous Ware: Fired vitreous china ware of the best quality, non-absorbent and burned so that the whole mass is thoroughly fused and vitrified, producing a material white in color, which when fractured will show a homogeneous mass, close-grained and free from pores. Glaze and finish shall be thoroughly fused and united to the body, without discoloration chips or flaws, and shall be free from crazing or cracks. Warped or otherwise imperfect fixtures will not be accepted.
- B. Exposed Trim: Including all fittings, escutcheons, faucets, traps, exposed piping, etc., shall be brass, chrome plated over nickel plate with polished finish. Any hanger nuts visible shall likewise be chrome plated over nickel plate.
- C. Provide supply stops with renewable seats for each plumbing fixture.
- D. All fixture colors shall be specified by Architect.
- E. All cold water faucets and supplies shall be to the right and open clockwise. All hot water faucets and supplies shall be to the left and open counter clockwise.
- F. All shower arms shall be secured to construction to prevent movement.

2.2 FIXTURES AND FITTINGS

- A. The following plumbing fixtures are representative of the style, design and capacity required. Refer to the acceptable manufacturer list in this section for allowable substitutions.
 - 1. F-1, Wall Hung Siphon Jet 1.6 GPF Water Closet:
 - a. Fixture: Vitreous China, Siphon Jet, elongated bowl, 1 ½" top spud, 1.6 GPF, color as selected by Architect. Fixture shall be [American Standard Aftwall 2257.103 or Kohler Kingston K4330].
 - b. Carrier: J. R. Smith 210-L-Y-M51, 210-R-Y-M51, 220-L-Y-M51, or 220-R-Y-M51 adjustable fixture support with anchor foot.
 - c. Seat: Church Duraguard No. 2155 SSC elongated open front less cover containing Antibacterial agent with external stainless steel check hinges.
 - d. Manual Flush Valves: Chrome plated semi red brass; diaphragm type, exposed, non-hold open; no external adjustment; ADA compliant handle; vandal resistant stop cap; cast set screw wall flange. Valve shall be Sloan Royal Model No. 111.
 - e. Electrical (low voltage) flush valve: chrome plated semi red brass; diaphragm type, exposed, non-hold open; no external adjustment; vandal resistant stop cap; cast set screw wall flange; self-adaptive infrared sensor; 3 second flush delay; manual flush button; chrome plated wall cover plate with vandal resistant screws; integral 24 volt AC solenoid operator; 24 volt transformer supplied by flush valve manufacturer. Valve shall be Sloan Royal Optima Model 111-ES-S with EL-154.
 - f. Electric (Battery) Flush Valve: Chrome plated semi red brass; diaphragm type, exposed; non hold open; no external adjustment; vandal resistant stop cap; cast set screw wall flange; battery self-adaptive infrared sensor; mounted on top of valve; 3 second flush delay; manual flush button; low battery indicator. Valve shall be Sloan Royal Optima Model 8111.
 - 2. F-1B Handicapped Wall Hung Water Closet
 - a. Same as F-1 except mount at ADA compliant height.

3. F-1C Wall Hung Blowout 3.5 GPF Water Closet.
 - a. Fixture: Vitreous China, blowout, elongated bowl, 1½" top spud. Color as selected by Architect. Fixture shall be [American Standard Instanto 2512.010 or Kohler Stratton K-4450-C.]
 - b. Carrier: J. R. Smith 210-L-Y-M51, 210-R-Y-M51, 220-L-Y-M51, or 220-R-Y-M51 adjustable fixture support with anchor foot.
 - c. Seat: Church Duragard No. 2155.SSC open front less cover containing anti-microbial agent with external stainless check hinges.
 - d. Manual Flush Valve: Chrome plated semi red brass; no external adjustment; ADA compliant handle; vandal resistant stop cap; cast set screw wall flange. Valve shall be Sloan Royal Model No. 110.
 - e. Electronic (low voltage) flush valve: chrome plated semi red brass; diaphragm type, exposed; non-hold open; no external adjustment; vandal resistant stop cap; cast set screw wall flange; self-adaptive infrared sensor; 3 second flush delay; manual flush button; chrome plated wall cover plate with vandal resistant screws; integral 24 volt AC solenoid operator; 24 volt transformer supplied by flush valve manufacturer. Valve shall be Sloan Royal Optima, Model 110-ES-S with EL-154.
 - f. Electronic (Battery) Flush Valve: Chrome plated semi red brass; diaphragm type, exposed; non-hold open; no external adjustment; vandal resistant stop cap; cast set screw wall flange; battery self-adaptive infrared sensor-mounted on top of valve; 3 second flush delay; manual flush button; low battery indicator. Valve shall be Sloan Royal Optima Model 8110.
4. F-1D Floor Mounted Pressure Assist Tank Type Water Closet
 - a. Fixture: Vitreous china, pressure assisted Sloan Flushmate siphon jet flush, 1.6 gpf, elongated bowl. Color as specified by Architect. Fixture shall be [American Standard Cadet 2292.100 or Kohler Wellworth K-3458].
 - b. Seat: Church Duraguard 2155.SSC open front, less lid containing anti-microbial agent with external stainless steel check hinge.
 - c. Supplies: McGuire chrome plated non-flexible loose key stops.
5. F-1E Floor Mounted Pressure Assisted Tank Type ADA Compliant.
 - a. Fixture: Vitreous china, pressure assisted Sloan Flushmate, siphon jet flush; 1.6 gpf; elongated bowl, ADA compliant. Color as selected by Architect. Fixture shall be [American Standard Cadet 2168.192 or Kohler Highline K-3544].
 - b. Seat: Church Duraguard 2155.SSC open front less seat, containing microbial agent with external stainless steel check hinges.
 - c. Supplies: McGuire chrome plated, non-flexible, loose key stops.
6. F-2 Wall Hung Urinal ADA Compliant Siphon Jet
 - a. Fixture: Vitreous china; wall hung; siphon jet; extended sides; 1.0 gpf; ¾" top spud. Color as specified by architect. Fixture shall be [American Standard Trimbrook 6561.017 or Kohler Bardon K-4960-T].
 - b. Carrier: J.R. Smith No. 637 – bolt legs to floor slab.
 - c. Manual Flush Valve: Chrome plated semi-red brass; diaphragm type, exposed, non-hold open; no external adjustment; ADA compliant handle; vandal resistant stop cap; cast set screw wall flange. Valve shall be Sloan Royal Model No. 186-1.
 - d. Electronic (Low Voltage) Flush Valve: Chrome plated, semi-red brass; diaphragm type; exposed; non-hold open; no external adjustment; vandal resistant stop cap; cast set screw wall flange; self-adaptive infrared sensor; 3 second flush delay; manual flush button; chrome plated wall cover plate with vandal resistant screws; integral 24-volt AC solenoid operator; 24 volt transformer supplied by flush valve manufacturer. Valve shall be Sloan Royal Optima Model 186-1-ES-S with EL-154.

- e. Electronic (Battery) flush valve: chrome plated, semi-red brass; diaphragm type, exposed; non-hold open; no external adjustment; vandal resistant stop cap; cast set screw wall flange; battery self-adaptive infrared sensor mounted on top of valve; 3 second flush delay; manual flush button; low battery indicator. Valve shall be Sloan Royal Optima Model 8186-1.
7. F-2A Wall Hung Urinal ADA Compliant Blowout
- a. Fixture: Vitreous china; wall hung; blowout; extended sides; 1.0 gpf; 1-1/4" top spud. Color as selected by Architect. Fixture shall be [American Standard Lynbrook 6501.012 Kohler Stanwell K-4972-T].
 - b. Carrier: Carrier: J.R. Smith No. 637 – bolt legs to floor slab.
 - c. Manual Flush Valve: Chrome plated semi-red brass; diaphragm type, exposed, non-hold open; no external adjustment; ADA compliant handle; vandal resistant stop cap; cast set screw wall flange. Valve shall be Sloan Royal Model No. 180-1.
 - d. Electronic (Low Voltage) Flush Valve: Chrome plated, semi-red brass; diaphragm type; exposed; non-hold open; no external adjustment; vandal resistant stop cap; cast set screw wall flange; self-adaptive infrared sensor; 3 second flush delay; manual flush button; chrome plated wall cover plate with vandal resistant screws; integral 24-volt AC solenoid operator; 24 volt transformer supplied by flush valve manufacturer. Valve shall be Sloan Royal Optima Model 180-1-ES-S with EL-154.
 - e. Electronic (Battery) flush valve: chrome plated, semi-red brass; diaphragm type, exposed; non-hold open; no external adjustment; vandal resistant stop cap; cast set screw wall flange; battery self-adaptive infrared sensor mounted on top of valve; 3 second flush delay; manual flush button; low battery indicator. Valve shall be Sloan Royal Optima Model 8180-1.
8. F-3 Lavatory (Wall hung, ADA compliant):
- a. Fixture: 20" x 18¹/₄"; 4" centers, vitreous china, concealed arms, rear overflow faucet ledge; ADA compliant. Color as specified by Architect. Fixture shall be [American Standard Comrade 0124.131 or Kohler Chesapeake K-1729].
 - b. Carrier: J. R. Smith 700-E-M31-E with chrome plated escutcheons.
 - c. Metering Faucet: All brass body; adjustable timing; 4" centers, ADA compliant; slo close metering faucet. Fixture shall be Speakman Easypush S-4141-LD.
 - d. Electronic Faucet (Low Voltage): Sensor operated, 24 VAC Hand Washing Faucet Chrome plated cast brass spout with integral sensor throat plate, splash-proof circuit control module with troubleshooting LED indicator lights, range adjustment screw, .5 gpm aerator, variable time-out settings, and modular, quick-release sensor and solenoid connections. Faucet includes back checks for hot and cold water supplies. Solenoid valve with integral 'Y' strainer filter, plug-in transformer, sensor and solenoid valve cables will be sheathed. Cast brass chrome plated mixing valve conforming to ASSE 1016. Faucet shall be Sloan Model No. ETF-600-A-Z-P with Watts MMV-1/2" mixing valve.
 - e. Electronic Faucet (Battery Operated): Battery powered, sensor operated, hand washing faucet chrome plated cast brass, .5 gpm aerator spout with integral sensor with "Low Battery" and Power Up Range Indicator Light and splash-proof circuit control module with integral solenoid valve operator with strainer filter. Control module includes sensing circuits with range adjustment screw and four (4) C-size alkaline batteries. Faucet includes back checks for hot and cold water supplies. Sensor cable shall be chrome plated. Cast brass chrome plated mixing valve conforms to ASSE 1016. Faucet shall be Sloan Model No. EBF-650 with Watts MMV – 1/2" mixing valve.
 - f. Supplies: McGuire loose key rigid stop.
 - g. Trap: Cast brass chrome plated P-trap with cleanout plug and wall escutcheon.
 - h. Strainer: Chrome plated grid strainer.
9. F-3A Lavatory (Countertop ADA Compliant):

- a. Fixture: Vitreous china; self-rimming; front overflow; ADA compliant [single hole, 4" centers, or 8" centers]. Color shall be as specified by Architect. Fixture shall be [American Standard Aqualyn 0475.020 (8" centers); 0475.047 (single hole) or Kohler Ellington K-2906-8 (8" centers); K-2906-4 (4" centers); K-2906-1 (single hole)].
 - b. Metering Faucet: All brass body; adjustable timing; 4" centers, ADA compliant; slo close metering faucet. Fixture shall be Speakman Easy-Push S-4141-LD.
 - c. Electronic Faucet (Low Voltage): Sensor operated, 24 VAC Hand Washing Faucet. Chrome plated cast brass spout with integral sensor throat plate, splash-proof circuit control module with troubleshooting LED indicator lights, range adjustment screw .5 gpm aerator, variable time-out settings, and modular, quick-release sensor and solenoid connections. Faucet includes back checks for hot and cold water supplies. Solenoid valve with integral 'Y' strainer filter, plug-in transformer, sensor and solenoid valve cables will be sheathed. Cast brass chrome plated mixing valve conforming to ASSE 1016. Faucet shall be Sloan Model No. ETF-600-A-Z-P with Watts MMV-1/2" mixing valve.
 - d. Electronic Faucet (Battery Operated): Battery powered, sensor operated, hand washing faucet, chrome plated cast brass, .5 gpm aerator spout with integral sensor with "Low Battery" and Power Up Range Indicator Light and splash-proof circuit control module with integral solenoid valve operator with strainer filter. Control module includes sensing circuits with range adjustment screw and four (4) C-size alkaline batteries. Faucet includes back checks for hot and cold water supplies. Sensor cable shall be chrome plated. Cast brass chrome plated mixing valve conforms to ASSE 1016. Faucet shall be Sloan Model No. EBF-650 with Watts MMV – 1/2" mixing valve
 - e. Supplies: McGuire 3/4" to 3/8" chrome plated, rigid, loose key stops.
 - f. Trap: Cast Brass Chrome plated P-trap with clean out plug and wall escutcheon
 - g. Strainer: Chrome plated grid strainer.
10. F-3B Undercounter ADA compliant lavatory
- a. Fixture: Vitreous China undercounter mount, rear overflow. Color shall be as selected by architect. Fixture shall be [American Standard Ovalyn II 0496.011 or Kohler _____].
 - b. Metering Faucet: All brass body, adjustable timing 4" centers ADA compliant; slo close metering faucet. Fixture shall be Speakman Easy-Push S-4141-LD.
 - c. Electronic faucet (low voltage): Sensor Operated, 24 VAC Hand Washing Faucet. Chrome plated cast brass Spout with Integral Sensor Throat Plate, splash-proof Circuit Control Module with troubleshooting LED indicator Lights, Range Adjustment Screw, .5 gpm aerater Variable Time-out Settings and modular, quick-release Sensor and Solenoid Connections. Faucet includes Back Checks for Hot and Cold water supplies, Solenoid Valve with Integral "Y" Strainer Filter. Plug-in Transformer and flow controlling. Sensor and Solenoid Valve cables will be sheathed. Cast brass chrome plated mixing valve conforming to ASSE 1016. Faucet shall be Sloan Model no ETF-600-A-Z-P with Watts mmv-1/2" mixing valve.
 - d. Electronic Faucet (Battery operated). Battery Powered, Sensor Operated, Hand Washing Faucet. Chrome plated cast brass Spout with integral Sensor with "Low Battery" and Power Up Range indicator Light and splash-proof Circuit Control Module with Integral Solenoid Valve Operator with strainer filter. Control Module includes Sensing Circuit with Range Adjustment Screw and four (4) C-size alkaline batteries. Faucet includes Back Checks for Hot and Cold water supplies. Sensor cable shall be sheathed to prevent vandalism. Cast brass chrome plated mixing valve conforming to ASSE 1016. Faucet shall be Sloan Model No. EBF-650 with Watts MMV-1/2" mixing valve.
 - e. Supplies: McGuire Chrome Plated rigid loose key stops.
 - f. Trap: Cast brass chrome plated P trap with cleanout plug and wall escutcheon.

- g. Strainer: Chrome plated grid strainer.
- 11. F-4 Mop Receptors:
 - a. Fixture: Stern Williams Model No. HL-2000, 36" x 36" x 12" receptor, 6" drop at threshold with one piece 20 ga. 302 stainless steel cap.
 - b. Faucet: Stern Williams T-10-VB chrome finish, mop sink fitting with vacuum breaker and T-35 36" hose with wall bracket.
 - c. Supplies: McGuire chrome plated loose key stops.
 - d. Accessories: Stern Williams T-40 stainless steel mop hanger.
- 12. F-4A Service Sink:
 - a. Fixture: Elkay ESS-2520 stainless steel service sink with wall hanger and support bracket.
 - b. Faucet: Elkay LK-401 chrome finish, service sink fitting with vacuum breaker, Elkay LK-402 36" hose, and Elkay LK-404 hose hanger.
 - c. Supplies: McGuire chrome plated loose key stops.
 - d. Accessories: Elkay LK-403 stainless steel mop hanger.
 - e. Trap: J. R. Smith Fig. 9120-SS 3" cast iron service sink P-trap.
- 13. F-5 Drinking Fountains:
 - a. Fixture: Elkay Model No. EDFP-117-C bi-level drinking fountain stainless steel drinking fountain with AP-99 access panel.
 - b. Trap: P-trap.
- 14. F-5A Electric Water Cooler
 - a. Fixture: Elkay Model No. ERP2-8-C. Two level ADA compliant. Stainless steel.
 - b. Trap: P-Trap
- 15. F-6 Showers (Locker Room):
 - a. Shower Valve: Symmons Temptrol No. S-86-1-X pressure balanced mixing valve with integral volume control, adjustable stop screw to limit handle turn and integral service stops.
 - b. Shower Head: Symmons No. 4-131-3 with 3 gpm flow restrictor. (See Architectural Drawings for mounting height.)
- 16. F-6A Showers (Locker Room, Handicapped):
 - a. Shower Valve: Symmons Temptrol No. S-86-1-X-L pressure balanced mixing valve with integral volume control, adjustable stop screw to limit handle turn, integral service stops and single blade lever handle.
 - b. Shower Head: Symmons No. FSB-24 hand spray unit with hose, wall hook, in-line vacuum breaker, wall connection and flange, with 24" slide bar, 3 gpm flow restrictor.
- 17. F-6B Showers (Handicapped Stall)
 - a. Shower Valve: Symmons Temptrol No. S-86-1-X-L pressure balanced mixing valve with integral volume control, adjustable stop screw to limit handle turn, integral service stops and single blade lever handle.
 - b. Shower Head: Symmons No. FSB-24 hand spray unit with hose, wall hook, in-line vacuum breaker, wall connection and flange, with 24" slide bar, 3 gpm flow restrictor.
 - c. Base: Stern Williams Serpentine wheelchair terrazzo base with integral drain (size as indicated on architectural drawings).
 - d. Trap: Cast iron 'P'-trap.

18. F-6C Shower (Stall):
 - a. Shower Valve: Symmons Temptrol No. S-86-1-X pressure balanced mixing valve with integral volume control, adjustable stop screw to limit handle turn and integral service stops.
 - b. Shower Head: Symmons No. 4-131-3 with 3 gpm flow restrictor. (See Architectural Drawings for mounting height.)
 - c. Base: Stern Williams Trieste terrazzo base with integral drain (size as indicated on architectural drawings).
 - d. Trap: Cast iron 'P'-trap.
19. F-6D Showers (Institutional, regular and handicapped):
 - a. Shower Valve: Symmons Temptrol No. S-86-1-L-X pressure balanced mixing valve with integral volume control, adjustable stop screw to limit handle turn, integral service stops and vandal proof single blade lever handle.
 - b. Shower Head: Symmons No. 4-151 Universal Institutional head with mounting bracket and fasteners.
20. F-7 Tub and Shower:
 - a. Tub and Shower Valve: Symmons Temptrol No. S-86-2-X pressure balanced mixing valve with combination integral diverter and volume control, adjustable stop screw to limit handle turn and integral service stops.
 - b. Shower Head: Symmons No. 4-131-3 with 3 gpm flow restrictor.
 - c. Tub Spout: Symmons No. 060.
21. F-7A Tub and Shower (Handicapped):
 - a. Tub and Shower Valve: Symmons Temptrol No. S-86-2-X-L pressure balanced mixing valve with combination integral diverter and volume control, adjustable stop screw to limit handle turn, integral service stops and single blade lever handle.
 - b. Shower Head: Symmons No. FSB-24 hand spray unit with hose, wall hook, in-line vacuum breaker, wall connection and flange, with 24" slide bar, 3 gpm flow restrictor.
 - c. Tub Spout: Symmons No. 060.
22. F-7B Shower Valve at Low Pressure Locations:
 - a. Shower Valve: Symmons Temptrol No. S-86-1-X pressure balanced mixing valve with integral volume control, adjustable stop screws to limit handle turn and integral volume control, adjustable stop screw to limit handle turn and integral service stops. Bronze flow control spindle assembly to be a maximum flow type, allowing 2.5 gpm flow at 10 psi.
23. F-7B Tub and Shower Valve at Low Pressure Locations:
 - a. Shower Valve: Symmons Temptrol No. S-86-2-X pressure balanced mixing valve with combination integral diverter and volume control, adjustable stop screws to limit handle turn and integral service stops. Bronze flow control spindle assembly to be a maximum flow type, allowing 2.5 gpm flow at 10 psi.
24. F-7B Shower Valve at Handicapped Low Pressure Locations:
 - a. Shower Valve: Symmons Temptrol No. S-86-1-X-L pressure balanced mixing valve with integral volume control, adjustable stop screw to limit handle turn, integral service stops and single blade lever handle. Bronze flow control spindle assembly to be a maximum flow type, allowing 2.5 gpm flow at 10 psi.
25. F-7B Tub and Shower Valve at Handicapped Low Pressure Locations:

- a. Shower Valve: Symmons Temptrol No. S-86-2-X-L pressure balanced mixing valve with combination integral diverter and volume control, adjustable stop screws to limit handle turn, integral service stops and single blade lever handle. Bronze flow control spindle assembly to be a maximum flow type, allowing 2.5 gpm flow at 10 psi.
- 26. F-8 Sink (General):
 - a. Fixture: Elkay 18 ga. stainless steel 25" x 22" Model #0SE-12522 self-rimming, 3 holes 8" deep.
 - b. Faucet: Elkay #LKA-2479-8.
 - c. Drain Grid: Elkay #D-1125.
 - d. Supplies: Chrome plated ¾" loose key, non-flex.
 - e. Trap: Chrome plated P-trap.
- 27. F-9 Washing Machine Connection:
 - a. Symmons W-602-X or equivalent with hot and cold faucets, service stops and 2" drain connection.

2.3 ACCEPTABLE MANUFACTURERS

A. Carriers

- 1. J. R. Smith Company
- 2. Wade
- 3. Ancon

B. Water Closets

- 1. American Standard
- 2. Kohler
- 3. Crane

C. Urinals

- 1. American Standard
- 2. Kohler
- 3. Crane

D. Lavatories

- 1. American Standard
- 2. Kohler
- 3. Crane

E. Flush Valves

- 1. Delaney
- 2. Sloan

F. Lavatory Faucets

- 1. American Standard
- 2. Kohler
- 3. T&S Brass
- 4. Speakman
- 5. Scott
- 6. Moen

- G. Mop Receptors
 - 1. Stern Williams
 - 2. Fiat
- H. Sinks (Stainless Steel)
 - 1. Elkay
 - 2. Just
 - 3. Kohler
- I. Drinking Fountains & Electric Water Coolers
 - 1. Elkay
 - 2. Filtrine
 - 3. Halsey-Taylor
- J. Shower Valves
 - 1. Moen
 - 2. Symmons
 - 3. Powers
- K. Showerheads
 - 1. Moen
 - 2. Powers
 - 3. Symmons
- L. Supplies
 - 1. McGuire
 - 2. EBC
- M. Toilet Seats
 - 1. Church Company
 - 2. Beneke Company
 - 3. Olsonite

PART 3 - EXECUTION

3.1 FIXTURE SUPPORTS

- A. Provide all hangers, supports, brackets, etc., for the proper installation of the lavatories, sinks, etc., requiring support.
- B. Such supports shall be in accordance with the recommendations of the manufacturers of the fixtures, and if built into partitions or walls shall be set as the wall construction progresses.

3.2 INSTALLATION

- A. Before roughing work is started, submit to the Engineer complete figured drawings and cuts of all plumbing fixtures, fittings, trimmings, etc., for review before proceeding with the installation of any work. These drawings shall accurately indicate the installation locations.
- B. Set all fixtures level and flush with finished floors and partitions.

- C. Fixture mounting heights shall be as detailed on the architectural drawings.
- D. Provide silicon caulking for wall mounted water closets and urinals.
- E. Protect fixtures from damage before and after installation.
- F. Fasten fixture carriers securely to slab construction with power driven expansion shields and bolts.

3.3 CLEANING

- A. Clean and adjust all fixtures and trim before acceptance.

END OF SECTION

SECTION 230001

DESIGN DOCUMENTS – SEPARATION OF WORK
BETWEEN THE TRADES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The specifications delineate various items of related work under separate trade headings in accordance with the Design Documents as listed below.
- B. Indications that the electrical and mechanical trades are to perform an item of work means that they are to perform the work for their own accommodation only, except as specifically noted otherwise.
- C. Key to coordinate actual contractual work separation with the owner owner's representative and associated construction contractor and sub-contractors.

Abbreviations:

"OTHER"	=	Provided for Owner by Construction Manager or General Contractor
"PLBG"	=	Plumbing
"FP"	=	Fire Protection
"HVAC"	=	Heating, Ventilating and Air Conditioning
"ELECT"	=	Electrical
"F"	=	Furnished
"I"	=	Installed
"P"	=	Provided (Furnished and Installed)
"C"	=	Final Connection

	Other	Plbg	FP	HVAC	Elect	Notes
Temporary Heat	P					
Temporary Water	P					
Temporary Light & Power	P				P	
Temporary Fire Standpipe	P		P			
Temporary Toilets	P					
Concrete Equipment Bases and Pads: Inside Building		P	P	P	P	P

	Other	Plbg	FP	HVAC	Elect	Notes
Outside Building		P	P	P	P	P
Anchors and Vibration Mounts in Inertia Blocks	I	F	F	F	F	1
Fastening and Supports		P	P	P	P	
Cutting, Chasing and Patching		P	P	P	P	
Framed Slots and Openings	I	F	F	F	F	
Sleeves through Slabs, Decks and Walls		P	P	P	P	
Waterproof Sealing of Openings		P	P	P	P	
Fireproof Sealing of Excess Openings		P	P	P	P	
Drilling & Patching Cutting of all Holes		P	P	P	P	
Hoisting and Rigging		P	P	P	P	
Floor Drain Flashing		P				
Base Flashing for all Roof Penetrations	P					
Cap Flashing for all Roof Piping Penetrations		P	P	P	P	
Roof Curb Base Flashing	P					
Roof Curb Cap Flashing				P		
Prime Painting M&E Work		P	P	P	P	
Field Touch-Up Painting		P	P	P	P	
Rustproofing Field Cut Iron Work		P	P	P	P	
Color Coding M&E Work		P	P	P	P	
Fire Hose & Cabinets		P				
Fire Extinguishers	P					
Fire Extinguisher Cabinets	P					
Finished Access Doors & Frames	P					
Ladders & Catwalks	P					
Motors for Mechanical Equipment		P	P	P	C	
Loose Motor Controls for Mechanical Equipment		F	F	F	I	
Motor Control Centers					P	
Disconnect Switches					P	2

	Other	Plbg	FP	HVAC	Elect	Notes
Tagging and Labels		P	P	P	P	
Wiring for Equipment Motors and Starters					P	
Premounted & Prewired Starters and Disconnects		P	P	P	C	
Electric Radiators and Convectors					P	
Electric Duct Heaters				P	C	
Heat Tracing Cable					P	
Electric Water Heater		P			C	
Power Circuit to Starter Disconnect Switch and Motor					P	
Line Voltage Control Device (Aquastat) etc.		P		P	C	
Control Device Not in Power Circuit to Motor		P		P		
Temperature Control Device & Electric Actuator				P		
Sprinkler & Standpipe Alarm System: Devices Panels			P		C P	
Pre-Action Sprinkler, Smoke and Thermal Detection			P			
Space Smoke Detector					P	
Duct Smoke Detector				I	F&C	
Smoke Control/Fire Alarm Panel					P	
Emergency Generator Room Shut-off & Break Glass				P	C	
Core Drill of Existing Bulkhead					P	
Fiberglass Utility Conduit and Support					P	
Concrete Encasement					P	
Lighting Fixtures					P	
Exterior Wall Louvers	P					
Radiator Enclosures				P		
Ornamental Grilles	P					
Lightning Protection					P	
Vermiculite Fireproofing	P					
Rubbish Removal	P					

	Other	Plbg	FP	HVAC	Elect	Notes
Maintenance Tools		F	F	F	F	
Emergency Generator					P	
Fire Smoke Dampers				P	C	
Automatic Louver Dampers				P	C	
HVAC Equipment				P		
HVAC Outlets				P		
Shop Opening in Beams	P					
Structural Steel for Mounting Equipment		P	P	P	P	
All Power Control and Interconnect Wiring for Fire-Smoke Dampers					P	

A. SPECIFIC NOTES:

1. Details furnished by individual Trades.
2. When not part of premounted starter.

END OF SECTION

SECTION 230003

MECHANICAL SCOPE OF WORK

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. The work includes the construction described in the Contract Documents, including all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction.
- B. The detailed scope of work required is indicated on the Mechanical Drawings:
 - 1. Install pipe wells and duct sensors required for the operation of the automated Building Management System and the operation of the pneumatic/electric control system. Install automatic temperature control valves and dampers.
 - 2. Operating and maintenance manuals and instructions.
 - 3. Identification of systems.
 - 4. System cleaning, balancing, testing, adjusting and inspections.
 - 5. Sound and vibration isolation.
 - 6. Prime painting.
 - 7. Provide all necessary supports, anchors, hangers and auxiliary structural members including seismic provisions required for support of mechanical work. Drawing, templates, structural steel, anchor bolts, isolation materials, formwork for concrete and other equipment supports.
 - 8. Provide electric motors (premium efficiency type).
- C. Provide internal wiring of factory-assembled prewired equipment.
- D. Provide counter flashing of pipe and duct roof penetrations.
- E. Provide automatic temperature controls.
- F. Provide systems activation and start-up.
- G. Furnishing individual electric motor starters and disconnect switch not included in motor control centers for installation by the Electrical trade.
- H. Provide firestopping of wall and floor duct and pipe penetrations.
- I. Provide rigging, hoisting and scaffolding.
- J. Provide alternates as described in the Drawings and Specifications.

- K. Coordinate work with all other trades involved in project.
- L. Provide the phased installation of all systems including temporary capping of piping and duct ends, and the preparation of shop drawings for each individual project phase.
- M. Provide for the selective demolition of existing building systems as required by the contract drawings.
- N. Provide for the creation of all ducting & piping shop drawings using the AutoCAD 2010 program format.

1.2 WORK NOT INCLUDED

- A. The items listed below are related to this work but specified under other sections of the contract:

- 1. Motor control centers.
- 2. Finish painting.
- 3. Base flashing for materials penetrating walls or roof.
- 4. Masonry pits, frames and covers.
- 5. Power wiring for motors and motor controllers.
- 6. Outdoor intake and discharge louvers with screens.
- 7. Installation of access doors in general construction.
- 8. Concrete for mechanical work.

- B. Installation of individual electric motor starters not included in the motor control centers.

PART 2 - PRODUCTS

2.1 NOT USED.

PART 3 - EXECUTION

3.1 NOT USED.

END OF SECTION

SECTION 230004

MECHANICAL UNIT PRICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide unit prices for possible revisions and alternates in the work.
- B. State and hold firm for the duration of the project all unit prices as described herein.

1.2 DEFINITIONS

- A. Unit prices, unless otherwise noted, are to include incidental work normally included in connection with the particular type of work involved and are to include, but not necessarily be limited to, the following:
 - 1. Engineering, including calculations, detailing, coordination, drafting and shop drawings.
 - 2. Material costs including an allowance for waste, connections, etc.
 - 3. Necessary accessories (e.g., hangers, inserts, clips, bolts, painting, etc.).
 - 4. Fabrication and shop costs.
 - 5. Shop and field labor including supervision and engineering layout costs.
 - 6. Temporary utilities required including safety precautions.
 - 7. Costs of standby trades during or beyond normal working hours.
 - 8. Transportation, hoisting rigging, freight, taxes of any kind, fringe benefits, overhead and profit (excluding Insurance Cost).
 - 9. Tools and equipment.
 - 10. Testing, cleaning, balancing and controlled inspection.
- B. Architect/Engineer documents will be used as the basis for calculating changes to contract work.
- C. Submit unit prices based upon the specification standards and as noted herein. Unit prices shall apply equally to work when added and also to work when deleted, except where specifically modified below.
- D. In addition to your contract proposal, quote prices for the work described below.

PART 2 - PRODUCTS

2.1 SHEETMETAL

- A. Pipe, Fittings and Valves
 - 1. Provide unit pricing for pipe fittings and valves in the following sizes for each pressure rating specified in the Contract Documents.
 - 2. Provide Schedule 40 welded pipe as specified. Calculate unit prices including one fitting for every 10 feet of run and one hanger for every 10 feet of run sized to accommodate insulation as specified.
 - a. 1" \$____/LF
 - b. 1½" \$____/LF

- c. 2" \$_____/LF
3. Provide welded pipe as specified. Calculate unit prices including one welded fitting for every 10 feet of run and number of hangers as specified for every 10 feet of run sized to accommodate insulation as specified.
- a. 3" \$_____/LF
- b. 4" \$_____/LF
- c. 5" \$_____/LF
4. Provide pipe insulation as specified for all pipe sizes including sealant, covering, adhesives, jackets, etc. Provide thickness listed. Include insulating one fitting for every 10 feet of run.
- a. Glass Fiber Insulation:
- (1) 1" \$_____/LF
- (2) 1½" \$_____/LF
- (3) 2" \$_____/LF
- b. Calcium Silicate Including Finish Wrap:
- (1) 1½" \$_____/LF
- (2) 2" \$_____/LF
- a. Foam glass including finish wrap
- (1) 1½" \$_____/LF
- (2) 2" \$_____/LF
- b. 2-hour, Fire-Rated Double Wall Fuel Piping
- (1) 5" internal, 7" outer pipe with 2-hour fire wrap & aluminum jacket. \$_____/LF
5. Valves
- a. Gate Valves:
- (1) 1", each \$_____
- (2) 2", each \$_____
- b. Ball Valves:
- (1) 1", each \$_____
- (2) 1½", each \$_____
- (3) 2", each \$_____
- c. Globe Valves:
- (1) 1", each \$_____
- (2) 1½", each \$_____

	(3)	2", each	\$_____
d.		Swing Check Valves:	
	(1)	1", each	\$_____
	(2)	1½", each	\$_____
	(3)	2", each	\$_____
e.		Silent Check Valves	
	(1)	2", each	\$_____
	(2)	2½", each	\$_____
f.		Balancing Valves	
	(1)	1", each	\$_____
	(2)	2", each	\$_____
	(3)	2½", each	\$_____
g.		Strainers (Y Type)	
	(1)	1", each	\$_____
	(2)	1½", each	\$_____
	(3)	2", each	\$_____

PART 3 - EXECUTION

3.1 NOT USED.

END OF SECTION

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SECTION 230200

FIRESTOPPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide a U.L. approved firestopping system in accordance with the Contract Documents.
- B. Work of this section is required to comply with Section 078400 "Firestopping."

1.2 WORK INCLUDED

- A. Firestop Compounds.
- B. Damming Material.

1.3 SUBMITTALS

- A. Submit shop drawings, product data, and manufacturer's installation instructions for all materials and prefabricated devices, providing descriptions sufficient for identification at the job site. Literature shall indicate product characteristics, typical used, performance and limitation criteria and test data.
- B. Submit shop drawings showing proposed material, reinforcement, anchorage, fastenings, and method of installation. Construction details shall accurately reflect actual job conditions.
- C. Submit Material Safety Data Sheets with product delivered to job site.
- D. U.L. Tested Systems: Submit drawings showing typical installation details for the methods of installation. Indicate which firestop materials will be used and thickness for different hourly ratings, and approved UL system number.
- E. Engineering Judgements: Submit manufacturer's drawings for all non-standard applications where no U.L. tested system exists. All drawings must indicate the "Tested" U.L. system upon which the judgement is based so as to assess the relevance of the judgement to some known performance.
- F. Submit manufacturer's installation procedures for each type of product.
- G. Approved Applicator: Submit document from manufacturer wherein manufacturer recognizes the installer as qualified or submit a list of past projects to demonstrate capability to perform intended work.
- H. Upon completion, installer shall provide written certification that materials were installed in accordance with the manufacturer's installation instruction and details.

1.4 QUALITY ASSURANCE

- A. Firestop system installation shall conform to requirements of qualified designs or manufacturer approved modifications, as supported by engineering reports. Field inspections shall be carried out by the firestop manufacturer to verify that the installation is in accordance with the manufacturer requirements.
- B. Install firestop materials and systems as required by these Contract Documents and meet and be accepted for use by applicable design building and construction codes.
- C. Penetrations through fire rated floors and wall assemblies are required to comply with special inspections requirements of the 2014 NYC Building Code.
- D. Submit manufacturer's product data, letter of certification, or certified laboratory test report that the material or combination of materials (firestop system) meets the requirements specified in accordance with the applicable referenced standards.
- E. The firestop compound shall not contain any solvents or inorganic fibers. The penetration seal material must be unaffected by moisture and must maintain the integrity of the floor or wall assembly for its rated time period when tested in accordance with ASTM E814 (UL1479). The system shall be U.L. Classified for up to and including 3 hours.
- F. Firestopping materials shall be asbestos and lead free and shall not incorporate or not require the use of hazardous solvents.
- G. Firestopping sealants must be flexible, allowing for normal pipe movement.
- H. All fire stopping materials shall be manufactured by one manufacturer.
- I. Installation of firestopping systems shall be performed by a Contractor (or Contractors) trained or approved by the firestop manufacturer.
- J. Material used shall be in accordance with the manufacturer's written installation instructions.
- K. Submit a line-by-line statement of compliance or non-compliance with this specification section.
- L. Work shall be "Year 2000 Compliant" as defined in Paragraph 1.4 of Section 15501 of the specifications.

PART 2 - PRODUCTS

2.1 FIRESTOPPING

- A. Provide firestop compounds for caulk, pour, trowel or pump application. Material must be capable of sealing openings around single or multiple against fire, smoke and toxic gases, and maintaining rating with a thickness no greater than the structure.
- B. Provide a damming material, where required, per manufacturer's recommendations and as shown on the Drawings.

- C. Provide a firestop system consisting of a material, or combination of materials, to retain the integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke or gases through penetrations in fire-rated barriers. It shall be used in specific locations as follows:
 - 1. Penetrations for the passage of duct or piping through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor slabs and floor/ceiling assemblies), and vertical service shafts.
 - 2. Locations shown specifically on the drawings or where specified in other sections of these specifications.

2.2 MATERIALS

- A. Firestopping materials/systems shall be flexible to allow for normal movement of building structure and penetrating item(s) without affecting the adhesion or integrity of the system.
- B. Firestopping materials shall not require hazardous waste disposal of used containers/packages.
- C. Provide firestopping materials free of solvents which will not experience shrinkage while curing.
- D. Firestopping materials shall be unaffected by moisture.

2.3 ACCEPTABLE MANUFACTURERS

- A. Specified Technologies, Inc.
- B. Dow Corning
- C. Flamesafe
- D. International Protective Coatings

PART 3 - EXECUTION

- 3.1 Deliver materials to site in original unopened containers or packages bearing the manufacturer's name, brand designation, product description and U.L. Classification Mark.
- 3.2 Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job site.
- 3.3 Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements.
- 3.4 Comply with recommended procedures, precautions or remedies described in Material Safety Data Sheets as applicable.
- 3.5 EXAMINATION
 - A. Examine areas and conditions under which work is to be performed and notify the Contractor in writing of conditions detrimental to proper and timely completion of the work.

- B. Verify that openings are properly sized and in suitable condition to receive the work of this section.
- C. Verify manufacturer's printed instructions for installation and when applicable, curing in accordance with temperature and humidity. Conform to ventilation and safety requirements.
- D. Verify the condition of the substrates before starting work.
- E. Verify Weather Conditions. Do not proceed with installation of firestop materials when temperatures fall outside the manufacturer's suggested limits.
- F. Verify that firestopping materials are installed so as not to contaminate adjacent surfaces.
- G. Schedule firestopping after installation of penetrants but prior to concealing the openings.
- H. Where firestopping is installed at locations which will remain exposed in the completed work, provide protection as necessary to prevent damage to adjacent surfaces and finishes, and protect as necessary against damage from other construction activities.
- I. Verify that all pipe, conduit, ducting which penetrate fire-rated construction have been permanently installed prior to installation of firestop.

3.6 PREPARATION

- A. Clean substrate of dirt, dust, grease, oil, loose materials, rust or other matter that may affect the proper fitting or adhesion of the firestopping materials.
- B. Clean metal and glass surfaces with a non-alcohol solvent.

3.7 INSTALLATION

- A. Installation of firestops shall be performed by an applicator/installer qualified and trained by the manufacturer. Installation shall be performed in strict accordance with manufacturer's details installation procedures.
- B. Apply firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, and manufacturer's recommendations.
- C. Unless specified and approved, all insulation used in conjunction with through-penetrations shall remain intact and undamaged and may not be removed.
- D. Seal holes and penetrations to ensure an effective smoke seal.
- E. In areas of high traffic, protect firestopping materials from damage. If the opening is large, install firestopping materials capable of supporting the weight of a human.
- F. Insulation types specified in other sections shall not be installed in lieu of firestopping material specified herein.
- G. All combustible penetrants (e.g. non-metallic pipes or insulated metallic pipes) shall be firestopped using products and systems tested in a configuration representative of the field condition.

H. Dam Construction

1. When required to properly contain firestopping materials within openings, damming or packing materials may be utilized. Combustible damming material must be removed after appropriate curing. Noncombustible damming materials may be left as a permanent component of the firestop system.
- 3.8 Firestopping may be required by other Subcontractors under related sections of the project specifications. Identify all locations requiring firestopping and coordinate the work of this section with work performed under other sections of the project to provide a uniform system of firestopping.
- 3.9 Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.
- 3.10 Do not proceed with installation of firestop materials when temperatures exceed the manufacturer's recommended limitations for installation.
- 3.11 Firestop systems do not re-establish the structural integrity of load bearing partitions. Contractor shall consult the structural engineer prior to penetrating any load bearing assembly.
- 3.12 Firestop systems are not intended to support live loads or traffic. Contractor shall consult the structural engineer if he has reason to believe these limitations may be violated.
- 3.13 The installation of firestop materials shall be inspected on site by a representative of the firestopping manufacturer and verified in writing that the installation is in accordance with the manufacturer's requirements. This shall be done for each firestop penetration installed on this project.
- 3.14 FIRESTOPPING

A. Insulated Cold Pipes

1. Install a pipe sleeve through the wall or slab to be penetrated with an inside diameter large enough to include the specified thickness of insulation.
2. Pipe insulation should be continuous through sleeve. Insulation should be covered with a vapor barrier. For depth of wall plus 1" on either side of wall or slab, vapor barrier shall be wrapped with a 26 gauge sheetmetal inner sleeve. Firestop shall be applied between wall sleeve and pipe protection sleeve.
3. Install firestop material at each end of sleeve to form a U.L. approved system.
4. Mark penetration in an approved manner to verify manufacturer's inspection.
5. Cover firestopping with escutcheon cover.

B. Hot Pipes (Up to 220°F)

1. Install a pipe sleeve through the wall or slab to be penetrated with an inside diameter large enough to include the specified thickness of insulation.
2. Pipe insulation should be continuous through sleeve. Insulation should be covered with a vapor barrier. For depth of wall plus 1" on either side of wall or slab, vapor barrier shall be wrapped with a 26 gauge sheetmetal inner sleeve. Firestop shall be applied between wall sleeve and pipe protection sleeve.
3. Insulate pipe on each of wall and caulk all around insulation at joint of wall and insulation.
4. Mark penetration in an approved manner to verify manufacturer's inspection.
5. Cover firestopping with escutcheon cover.

- C. Diesel Engine Exhaust Pipes, Flue System for Gas-Fired Boilers and Domestic Hot Water Heaters
 - 1. Install proper sleeve through wall with an inside diameter large enough to include specified insulation thickness.
 - 2. Eliminate insulation for depth of wall and using section of specified insulation as backing, install proper depth of firestop material on each end of sleeve to form a U.L. approved system.
 - 3. Install specified insulation on each side of wall up to expansion compensator.
 - 4. Roof penetration shall be suitable for non-combustible roof construction and shall meet building code requirements.

3.15 FIELD QUALITY CONTROL

- A. Prepare and install firestopping systems in accordance with manufacturer's printed instruction and recommendations.
- B. Follow safety procedures recommended in the Material Safety Data Sheets.
- C. Finish surfaces of firestopping which are to remain exposed in the completed work to a uniform and level condition.
- D. All areas of work must be accessible until inspection by the applicable Code Authorities.
- E. Correct unacceptable firestops and provide additional inspection to verify compliance with this specification.

3.16 CLEANING

- A. Remove spilled and excess materials adjacent to firestopping without damaging adjacent surface.
- B. Leave finished work in neat, clean condition with no evidence of spill overs or damage to adjacent surfaces.

END OF SECTION

SECTION 230513
ELECTRIC MOTORS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide electric motors in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Electric Motors.

1.3 SUBMITTALS

- A. Shop Drawings: Submit electric motor characteristics with each equipment submission.
- B. Product Data: Manufacturer's latest published data for materials, equipment, accessories and installation.

1.4 QUALITY ASSURANCE

- A. Motor efficiency is Guaranteed Minimal Efficiency according to NEMA Standard MG-1-12.53a when tested in accordance with IEEE Standard 112.

PART 2 - PRODUCTS

2.1 ELECTRIC MOTORS

- A. Provide premium efficiency electric motors for driving the mechanical equipment. Motors to be of proper power, construction and speed to suit the specified makes of equipment; if other makes of equipment are accepted, the proper adjustment of motor speed, power, and work of Division 16 must be included without additional cost to the Contract.
- B. 1/2 horsepower and larger motors to be rated at 460 volts for operation on 480 volt, 3 phase, 60 hertz, alternating current systems, except as otherwise noted. 1/3 horsepower and smaller motors to be rated at 115 volts for operation on 120 volt, single phase, 60 hertz, alternating current systems, except as otherwise noted.
- C. Motors to be of constant speed, squirrel-cage type. Single phase motors to be capacitor start, induction run, or split phase type as approved for the service. Motors over 100 horsepower to be suitable for operation with reduced-voltage auto-transformer type starters.
- D. All 1/2 horsepower and larger motors to have Class F insulation suitable for ambient temperature of 40°C. when operated at 115% load.
- E. All motors to be of quiet operation, guaranteed to fulfill the specified requirements without producing any sound audible outside of Machine Rooms. All belt connected motors to have adjustable bases and set screws to maintain proper belt tension; provide proper belt guards.
- F. All motors and accessories to comply in all respects with NEMA standards.

- G. Coordinate the NEMA type of each motor with the torque and inertia load of the equipment served, and the inrush characteristics of the motor with the starter selection, so that all items furnished constitute a properly related package. No motor to operate in the service factor range.
- H. Cooling tower motors to be TEFC; others to be cast iron, drip-proof construction. Motors 1 horsepower or larger to have encapsulated stator windings of the epoxy or silicone type.
- I. Fan motors to be capable of accelerating their respective fans from 0 revolutions per minute to design or synchronous revolutions per minute within a maximum of 10 seconds. Submit for approval curves which plot time versus revolutions per minute for the particular motor and fan combination.
- J. All motors used in variable speed applications to be suitable for use with variable frequency drives.
- K. Motorized equipment rated at more than 1000 watts to have a power factor not less than 95 percent under rated nameplate conditions. Provide corrective devices where required to achieve this.
- L. Provide thermistor protection for windings on all motors 25 horsepower and above. Where motors are controlled by individual motor starters, provide relays for installation under Division 16. Relays in "motor control centers" to be provided by the Contractor furnishing the motor control centers.
- M. All vertical motors 150 horsepower and above to be provided with bearing temperature detectors on thrust bearing. Provide contactors and circuitry to give remote alarm at temperatures above 175°F.

2.2 ACCEPTABLE MANUFACTURERS

- A. General Electric
- B. Marathon
- C. Lincoln
- D. Siemens-Allis

PART 3 - EXECUTION

3.1 WIRING

- A. Wiring between motor and controllers will be performed under Division 16.
- B. Review Division 16 and Automatic Temperature Control Division 17 Documents for required accessories, interlocks, etc. Failure to fully coordinate this item with the other Divisions in no way relieves this Contractor from providing a complete, functional, and coordinated system as described.

END OF SECTION

SECTION 230523

VALVES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide valves in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Gate Valves.
- B. Globe Valves.
- C. Y-Pattern Globe Valves (Balancing Valves).
- D. Check Valves.
- E. Ball Valves.
- F. High Performance Ball Valves.

1.3 SUBMITTALS

- A. Valve List: Overall table showing valve type, size, figure number, and manufacturer's catalogue cuts of proposed valves.
- B. Product Data: Manufacturer's latest published data for materials, intended service and installation.
- C. Submit a system checklist indicating valve location, size, type and figure number for each piping system (chilled, hot, steam condenser, glycol; fuel).
- D. Submit data for each balancing valve used on the project (i.e., location, size, flow, pressure drop).
- E. Submit data for each flow control valve used on the project (i.e., location, size, flow, pressure drop).
- F. Submit a line-by-line statement of compliance or non-compliance with this specification section.

1.4 QUALITY ASSURANCE

- A. Valves and valve construction to be suitable for the pressure, temperature, and fluid quality of the service in which they are to be used.
- B. All valves to be in accordance with ANSI, AWWA, ASTM, MSS-SP-70 & 80 (Manufacturers Standardization Society), and ASME standards and specifications.
- C. Minimum test pressure for all valves to be 1.5 times maximum system working pressure unless noted otherwise.

- D. Provide butterfly valves suitable for dead end service and constructed of high quality industrial design.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide valves of the same manufacturer throughout where possible.
- B. Provide valves with manufacturer's name and pressure rating clearly marked on the outside of body.
- C. Provide valves suitable for connection to adjoining piping as specified for pipe joints.
- D. All valves to be full pipe size unless noted otherwise.

2.2 GATE VALVES

- A. Use for stop and isolation in steam systems, water systems over 200°F, and as shown on Drawings for other water systems.
- B. 2" and smaller valves with rising stem, screwed bonnet, inside screw and wedge gate. Bronze body and trim with screwed ends for steel piping and sweated ends for copper piping.
- C. 2½" and larger valves with rising stem, bolted bonnet, outside screw and yoke, wedge gate, iron body with bronze trim and flanged ends for steel piping and bronze body for copper piping.
- D. Gate valves to be backseating and suitable for repacking under pressure. Packing to be non-asbestos.
- E. Acceptable Manufacturers
 - 1. OMB
 - 2. Kerotest Bellowseal
 - 3. Hammond
 - 4. Stockham
 - 5. Nibco

2.3 GLOBE VALVES

- A. Use for throttling in steam systems.
- B. 2" and smaller valves bronze body and trim with rising stem, screwed bonnet with screwed ends for steel piping and sweated ends for copper piping.
- C. Globe valves to be suitable for repacking under pressure. Packing to be non-asbestos.
- D. Acceptable Manufacturers
 - 1. OMB
 - 2. Kerotest Bellowseal
 - 3. Crane
 - 4. Hammond
 - 5. Nibco
 - 6. Walworth
 - 7. Stockham

2.4 Y-PATTERN GLOBE VALVES (BALANCING VALVES)

- A. Use for throttling in water service ½" to 12".
- B. Provide valves of Y-Pattern design suitable for water temperatures to 250°F. Provide valves with provision for connecting a portable differential pressure meter. Each meter connection to have pressure/temperature readout points.
- C. Construct valves up to 2" of pressure die cast nonporous copper alloy and 2½" and over of cast iron body and nonferrous copper alloy, with Teflon disc.
- D. Valves to be omnidirectional without affecting flow measurement and shall provide precise flow measurement, precision flow balancing, positive shut-off with no drip seat.
- E. Construct valves so that 4 full turns of handwheel provides maximum setting with hidden memory feature and tamper proof balancing setting.
- F. Provide two (2) computerized flow reading kits compatible with valve flow reading kits to be handed over to the owner.
- G. Acceptable Manufacturers
 - 1. Tour & Anderson
 - 2. Armstrong

2.5 CHECK VALVES

- A. Swing Type: Use for water and low pressure general services: 2" and smaller with screwed bonnet, screwed end for steel piping and sweated end for copper piping; 2½" and larger with bolted bonnet, flanged end. Valves to have renewable bronze seat and disc.
- B. Silent Type: Use on pumps with cycling control and larger than 2" discharge. Valves to have cast iron body with bronze or stainless steel trim and to be of the center guide type, with flanged end.
- C. Acceptable Manufacturers
 - 1. Grinnell
 - 2. Crane
 - 3. Hammond
 - 4. Mueller

2.6 BALL VALVES

- A. Use for stop, isolation and as drain valves, in water systems up to 200°F and pipe sizes to 3".
- B. Provide ball valves of the bronze top-entry body type, having a straight-through full port flow passage. Design to permit disassembly without removing body from line.
- C. Construct seats and all gland packing of Teflon. Lever handle to be vinyl covered. Body to be 2-piece screwed end for steel piping and sweated end for copper piping.
- D. Provide lever for quarter turn operation; lever to indicate open or closed position.
- E. When used as drain valves, provide with hose thread and brass cap with chain. Cap to be rated for full system pressure.

F. Valve shaft shall be extended type to accommodate insulated pipe.

G. Acceptable Manufacturers

1. Apollo
2. Jamesbury
3. Hammond

2.7 VALVE LIST

A. The following is a listing of representative figure numbers by service, indicative of the product quality required.

Service	Size	Type	Description
A. Fuel Oil	3" and under	Ball Valve with memory stop	Apollo, Top Entry, CS Socket Weld, Model CB-N2, 300#
	3" & under	Strainer.	Mueller Fig 582, 600#, Socket-weld ends
	3" & under	Swing check.	Flowserve, Vogt swing-check with socket-weld ends, 800# WOG.

2.8 VALVE HOOK-UP

A. Pumps

1. Inlet Pipe = Isolating Valve, Strainer
2. Outlet Pipe = Swing Check Valve, Isolating Valve, Relief Valve

B. Emergency Generator

1. Inlet Pipe = Ball Valve, Strainer, Union, Flexible Connection
2. Outlet Pipe = Ball Valve, Union, Flexible Connection

PART 3 - EXECUTION

- 3.1 Install with stem vertical and handle up wherever possible, never with stem below horizontal position.
- 3.2 Install with operating clearance for handle and stem.
- 3.3 Install isolation valves on equipment so that valve and piping do not interfere with equipment removal or maintenance. Install unions or flanges on equipment side of valves.
- 3.4 Provide 1" drain valves with threaded ends for hose connections at drain points, at main shutoff valves, low points of piping systems, bases of vertical risers, and at equipment.
- 3.5 Provide all gate valves 8 inches and larger having a rating of over 150 lbs. with a 1-inch bypass valve of same pressure rating.
- 3.6 Provide required manual or automatic vent valves at high points of piping systems to facilitate venting of air and to ensure quiet operation.
- 3.7 Provide renewable bronze seat rings and bronze spindles for cast iron body valves.
- 3.8 Provide chain operated sheaves and chains for all valves which are more than 8 feet above the floor in Mechanical Equipment Rooms. Chains shall not extend lower than 6'6" above the mechanical room floor
- 3.9 Furnish and install other valves, check valves, cocks, etc., as required for the complete and proper valving of the entire installation.
- 3.10 Install butterfly valves in horizontal piping with stem in the horizontal position so that bottom of disk lifts in the direction of flow.
- 3.11 Install butterfly valves in vertical piping at pumps with stem perpendicular to pump shaft.
- 3.12 Provide valve handle extension stems to accommodate valve insulation.
- 3.13 Provide lockshield devices where required on drawings.

END OF SECTION

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SECTION 230529

HANGERS, ANCHORS AND SUPPORTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide hangers, anchors and supports in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Hangers.
- B. Structure Attachments.
- C. Seismic Supports

1.3 SUBMITTALS

- A. Shop Drawings: Submit details of pipe hangers, anchors and supports for each pipe size and pipe service. Submit details of support methods and point loadings, and anchor reactions.
- B. Product Data: Manufacturer's latest published data for materials, equipment and installation.
- C. Submit an overall pipe support schedule indicating pipe size, hanger type, hanger intervals and seismic provisions.
- D. Submit AutoCAD 2014 Computer Generated drawing showing all hanger, anchor, guide and support loads imposed onto the structure.
- E. Submit AutoCAD 2014 Computer Generated drawing indicating all supplementary steel locations and details of attachment of structure.
- F. Submit written confirmation by an independent licensed professional engineer that supporting systems comply with the State of New York requirements for seismic supports of equipment, piping and ducting. Confirmation shall include support calculations to verify bracing system.
- G. Submit a line-by-line statement of compliance or non-compliance with this specification section.

1.4 QUALITY ASSURANCE

- A. Hangers and supports to be constructed and applied according to the following standards:
 - 1. Manufacturer's Standardization Society MSS SP-58, SP-69 and SP-89.
 - 2. Power Piping Code, ANSI B31-1.
 - 3. International Building Code, Year 2000 for seismic provisions.
 - 4. International Mechanical Code.
 - 5. New York City Building Code 2014
 - 6. New York City Mechanical Code 2014

PART 2 - PRODUCTS

- 2.1 Provide hangers of heavy construction suitable for the size of pipe to be supported. All materials to be of steel, except rollers which are to be of wrought or malleable iron. Hangers for pipes up to and including 5 inches to be adjustable swivel ring, split ring, wrought pipe clamp, or adjustable wrought clevis type. Hangers for pipes 6 inches and above to have 2 rods and cross-rod with cast iron pipe roll complete with adjustable sockets and nuts.
- 2.2 Support vertical piping with double bolt riser clamps attached to the pipe, resting on the floor slab. In general, use one clamp for each two floors and one clamp at each floor for copper tubing. Where pipes are in open shafts, provide forged steel bar brackets fixed to wall.
- 2.3 Support vertical piping risers on base elbow supports. Supports to be no less than one pipe size smaller than riser.
- 2.4 The following tables will establish a minimum level of acceptance for pipe hangers, supports and attachments.

A. Hangers and Supports

Service	Hanger Type	Grinnell Figure No.	Pipe Size
Uninsulated Steel	Adj. Clevis Pipe Roll	260	½" to 4"
		171	5" to 12"
Uninsulated Copper	Adj. Clevis	CT-65C	½" to 4"
All Insulated Piping (Individual)	Adj. Steel Yoke Pipe Roll Insulation Protection	181	½" to 4"
		167	
	Single Pipe Roll Insulation Protection	171	5" to 30"
		167	
All Insulated (Trapeze)	Universal Trapeze Adjustable Pipe Roll Insulation Protection Steel Washer Plate	46	½" to 30"
		274	
		167	
		60	
Uninsulated Trapeze	Universal Trapeze Adjustable Pipe Roll Steel Washer Plate	46	½" to 12"
		274	
		60	
Wall Brackets	Welded Steel Welded Steel	195	½" to 4"
		199	5" to 12"
Hanger Rods	Continuous Thread (Maximum Loads as Listed)	146	--

B. Structure Attachments

Type	Grinnell Figure No.	Maximum Rod Size
Beam Clamp	218	1/2"
Beam Clamp	292	1
Side Mount Clamp	225	1/2"
Channel Clamp	226	1/2"
Concrete Insert	281	1/2"
Welded Beam Attachment	Refer to details on drawing.	1-1/2"

C. Seismic Supports

1. The support system for all fuel-oil piping and generator flues shall be braced to withstand seismic loads (life safety equipment):
 - a. Per BOCA 1996 Section 1610.0:
 - 1) $A_v = A_o = 0.12$
 - 2) Seismic Hazard Exposure Group #
 - 3) Seismic Performance Category C
 - 4) Steel Concentrically Braced Frame Lateral Force Resisting System, $R_w=5$, $C_d=4.5$
 - 5) Site Coefficient $S=1.0$ (or in accordance with Geotechnical Report)
 - b. Per IBC 2000 Section 1617.0:
 - 1) Site Class D (Per Geotechnical Report)
 - 2) MCE Spectral Response
 - a) $S_{ms} = 0.426$
 - b) $S_{m1} = 0.193$
 - 3) Design Spectral Response:
 - a) $S_{de} = 0.283$
 - b) $S_{d1} = 0.128$
 - c) Seismic Use Group #
 - c. Design shall conform to maximum lateral load effects using equivalent lateral force procedure.
2. The seismic support system shall conform to the New York City Building Code (2014) requirements.

2.5 ACCEPTABLE MANUFACTURERS

- A. Grinnell
- B. Pipe Shields Inc.
- C. C&S Manufacturing

PART 3 - EXECUTION

3.1 Support horizontal piping in accordance with the following schedule:

Pipe Size	Maximum Hanger Spacing	Rod Size
Up to 1-½"	6'-0"	3/8"
1½" to 2"	9'-0"	1/2"
2-½" to 3"	10'-0"	5/8"
4" to 6"	12'-0"	3/4"
8"	12'-0"	7/8"
10" to 12"	12'-0"	1"
14" to 16"	15'-0"	1-1/4"
18" to 20"	15'-0"	1-1/4"
24" to 30"	15'-0"	1-1/2"

3.2 Provide hangers at each change in direction and both sides of each valve.

3.3 Support hangers from concrete inserts or beam clamps. Furnish, locate and set such inserts and make sure that such inserts are in place when the concrete is poured. Construct inserts of malleable iron or pressed steel with space for rods of all sizes. Install all inserts for pipes 3" and larger in size with a reinforcing rod 5/8" in diameter run through a slot in the insert specifically provided for this purpose. All inserts into the structural slab system require the approval of the structural engineer.

3.4 If any pipe is to be hung in a space where no inserts have been provided, drill holes in the slab (subject to the Structural Engineer's prior approval) and provide rods and hanger attached to an approved fishplate hanger using four expansion shields or install double expansion shields connected by a 2" x 2" angle, from which the hanger rod is to be suspended. For pipe size 2" and under, use single shields but the hanger spacing defined hereinbefore to be reduced to 5'-0". The carrying capacity and size of each shield to be calculated on the basis of the spacing indicated above but the minimum size to be 3/8". Install additional shields of the same size so that the number of hangers are of adequate size to support the loads which they carry. Shields may be used in concrete slabs only. The maximum applied load to any insert in tension shall not exceed 100 pounds. The use of expansion shields for mechanical system support shall require the approval of the structural engineer.

3.5 Regardless of the type of construction (i.e., concrete, concrete-deck-steel or other variations) take particular care to support all main lines and all large and heavy pipes in an approved manner, including the furnishing and installation of supplementary steel, if required. Supplementary steel sections are to be mill-rolled. Submit shop drawings, indicating support methods, point loadings to the building structure and hanger locations for review sufficiently in advance of concrete pouring schedules to permit evaluation, critique and any necessary changes to handling and support methods. Supplementary steel sections shall be sized for a maximum deflection of 1/360.

3.6 Set all inserts for all pipes in ample time to allow concrete work to be performed on scheduled time.

3.7 Hangers may be directly attached to steel beams of building construction, where they occur, if approved by Structural Engineer. Smaller pipes may be suspended from crosspieces of pipe or steel angles, which in turn, are to be securely fastened to building beams or hung from building concrete construction by means of rods and inserts. The intention is to provide supports which, in

each case, will be amply strong and rigid for the load, but which will not weaken or unduly stress the building construction.

- 3.8 Provide approved roller support, floor stands, wall brackets, etc., for all lines running near the floor or near walls, which can be properly supported or suspended by the floors or walls. Pipelines near walls may also be hung by hangers carried from approved wall brackets at a level higher than the pipe.
- 3.9 Do not hang piping from other piping. Support of hangers by means of vertical expansion bolts is not permitted.
- 3.10 Wherever hangers using pipe rolls are used provide approved steel pipe covering protection saddles, spot welded to the piping at each hanger location. Vapor barrier jackets to cover shield.
- 3.11 Anchor piping where shown on Drawings and as required to localize expansion or to prevent undue strain on piping and branches. Anchors to be entirely separate from hangers. All anchor designs to be submitted for approval and to include piping reactions which respective anchors are capable of supporting. Provide all indicated or required expansion loops.
- 3.12 Support all lines of copper tubing individually by approved type hangers not more than 6' apart, or as shown on the drawings. Use hangers especially designed for copper tubing and of exact outside diameter of tubing. On hangers for covered tubing, use broad straps fitting outside of covering.
- 3.13 Hangers used for cold piping will support the pipe without piercing the insulation. Use insulation shields to protect the insulation on cold pipes. Weld insulation protection saddles to insulated hot pipes, or any piping subject to axial movement, at roller supports. Space between pipe and saddle to be filled with insulation. Wherever fibrous glass pipe insulation is installed, install calcium silicate of equal thickness in lieu thereof, wherever hangers and insulation shields bear on insulation. Vapor barrier jackets to cover shields.
- 3.14 For piping 4" and larger, support the elbows of the piping adjacent to the pumps with steel base elbow supports from the inertia base which pump is on to prevent loading heavy weights of piping on pump casing. Where inertia base is not provided, base elbows to be supported on floor with 1" neoprene pad.
- 3.15 Support risers using base elbow supports, no smaller than one pipe size, mounted on 1" neoprene pad and concrete housekeeping pad. Submit pipe loads to structural engineer for review.
- 3.16 All hanger materials of construction (supplementary steel, threaded rods, nuts, bolts, structural attachments, pipe hangers, etc.) shall be galvanized construction. All exposed-to-weather supports shall be hot dipped, galvanized in accordance with ASTM A-153 or A-386, as described in MSS SP-58.
- 3.17 Seismic hanger, anchors and supports are to be provided as required by code. These systems include but are not limited to fuel oil system, emergency generator exhaust, smoke control systems and other systems associated with life safety.

END OF SECTION

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SECTION 230548
VIBRATION ISOLATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide vibration isolation in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Vibration isolation elements for piping and equipment.
- B. Equipment isolation bases.
- C. Seismic restraints.

1.3 SUBMITTALS

A. Manufacturer's Data

1. Catalog cuts and data sheets on specific vibration isolators to be utilized showing compliance with the specifications.
2. An itemized list showing the items of equipment or piping to be isolated, the isolator type of model number selected, isolator loading and deflection, and reference to specific drawings.
3. An itemized list of non-isolated equipment, piping, and ductwork to be seismically restrained.
4. Seismic restraint calculations.
5. Written approval of the base design to be obtained from the equipment manufacturer.

B. Shop Drawings

1. Drawings showing equipment base constructions for each machine, including dimensions, structural member sizes and support point locations.
2. Drawings showing methods of suspension, support guides for piping and ductwork.
3. Drawings showing methods for isolation of pipes and ductwork piercing walls and floor slabs.
4. Concrete and steel details for bases including anchor bolt locations.
5. Number and location of seismic restraints and anchors for each piece of equipment and of ductwork and piping.
6. Specific details of restraints, including anchor bolts for mounting and maximum loading at each location for each piece of equipment and lengths of ductwork and piping.
7. Provide installation instructions, drawings and field supervision to assure proper installation and performance.

1.4 QUALITY ASSURANCE

- A. Provide control of excessive noise and vibration in the buildings due to the operation of machinery or equipment, and/or due to interconnected piping, ductwork or conduit. Installation of vibration isolation units, and associated hangers and bases, under the direct supervision of the vibration isolation manufacturer's representative.
 1. All vibration isolators shall have either known undeflected heights or calibration markings so that, after adjustment, when carrying their load, the deflection under load

- can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.
2. All isolators shall operate in the linear portion of their load versus deflection curve. Furnish load versus deflection curves linear over a deflection range of not less than 50% above the design deflection.
 3. The ratio of lateral to vertical stiffness to be not less than 0.9 nor greater than 1.5.
 4. The theoretical vertical natural frequency for each support point, based upon load per isolator and isolator stiffness shall not differ from the design objectives for the equipment as a whole by more than $\pm 10\%$.
 5. All neoprene mountings shall have a Shore hardness of 40 to 65, after minimum aging of 20 days or corresponding oven-aging.
- B. Adhere to SMACNA Guidelines for Seismic Restraints of Mechanical Systems.
- C. Adhere to ASHRAE Guide 1995 Chapter 50.
- D. Design seismic restraints in accordance with Local Code Seismic Zone ____.
- E. Manufacturer of vibration isolation equipment has the following responsibilities:
1. Determine vibration isolation and seismic restraint sizes and locations.
 2. Guarantee specified isolation system deflection.
 3. Provide piping and equipment isolation systems and seismic restraints as scheduled or specified.
 4. Guarantee specified isolation system deflection.
 5. Provide installation instructions, drawings and field supervision to assure proper installation and performance.
- F. Structural or civil engineer's stamp verifying design and calculations for seismic restraining systems used.
- G. Substitution of internally isolated mechanical equipment in lieu of the specified isolation of this Section must be approved for individual equipment units and is acceptable only if above acceleration loads are certified in writing by the equipment manufacturer and stamped and sealed by a licensed civil or structural engineer.
- H. Purchased and/or fabricated equipment must be designed to safely accept external forces of 1.0g load in any direction for all rigidly and resiliently supported equipment, piping and ductwork without failure and permanent displacement of the equipment. Life safety equipment such as fire pumps, smoke exhaust fans, emergency generators and other life safety designated equipment must be capable of accepting external forces of up to 1.5g in any direction without permanent displacement or failure of the equipment.
- I. Vibration isolation firms having a minimum ten years' experience designing and installing vibration isolation and seismic restraint systems shall be qualified to provide the materials and installation required by this section. Project listings shall be provided including geographical location and a reference contact.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All vibration isolation devices to be the product of a single manufacturer.
- B. Where spring isolation systems are described in the following specifications, the mounting assemblies shall utilize bare springs with the spring diameter not less than 0.8 of the loaded

operating height of the spring. Each spring isolator shall be designed and installed so that the ends of the springs remain parallel. The minimum deflection from loaded operating height to spring solid height shall be 50% of the rated static deflection of the spring.

- C. Where neoprene-in-shear isolation systems are described in the following specifications, the mounting assemblies shall utilize bare neoprene elements with unit type design molded in oil resistant neoprene. The neoprene shall be compounded to meet the following:
1. Shore hardness of 35 to 65 \pm 5, after minimum aging of 20 days or corresponding oven-aging.
 2. Minimum tensile strength of 2000 PSI.
 3. Minimum elongation of 300%.
 4. Maximum compression at 25% of original deflection.
- D. All mounting systems, including seismic restraints, exposed to weather and other corrosive environments shall be protected with factory corrosion resistance. All metal parts of mountings (except springs and hardware) to be hot dip galvanized. Springs shall be cadmium plated and neoprene coated. Nuts and bolts shall be cadmium plated.

2.2 VIBRATION ISOLATORS

- A. Refer to schedule sheets for vibration isolator types to be used.
1. Type A: Bare spring isolators to incorporate the following:
 - a. Minimum ¼ inch thick neoprene acoustical base pad on underside, unless designated otherwise.
 - b. Designed and installed so that ends of springs remain parallel.
 - c. Non-resonant with equipment forcing frequencies or support structure natural frequencies.
 - d. Requires seismic restraint Type II.

Type SLF	MII
Type OSK	VEC
Type AN	VMCI
 2. Type B: Spring isolators to be same as Type A, except:
 - a. Provide built-in vertical limit stops with minimum ¼" clearance under normal operation.
 - b. Tapped holes in top plate for bolting to equipment.
 - c. Capable of supporting equipment at a fixed elevation during equipment erection. Installed and operating heights shall be identical.
 - d. Shall incorporate snubbing restraint in all directions. Cast or aluminum housings are unacceptable. System to be field bolted or welded to deck with ability to resist forces of g acceleration.

Type SLR	MII
Type KW	VEC
Type AWR	VMCI
 3. Type C: Spring hanger rod isolators to incorporate the following:
 - a. Spring element seated on a steel washer within a neoprene cup incorporating a rod isolation bushing.
 - b. Steel retainer box encasing the spring and neoprene cup.
 - c. Provide sufficient clearance between retainer box and spring hanger rod to permit minimum 15 degree allowable rod misalignment in any direction, total 30 degrees.

- d. Requires seismic restraint Type III.
- | | |
|--------------------|------|
| Type 30N | MII |
| Type SNRC | VEC |
| Type RSH-30A | VMCI |
- Where operating weight differs from installed weight provide built-in adjustable limit stops to prevent equipment rising when weight is removed. Stops shall not be in contact during normal operation.
4. Type D: Elastomer isolators to incorporate the following:
- Bolt holes for bolting to equipment base.
 - Bottom steel plates for bolting to sub-base as required.
 - Unit type design molded in oil-resistant neoprene.
 - Encased in ductile steel or iron casing and capable of withstanding external forces of up to 1.0 g. System to be field bolted or welded to deck with ability to resist forces of 1.0 g.
- | | |
|-------------------|------|
| Type BR/RBA | MII |
| Type 368 SD | VEC |
| Type RD | VMCI |
5. Type E: Elastomer hanger rod isolators to incorporate the following:
- Molded unit type neoprene element with projecting bushing lining rod clearance hole.
 - Neoprene element to be minimum 1¾" thick.
 - Steel retainer box encasing neoprene mounting.
 - Clearance between mounting hanger rod and neoprene bushing shall be minimum _".
 - Requires seismic restraint Type III.
- | | |
|----------------|------|
| Type HD | MII |
| Type CD | VEC |
| Type RHD | VMCI |
6. Type F: Combination spring/elastomer hanger rod isolators to incorporate the following:
- Spring and neoprene isolator elements in a steel box retainer.
 - Other characteristics of steel box retainer and hanger rod swing as described for Type C isolators.
 - Requires seismic restraint type III.
7. Type G: Pad type elastomer mountings to incorporate the following:
- 0.750" minimum thickness.
 - 50 psi maximum loading.
 - Ribbed or waffled design.
 - .10" deflection per pad thickness.
 - 1/16" galvanized steel plate between multiple layers of pad thickness.
 - Suitable bearing plate to distribute load.
 - Requires seismic restraint type II or III as installation requires.
- | | |
|----------------------|------|
| Type Super W | MII |
| Type 200N | VEC |
| Type Shearflex | VMCI |
8. Type H: Pad type elastomer mountings to incorporate the following:
- Laminated canvas duck material and neoprene.
 - Maximum loading 1000 psi.

- c. Suitable bearing plate to distribute load.
- d. Minimum thickness, ½ inch.
- e. Requires seismic restraint type II or III as installation requires.

Type HLMII
Type Fabriflex.....VMCI

2.3 EQUIPMENT BASES

A. Curb Mounted Base, Type B-3

- 1. Curb mounted rooftop equipment shall be mounted on spring isolation curbs that directly sit on roof construction and are flashed and incorporated into roof's membrane waterproofing system.
- 2. All spring locations shall have removable waterproof covers to allow for spring adjustment and/or removal.
- 3. All spring mounts shall be as Isolator Type B.
- 4. Curb and spring mounting shall be capable of withstanding 110mph wind and 1.5g seismic loads.
- 5. Curbs shall be Mason Type CMAB or RSC (depending on deflection required), or approved equal.

B. Isolated Rail Base, type B-4

- 1. Rails shall be constructed from structural steel angles, as required, to prevent flexure and misalignment under load.
- 2. Each rail shall be the full length of the supported equipment and be welded to a series of vertically restrained spring isolators as Type B described above.
- 3. Angles shall have bolt-together ties at the ends and center to form one rigid base platform.

Mason Type TRSLR.

2.4 FLEXIBLE CONNECTORS

A. Flexible Stainless Hose, Type FC-2

- 1. Braided flexible metal hose.
- 2. 2 inch pipe size and smaller with male nipple fittings.
- 3. 2½ inch and larger pipe size with fixed steel flanges.
- 4. Suitable for operating pressure with 4:1 minimum safety factor.
- 5. Length as shown on Drawings.

Type BSSMII
Type MFPVMCI

B. Unbraided Exhaust Hose, Type FC-3

- 1. Low pressure stainless steel annually corrugated.
- 2. Fitted with flanged ends.
- 3. Maximum temperature 1500°F.

Mason Type SDL-RF.

2.5 SEISMIC RESTRAINTS

A. General

- 1. Provide restraints capable of safely accepting 1.0 "G" external forces without failure, or 1.5 "G" for life safety equipment to maintain equipment, piping, duct and fan powered

boxes in a captive position. Restraints must not short circuit vibration isolation systems or transmit objectionable vibration or noise.

2. Submit calculations by a licensed Structural or Civil Engineer substantiating that all equipment mountings and foundations and their seismic restraints can safely accept external forces of 1.0g load for all rigidly and resiliently supported equipment, piping, and ductwork (1.5g load for all life safety equipment) without failure and permanent displacement. Restrain all resiliently mounted piping and ductwork with cable sway bracing by Mason Industries, or approved equal.

B. Seismic Restraint, Type I

1. Comply with general characteristics of spring isolators.
2. Provide vertical restraints that are capable of supporting equipment at fixed elevation during equipment erection.
3. Incorporate seismic snubbing restraint in all directions at specified acceleration loadings.
4. System to be field bolted to structure with minimum capability to withstand external forces of 1.5g.

Mason Type SSLF.

C. Seismic Restraint, Type II

1. Each corner or side seismic restraint shall incorporate minimum "thick pad limit stops. Restraints shall be made of plate, structural members or square metal tubing in a welded assembly, incorporating resilient pads. Angle bumpers are not acceptable. System to be field bolted to deck with 1.5g acceleration capacity.
2. Seismic spring mountings as described above are an acceptable alternative providing all seismic loading requirements are met.

Mason Industries Type Z-1011, Type Z-1225.

D. Seismic Restraint, Type III

1. Metal cable type with approved end fastening devices to equipment and structure. System to be field bolted to deck or overhead structural members or deck with aircraft cable and clamps as per SMACNA guidelines.

2.6 ACCEPTABLE MANUFACTURERS

- A. Mason Industries, Inc. (MII)
- B. Vibration Mountings & Controls, Inc. (VMCI)
- C. Peabody Engineering (PE)
- D. Korfund Dynamics Corp. (KDC)
- E. Amber-Booth (AB)
- F. Vibration Eliminator Co. (VEC)

PART 3 - EXECUTION

3.1 GENERAL

- A. Install in accordance with manufacturer's written instructions. Vibration isolators must not cause any change of position of equipment or piping resulting in piping stresses or misalignment.
- B. Isolate mechanical equipment from the building structure by means of noise and vibration isolators as scheduled on the Drawings and in these specifications.
- C. Piping and ductwork to be isolated must pass freely through walls and floors without rigid connections. Maintain 3/4 inch to 1 1/4 inch clearance around outside surfaces of piping or ductwork at penetration points. Pack this clearance space tightly with fiberglass, and caulk airtight after installation of piping or ductwork.
- D. Make no rigid connections between equipment and building structure that degrades the noise and vibration isolation system specified herein.
- E. Loop electrical circuit connections to isolated equipment to allow free motion.
- F. Bring to the Engineer's attention prior to installation any conflicts with other trades which will result in unavoidable rigid contact with equipment or piping as described herein, due to inadequate space or other unforeseen conditions. Corrective work necessitated by conflicts after installation will be at the responsible contractor's expense.
- G. Support vertical piping loads, including water strainers, and valves between pump base elbow supports and the suction and discharge header piping by means of the pump base spring isolators without stress or strain to the pump housing.
- H. Do not install any equipment, piping or conduit which makes rigid contact with the "building" unless permitted in this Specification. Building includes, but is not limited to, slabs, beams, columns, studs and walls.
- I. Coordinate work with other trades to avoid rigid contact with the building. Inform other trades following work, such as plastering or electrical, to avoid any contact which would reduce the vibration isolation.

3.2 EQUIPMENT ISOLATORS

- A. Mount floor mounted equipment on 4" high concrete housekeeping pads over complete floor area of equipment. Mount vibration isolating devices and related inertia blocks on concrete pad. Key housekeeping pads with hair pins, as required, to be integral with structural slab. Provide approved seismic restraint anchor plates flush with top of housekeeping pad.
- B. Support each fan and motor assembly on a single structural steel frame. Provide flexible duct connections at inlet and discharge of fans.
- C. Provide brackets to accommodate the isolator. Manufacturer to specify the vertical position and size of the bracket.
- D. Maintain a minimum operating clearance between the equipment frame on rigid steel base frame and the housekeeping pad of 1 inch. Maintain a minimum operating clearance between concrete inertia and base and housekeeping pad or floor of 2 inches.

- E. Temporarily support the structural steel or concrete inertia base with blocks or shims, as appropriate, prior to the installation of the machine or isolators.
- F. Install the isolators without raising the machine and frame assembly.
- G. Adjust the isolator after the entire installation is complete and under full operational load so that the load is transferred from the blocks to the isolator. When all isolators are properly adjusted, the blocks or shims will be barely free and shall be removed.
- H. Verify that all insulated isolator and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to flexibly limit equipment start-up lateral motion to ½ inch.
- I. Prior to start-up, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base or isolators.

3.3 ADDITIONAL REQUIREMENTS

- A. Diagonal thrust restraint shall be as described for Type C hanger with the same deflection as specified for the spring mountings. The spring element shall be designed so it can be pre-set for thrust and adjusted to allow for a maximum of ¼" movement at start and stop. Diagonal restraints shall be attached at the centerline of thrust. Restraint shall be Mason Type WB, or as approved.
- B. All piping and ductwork to be isolated shall freely pass through walls and floors without rigid connections. Penetration points shall be sleeved or otherwise formed to allow passage of piping or ductwork, and maintain ¾" to 1¼" clearance around the outside surfaces. This clearance space shall be tightly packed with fiberglass, and caulked airtight after installation of piping or ductwork.
- C. All HVAC piping vertical risers larger than 2" in diameter shall be isolated from the building structure by means of noise and vibration isolation guides and supports.
- D. Isolators shall be installed with the isolator hanger box attached to, or hung as close as possible to, the structure. Hanger rods shall be aligned to clear the hanger box.
- E. Isolators shall be suspended from substantial structural members, not from slab diaphragm unless specifically permitted.
- F. Structural steel for cooling tower or other equipment must support the equipment without excessive deflection. The structural steel support shall not be resonant with the isolation system resonant frequencies or the driving frequencies of the supported equipment.

3.4 PIPING BOILER BREECHING AND ENGINE EXHAUST ISOLATORS

- A. All piping, boiler breeching and engine exhaust, except fire standpipe systems, are included under this Section.
- B. Installation:
 - 1. Isolate piping, boiler breeching and engine exhaust outside of shafts as follows:
All water, steam and glycol piping, boiler breeching and engine exhaust in machine rooms.

Piping where exposed on roof.

Water piping, boiler breeching and engine exhaust within 50 ft., or 100 diameters if

greater than 50 ft. from connected rotating equipment and pressure reducing stations.

All other piping shall be rigidly supported and provided with approved seismic restraints to maintain the piping in a captive position without excessive motion.

2. All piping 2" and over located in mechanical equipment rooms, and for a minimum of fifty (50) feet or 100 pipe diameters, whichever is greater, from connection to vibrating mechanical or electrical equipment, shall be isolated from the building structure by means of noise and vibration isolation hangers, Type F.
3. Horizontal suspended pipe 2" and smaller and all steam piping shall be suspended by Type E isolator with a minimum $\frac{1}{2}$ " deflection. Water pipe larger than 2" shall be supported by Type F isolator with a minimum 1", or same static deflection as isolated equipment to which pipe connects, whichever is greater.
4. Horizontal pipe floor supported at slab shall be supported via Type B, with a minimum static deflection of 1" or same deflection as isolated equipment to which pipe connects, whichever is the greater.
5. Vertical riser pipe supports shall utilize Type H.
6. Vertical riser guides, if required, shall avoid direct contact of piping with building.
7. Pipe anchors, where required, shall utilize resilient pipe anchors, Mason Industries Type ADA, or equivalent, to avoid direct contact of piping with building.
8. Pipe sway braces, where required, shall utilize two (2) neoprene elements (Type G or H to accommodate tension and compression forces).
9. Pipe extension and alignment connectors: Provide connectors at riser takeoffs, cooling and heating coils, and elsewhere as required, to accommodate thermal expansion and misalignment.
10. Adjust, as required, all isolators to eliminate all contact of the isolated rod with the hanger rod box retainer or short circuiting of the spring.

3.5 GENERAL SEISMIC RESTRAINT REQUIREMENTS

- A. All equipment whether isolated or not shall be bolted to structure to allow for minimum 1.0g of acceleration (1.5g for life safety equipment). Bolt points and diameter of inserts shall be submitted and verified as part of the contractor's submission for each piece of equipment and stamped and sealed by a civil or structural engineer.
- B. All suspended equipment, whether isolated or not, shall be seismically restrained at four points with Type III cable restraints.
- C. Install seismic restraining system Type III taut for overhead suspended unisolated equipment, piping or ductwork, and slack with $\frac{1}{2}$ " cable deflection for isolated systems.
- D. Seismically restrain all piping and ductwork with center bracing or Type III restraining system in accordance with SMACNA guidelines to comply with UBC 1988 State of California with 1989 amendments as outlined below:
 1. All schedule 10, 20, or 40 piping shall be welded or laterally braced at 40 foot intervals and at turns of more than 4 feet. Longitudinally bracing shall be supplied at 80 foot intervals. No-hub piping shall be braced at 10 foot intervals or at 40 foot intervals if 1.0g rated couplings are used.
 2. Ductwork to be braced every 30 feet (9m) and at every turn and duct run ends. Longitudinal bracing to be provided at 60 foot intervals.
- E. Seismic restraints are not required for the following:
 1. Gas piping less than 1" internal diameter.
 2. Piping in boiler and MER room that is less than 1 $\frac{1}{4}$ " internal diameter.
 3. All other piping and electrical conduit less than 2 $\frac{1}{2}$ " internal diameter.
 4. All rectangular ducts less than 6 sq. ft. in cross sectional area.

5. All round ducts less than 28" in diameter.
 6. All piping suspended by individual hangers 12" in length or less from the point of the attachment to the duct to the bottom of the support for the hanger.
 7. All ducts suspended by hangers 12" or less in length from the point of the attachment to the duct to the bottom of the support for the hanger.
- F. Chimneys and stacks passing through floors are to be bolted at each floor level or secured above and below each floor with riser clamps or approved vibration isolation systems with seismic restraints.
- G. Chimneys and stacks running horizontally to be braced every 30 ft. with Type III restraining system.
- H. Where base anchoring is insufficient to resist seismic forces, supplementary restraining such as seismic restraint system Type III shall be used above system's center of gravity to suitably resist 'g' force levels. Vertically mounted tanks may require this additional restraint.
- I. For overhead supported equipment, overstress of the building structure must not occur. Bracing may occur from:
1. flanges of structural beams;
 2. upper or lower truss chords in bar joist construction at the panel points;
 3. cast-in-place inserts or drilled and shielded inserts in concrete structures.
- J. Each seismic restraint and snubbing device shall be installed after equipment is installed and fully operational. Each isolation mounting incorporating seismic restraint shall be adjusted to provide the minimum operating clearance in all directions to permit the operation of the equipment without objectional noise or vibration to any part of the building structure. The operating clearance for equipment seismic restraints shall not be greater than ¼" (6mm). Seismic restraints must not result in short-circuiting of isolated equipment.

3.6 INSPECTION

- A. On completion of installation of all vibration isolation and seismic restraint devices herein specified, the local representative of the isolation materials manufacturer shall inspect the complete system and report in writing any installation errors, improperly selected isolation or restraint devices, or other faults that could affect the performance of the system. Contractor shall submit a report to the Architect, including the manufacturer's representative's final report, indicating all isolation reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.

END OF SECTION

SECTION 230553
SYSTEM IDENTIFICATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide systems identification in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Valve Tags.
- B. Piping Identification.
- C. Equipment Identification.
- D. Charts and Schedules.

1.3 SUBMITTALS

- A. Shop Drawings: Submit valve tag chart; pipe, duct and equipment labels, paint and color chart.
- B. Product Data: Manufacturer's latest published data for materials, equipment and installation, including samples of valve tags, equipment identification and piping identification, showing size of lettering.
- C. Maintenance Manuals: Provide valve tag charts for inclusion in maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Piping identification to be in accordance with ANSI A 13.1 - 1996 (latest edition) as to sizes, color, lettering and background color.

PART 2 - PRODUCTS

2.1 VALVE TAGS

- A. Use tags 2 inch minimum diameter, fabricated of brass, stainless steel, aluminum or shatterproof plastic. Attach tags with chain, S-hook or split ring as appropriate.

2.2 PIPING IDENTIFICATION

- A. Paint all piping exterior surfaces using a color scheme approved by the hospital.
- B. Provide pipe identification bands for all piping systems per ANSI-A 13.1-1996.
- C. Adhesive bands to be B350, Perma Code Film markers for indoor use and Quick-Apply mechanically affixed markers for outdoors use, by W.H. Brandy Co.

2.3 EQUIPMENT IDENTIFICATION

- A. Identify mechanical equipment by means of nameplates permanently attached to the equipment. Provide black surface, white core laminated bakelite with engraved letters. Minimum size plates 3" long by 1" wide with white letters 3/8" high. Fan powered terminals do not require nameplates.
- B. Identification of Automatic Controls to be as per Automatic Temperature Control specification.

2.4 CHARTS & SCHEDULES

- A. Provide two diagrammatic charts of all piping systems showing location, numbers and types of all valves, framed for mounting. Legend to show service (steam, chilled water, etc.) and valve number. Assign numbers by floor.

2.5 ACCEPTABLE MANUFACTURERS

- A. W.H. Brady
- B. Seton
- C. Marking Services Inc.
- D. Metalcraft Inc.
- E. Craftmark Inc.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS

- A. Identify all piping systems using exterior paint and with identification bands per ANSI A13.1-1996, sharply contrasting with background. Locate bands near strategic points, such as valves, items of equipment; changes in direction, wall penetrations, capped stub out for future connection and every 40 feet of straight runs. If necessary, paint a strip background of black or white to obtain contrast.
- B. Each set of bands to consist of one (1) band on which the name of the service is printed in black letters not less than 1½" high, and two (2) bands on which is printed a black directional arrow located on each side of legend. Apply bands where they can be easily read and with their long dimension parallel to the axis of the pipe. Provide bands with backgrounds of different colors from the various service groups.
- C. Do not tag valves whose use is obvious, such as equipment isolation valves.
- D. Provide three schedules of all valves showing number, size, type and service of each valve, suitable for use with three ring binder. Provide separate list for each system.
- E. Drain piping serving mechanical equipment items for which the drain discharge is not visible from the equipment shall be marked in accordance with ANSI 13.1-1996 near the point of discharge indicating the item of equipment served.

3.2 EQUIPMENT

- A. Attach nameplates in a permanent manner in a location that will be clearly visible after installation is complete.
- B. Mask all labels prior to field painting of equipment. Labels that are painted over will be replaced by Contractor at no cost to the Owner.

3.3 CHARTS & SCHEDULES

- A. Prepare valve charts in a framed mounting behind a clear covering, such as glass, for protection.
- B. All identifying numbers will correspond to those numbers as shown on Contract Documents, such as riser numbers, equipment numbering, piping and duct symbols, etc.

END OF SECTION

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SECTION 230593

TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide testing, adjustment and balancing for all water and air systems in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Pressure testing of new piping and new duct systems.
- B. Preliminary and final adjustment of all new water systems.
- C. Preliminary and final adjustment of all new air systems.
- D. Temporary pipe and duct connections, pipe caps, duct caps, tees, valves, dampers, etc.
- E. Performance testing of all HVAC systems.
- F. This section covers general duct, pipe and equipment testing. Additional specific equipment tests are covered in individual sections.
- G. Operation of mechanical systems as required for testing by other trades.
- H. Cooperate with independent agent performing controlled inspections.

1.3 SUBMITTALS

- A. Submit the following at least six (6) months prior to the execution of testing:
 - 1. Complete brochure of proposed independent certified balancing firm, listing previous installations successfully balanced, length of time in business, names and qualifications of employees who will be assigned to the project, and list of instruments, equipment and elapsed time schedule to be used on the project.
 - 2. Procedures and recording forms for testing and adjusting each system and each item of equipment.
 - 3. Documentation of instrumentation calibration including date of calibration.
- B. Submit the following within two (2) weeks of completion of testing and adjusting.
 - 1. Submit six (6) certified copies of each complete testing and adjustment report to the Engineer for review and send two (2) copies of the report to the Owner. The Contractor shall submit individual testing and adjustment reports for each individual air distribution system, each return and exhaust system, and each pumping system within two (2) weeks after completion of the testing and adjustment of each system.
- C. Controlled inspection reports.
- D. Submit an overall static and dynamic testing chart for all systems indicating intended tests. Chart shall include provisions for testing at the end of each construction phase.

- E. Submit a written method statement describing all static and dynamic testing procedures. Method statement shall address the phased construction of this project.
- F. Submit a line-by-line statement of compliance or non-compliance with each clause of this specification section.

1.4 QUALITY ASSURANCE

- A. Testing
 - 1. SMACNA - 2016 Testing, Adjusting and Balancing.
 - 2. ANSI/ASME B31.9 - 2014; Chapter VI Part 937.
 - 3. ANSI/ASME B31.1 - 2014; Power Piping Code.
 - 4. Local codes.
- B. Balancing
 - 1. AABC 7th Edition National Standards; Air and Hydronic.
 - 2. NEBB 2015 Eight Edition of the Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.
 - 3. SMACNA - 2016 Testing, Adjusting and Balancing.
- C. During the progress of the work, make tests as specified herein and as required by authorities having jurisdiction, including local authorities' Inspection Department, Owner, Owner's Insuring Agency, or Engineer. Tests shall be conducted by the Mechanical Contractor as part of the work of this Division. Include all qualified personnel, equipment apparatus, and services required to perform the tests.
- D. Submit a detailed method statement describing procedures to be followed for testing:
 - 1. Pipe system pressure tests.
 - 2. Pipe system balancing.
 - 3. Life safety system testing.
- E. Calibrate all instruments used for testing and adjusting within a period of six (6) months prior to testing and/or balancing. Certify instrument calibration as specified in Section 15501.

PART 2 - PRODUCTS

2.1 PRESSURE AND TEMPERATURE SENSING TAPS

- A. Review location of all pressure and temperature test stations specified in Section 15526.

PART 3 - EXECUTION

3.1 TESTING

- A. General
 - 1. Provide a complete set of approved mechanical and electrical shop drawings to the balancing contractor.
 - 2. Perform all tests required by Codes, Ordinances, and as specified herein, as well as demonstrations of operation for all equipment. Each final test to be witnessed by the Owner or Owner's designated representative. Give a minimum of seven (7) days written notice before performing tests.

3. Install all temporary and permanent equipment and instruments required for tests, as well as additional thermometer wells, gauge and instrument connections, at no additional cost to the Owner.
4. Perform preliminary tests and repair all leaks before notifying the Owner of final tests.
5. Repair leaks, damage, or defects discovered during or resulting from tests or replace to a like-new condition. Remove leaky pipe joints, ductwork, etc., and replace with acceptable materials. Retest systems repaired.
6. Maintain a log book of all tests, preliminary and final, showing dates, personnel, observers' initials, description of test, and test status. Provide updated log to Owner each month throughout the construction period. Initial log submitted to include listing of all anticipated tests.
7. Testing, balancing, and adjusting will not relieve the Contractor of the warranty requirements.
8. Furnish all fuel, water, and electricity required in performing the testing, balancing and adjustment of mechanical systems.
9. Clean all piping and ducts before testing.
10. Use calibrated test gauges with at least 4½" diameter dial. Gauge range not to be more than three (3) times test pressure.
11. Provide and demonstrate operation of all test equipment and apparatus required for the complete testing and inspection of all systems at such time and locations as may be directed by the Engineer and/or by the authorities having jurisdiction.
12. When freezing is a hazard, take all precautions necessary to prevent damage. Correct any and all damage that results due to freezing at no expense to the Owner.
13. All tests shall be successfully completed and approved prior to the application of insulation and prior to the concealment of any portion of the system being tested.

B. Piping

1. Before covering or enclosing piping of various systems, all piping must be tested tight for 8 hours. Start and coordinate testing to be completed by 4:30 PM on the day started. The maximum test pressure not to exceed 500 psig. Tests may be witnessed by the Engineer if he so desires, and pronounced satisfactory before pressure is removed. Note: Equipment must be valved off or removed during the test if the pressure rating of equipment is not as high as the test. Drain equipment and piping and protect against freeze-up anytime the ambient temperature is below freezing.
2. Mix water for each hydrostatic test with Nalco 2572, or approved equal, to a ratio of fifty (50) gallons of Nalco 2572 to 10,000 gallons of water, or a higher concentration if recommended by the chemical manufacturer. At least sixty (60) days prior to the start of hydrostatic leak testing, submit a two (2) foot long length of the typical piping installed on the project to Nalco or another chemical manufacturer acceptable to the Owner, to determine the composition of the internal pipe coating. Provide injection pumps, water meters and coupon racks to control and monitor the concentration. After leak testing and a sufficient time period to allow the interior of the piping to be chemically coated to prevent rust formation, drain the piping system until empty.
3. Test piping within conduit prior to encasement of joints.
4. Hydrostatically test water piping at 1.5 times' actual maximum working pressure.
5. Hydrostatically test steam and condensate piping (less than 90 psig) for eight (8) hours at 150 psig.
6. Hydrostatically test steam and condensate piping (over 90 psig) for eight (8) hours at 1.5 times' maximum working pressure. Provide radiographic examination of 10% of all high pressure steam welds. Owner to select welds to be tested. If any welds fail, test all other welds as directed by the Owner at no cost to the Owner.
7. Compressed Air Piping: Air test at 125% of relief valve setting of compressor but not exceeding 150 psig for four (4) hours.
8. Refrigerant Piping: Air test at 125% of maximum operating pressure but not exceeding 150 psig for four (4) hours.

C. Equipment and Systems

1. Take vibration and alignment field measurements on every pump, fan and chiller over 10 HP. Readings shall include shaft alignment, equipment vibration, bearing housing vibration and foundation vibration. Building structure vibration shall be tested when directed by the Engineer. Readings shall be made using portable IRD (or as approved) equipment capable of filtering out various unwanted frequencies. Maximum vibration at any point listed above, or where specified, shall not exceed 2 mils on air handling units and individual fans, and 2 mils on pumps, unless otherwise specified. Equipment manufacturers shall certify in writing that the field readings, which do not exceed the maximum specified, are acceptable to them.
2. Take sound level readings at twelve (12) locations in the building as selected by the Engineer. Take the readings on an Octave Band Analyzer in a manner acceptable to the Project Acoustical Consultant and/or the Engineer. Submit the test equipment data and reporting forms to the Engineer for review at least three (3) months prior to the field testing. In order to reduce the ambient noise level, take the readings at night. Perform all tests in the presence of the Owner, Project Acoustical Consultant, and/or the Engineer, if they so desire.
3. When each mechanical system is complete and functional, prove the capacity and performance of each item of equipment (i.e., fans, pumps, chillers, cooling towers, boilers, heat exchangers, etc.). Operate each item of equipment for a minimum of four (4) hours and record all associated operating data every 30 minutes (i.e., temperatures, flows, pressures, amps, volts, etc.). Verify all integral and external equipment controls and safeties are in proper working order. Complete system testing and demonstration to be done for both normal and emergency modes of operation. Owner or Owner's representative may witness final tests.
4. Assist Division 17 Contractor in demonstrating to Owner or Owner's representative, the proper operation of each control, monitor and alarm function of the Building Management System, and/or control system, along with all software routines. These functions and routines will be demonstrated from the front end and local panels under both normal and emergency power. Proper operation of battery back-up and downloading of software from the front end to the remote microprocessor panels will be verified.
5. Demonstrate to Owner or Owner's representative, the proper operation of each control, monitor and alarm function of the control system, along with all software routines. Demonstrate these functions and routines from the front end and local panels under both normal and emergency power. Verify proper operation of battery back-up and downloading of software from the front end to the remote microprocessor panels.
6. Provide operation of all mechanical equipment required for systems testing by other trades (i.e., fuel oil systems, smoke exhaust systems, etc.).

3.2 ADJUSTMENT

A. General

1. Prior to start of air balancing, take traverse readings at all connections to building systems with all downstream dampers and VAV devices in fully open position and report results to Architect/Engineer. Await instructions if air quantities are below that shown on drawings.
2. Prior to start of water balancing, take ultrasonic flow readings at all connections to building systems with all downstream valves in full flow position and report results to Architect/Engineer. Await instructions if water quantities are below that shown on drawings.
3. After the entire installation has been completed, make required adjustments to balance valves, air vents, automatic controls, pumps, air dampers, VAV boxes, air distribution devices, pressure reducing valves, fans, sheaves, etc., until performance requirements are met. Make these adjustments with equipment operating. In addition, repeat these adjustments for each of the remaining three seasons of the year. During such periods of adjustment prior to the date of acceptance of the mechanical systems, operate equipment.

4. Permanently mark the balanced position of each balancing valve and damper on the pipe or duct or insulation.

B. Water Balancing

1. Before any hydronic balancing work is done, install clean strainers, check proper pump rotation, proper control valve installation and operation. Verify that each system is adequately bled and vented, proper system static pressure is available to assure a full system, flow meter and check valve is properly installed. Maintain throttling devices and control valves open at this time as required and appropriate.
2. After piping systems have been installed, tested, cleaned and flushed, complete with all pumps, piping, valves, coils, and other items as herein specified, make adjustments as required to deliver the water volumes at each coil and piece of equipment to within 5% of design flow as shown on the Drawings, or as required to properly balance the load throughout the conditioned areas. During balancing set control for full-flow through coils. Set automatic throttling valves in the full-open position. Close the bypass port on automatic 3-way valves.
3. Each air handling unit with multiple coils shall have the flow through each coil balanced. Make adjustments in water volumes in a manner satisfactory to the Engineer. Submit detailed balancing procedure and recording forms for the Engineer's review at least six (6) months prior to commencing any water balancing work.
4. After water flow is adjusted, and with the temperature controls set to produce design cooling, measure and record all data necessary to compile a complete report to demonstrate the acceptability of the various mechanical systems.
5. Record the following design requirements for pumps and pump motors from the design drawings and reviewed shop drawings:
 - a. Manufacturer, model and size.
 - b. Water quantity - gallons per minute.
 - c. Total head - feet of water.
 - d. Pump speed - revolutions per minute.
 - e. Net positive suction head.
 - f. Motor horsepower and brake horsepower.
 - g. Volts, hertz, amperes and service factor at design conditions.

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SECTION 230700

INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION

- A. Provide thermal insulation in accordance with the Contract Documents.

1.3 WORK INCLUDED

- A. Piping Insulation.
- B. Duct Insulation.
- C. Equipment Insulation.
- D. Fire Barrier Duct Wrap.

1.4 SUBMITTALS

- A. Shop Drawings: Submit list of insulation to be used for each service.
- B. Product Data: Manufacturer's latest published data for materials, "R" values and installation.

1.5 QUALITY ASSURANCE

- A. All insulating materials to be free of asbestos.
- B. Comply with all requirements of ASTM for thermal and moisture transmission.
- C. Provide insulation (including insulation jacket or facing and adhesives used to adhere the facing or jacket to the insulation) with non-combustible material meeting Code requirements and fire and smoke hazard ratings as tested by procedure ASTM E-84, National Fire Protection Association 255, and UL 723, not exceeding flame spread 25 and smoke developed 50. Adhesives, mastics, cements, etc. shall not exceed the same component ratings. Foam glass insulation to be manufactured in accordance with ASTM C552.
- D. All insulating products and coverings to be U.L. listed.
- E. All insulation thicknesses shall be at least the minimum thickness required by AHRAE 90.1 – 2001 for the respective services, materials and project location.
- F. Insulation materials, including all weather and vapor barrier materials, closures, hangers, supports, fitting covers, and other accessories, shall be furnished and installed in strict accordance with project drawings, plans, specifications and manufacturer's requirements.

- G. Insulation materials and accessories shall be installed in a workmanlike manner by skilled and experienced workers who are regularly engaged in commercial insulation work.

1.6 DELIVERY AND STORAGE OF MATERIALS

- A. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.
- B. The contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way. The contractor shall also use all means necessary to protect work and materials installed by other trades.
- C. If any insulation material has become wet because of transit or job site exposure to moisture or water, the contractor shall not install such material, and shall remove it from the job site.

PART 2 - PRODUCTS

2.1 PIPE INSULATION

A. Materials

1. When the temperature of a fluid falls within the following temperature ranges at any time during the system cycle, provide the insulation thickness indicated.

Service	Temp. Range °F	Material	Insulation Thickness In Inches for Pipe Sizes In Inches				
			less than 1 in.	1 in. to less than 1- 1/2 in.	1-1/2 in. to less than 4 in.	4 in. to less than 8 in.	8 in. and larger
Glycol Piping	50 to 120	Glass Fiber	1	1	1-1/2	2	2
Condensate drains	-	Glass Fiber	1/2	1/2	1/2	1	1
Refrigerant		Glass Fiber	1	1-1/2	1-1/2	--	--

- B. Provide insulation materials and thickness for steam piping and metering equipment at the building service entry in accordance with Utility Company requirements.
- C. Fiberglass Density: Fiberglass pipe insulation in equipment rooms and/or where exposed to be of the sectional type having 6 lbs./cu. ft. density. Other fiberglass insulation to be of the 1-piece type with at least 4 lbs./cu. ft. density.
- D. Thermal conductivity of fiberglass to be .23 BTU/hr/inch/sq.ft./°F/at a mean temperature of 75°F.

E. Insulation Jackets

1. Concealed pipes carrying fluids 105°F and above. Factory applied white fire retardant jacket, (ASJ), stapled and banded. Pipes banded with not less than 3 bands per section.
2. Exposed pipes carrying fluids 105°F and above. Factory applied white fire retardant jacket, (ASJ), with butt strips stapled and banded. Pipes banded with not less than 3 bands per section.
3. Pipes carrying fluids 60°F and below up to 14 inches. Factory applied white fire retardant vapor barrier jacket with self-sealing lap (ASJ) and butt strip. Ends of pipe insulation sealed off at valves, fittings and flanges with I.C. 301 or FB 30-35).
4. Pipes carrying fluids 60°F and below over 14 inches. Factory applied white fire retardant vapor barrier jacket (ASJ) sealed with I.C. 215 (or BF 82-07) adhesive. All circumferential joints wrapped with a 3 inch wide strip of white fire retardant jacket adhered with I.C. 215 (or BF 72-07) adhesive. Ends of pipe insulation sealed off at valves, fittings and flanges with I.C. 301 (or BF 30-35).
5. Vapor barrier jacket permeability to be 0.02 perms.
6. Jacket Puncture Resistance to be 50 units (Beach).
7. When multiple layers are required, all inner layer(s) shall be No Wrap.
8. On cold systems, vapor barrier performance is extremely important. All penetrations of the ASJ and exposed ends of insulation shall be sealed with vapor barrier mastic. If humidities in excess of 90% are expected, the ASJ shall be protected with either a mastic coating or a suitable vapor retarding outer jacket. Vapor seals at butt joints shall be applied at every fourth pipe section joint and at each fitting to provide isolation of water incursion.

F. Fittings, Valves and Flanges

1. Where manufactured, use factory premolded fittings (of the same material and thickness as the pipe insulation) for fittings, flanges and valves.
2. Where premolded insulation fittings are not manufactured, insulate fittings, flanges and valves with mitered segments of the same thickness and density as the adjoining pipe covering.
3. On cold systems, particular care must be given to vapor sealing the fitting cover or finish to the pipe insulation vapor barrier. All valve stems shall be sealed with caulking to allow free movement of the stem but provide a seal against moisture incursion.

G. Piping located outdoors and indoors up to a level of 8 feet shall be protected with the following additional covering:

1. Metal jacketing shall be 0.016" (0.4 mm) minimum aluminum or stainless steel with moisture barrier, secured in accordance with the jacket manufacturer's recommendations. Joints shall be applied so they will shed water and shall be sealed completely.
2. UV resistant PVC jacketing may be applied in lieu of metal jacketing provided jacketing manufacturer's limitations with regard to pipe size, surface temperature, and thermal expansion and contraction are followed.

3. Fittings shall be insulated as prescribed above, jacketed with preformed fitting covers matching outer jacketing used on straight pipe sections, with all joints weather sealed.
4. On outdoor glycol and refrigerant lines, the insulation system shall be completely vapor sealed before the weather-resistant jacket is applied. The outdoor jacket shall not comprise the vapor barrier by penetration of fasteners, etc. Vapor stops at butt joints shall be applied at every fourth pipe section joint and at each fitting to provide isolation of water incursion.

2.2 DUCTWORK INSULATION

A. Glass Fiber Blanket

1. Glass fiber blanket insulation shall be insulated with 0.75 pcf (12 kg/m³) density, FSK-faced fibrous glass duct wrap insulation having a k-value of .28 Btu•in/(h•ft²•°F).
2. The duct wrap insulation shall consist of a blanket-type insulation composed of wool-type glass fibers firmly bonded with a thermosetting resin. Duct wrap material shall be factory-laminated to a scrim reinforced, foil-kraft (FSK) vapor retarder facing have a 2" (51 mm) stapling flange on one edge.
3. When installed in accordance with recommended installation procedures, duct wrap insulation shall provide installed R-values as follows:

<u>DENSITY</u>	<u>LABELED THICKNESS</u>	<u>INSTALLED R-VALUE</u>
.75# (12 kg/m ³)	1-1/2" (38 mm)	4.2
.75# (12 kg/m ³)	2" (51 mm)	5.6
.75# (12 kg/m ³)	2-1/8" (54 mm)	6.0
.75# (12 kg/m ³)	2-1/4" (57 mm)	6.5
.75# (12 kg/m ³)	2-1/2" (64 mm)	7.0
.75# (12 kg/m ³)	3" (76 mm)	8.5
1.0# (16 kg/m ³)	1-1/2" (38 mm)	4.5
1.0# (16 kg/m ³)	2" (51 mm)	6.1
1.5# (24 kg/m ³)	1-1/2" (38 mm)	4.8
1.5# (24 kg/m ³)	2" (51 mm)	6.4

B. Fiberglass Duct Board

1. Material to be high-density fiberglass duct board with foil kraft laminate facing, reinforced with scrim. Maximum thermal conductivity (K-value) at 75°F (24°C mean temperature to be 0.23 Btu – in/hr. – sq. ft. -°F (0.035 w/m - °C) when tested in accordance with ASTM C518 or ASTM C177.

C. Application

Service	Material	Insulation Thickness (inches)
Cooled Supply Air Ducts	Glass Fiber Board	1-1/2
Return air ducts from heated or cooled spaces in exposed locations.	Glass Fiber Rigid Board	1
Outside Air Intake Ducts & Plenums from intake louver to supply system.	Glass Fiber Rigid Board	1-1/2

Service	Material	Insulation Thickness (inches)
Unused portion of louvers where blanked off with sheetmetal	Glass Fiber Rigid Board	1-1/2

- D. Rigid Glass Fiber Board to be six (6) pound per cu. ft. density with factory applied white fire retardant jacket (ASJ). Apply with mechanical fasteners. Seal joints and breaks.
- E. Ventilating systems (which are neither heated nor cooled) supply ducts need not be insulated.

2.3 EQUIPMENT INSULATION

A. Materials

Service	Material	Insulation Thickness (inches)
Glycol Pumps	Custom Fit Cover	1

2.4 CUSTOM FIT COVERS

- A. Materials: All materials shall be new and undamaged. "Off spec" materials shall not be acceptable. Trade names and manufacturers referred to in this specification are intended to ensure a minimum quality of materials for construction. Any supplier or manufacturer not listed shall be submitted for approval before construction. Detailed information on fire resistance, thermal efficiencies, tensile strength and tear strengths shall be made available by a representative of the company upon request.

B. Components:

1. Cover

Inner Jacketing:	18 oz. color-coded Teflon fiberglass cloth.
Gussets:	18 oz. color-coded Teflon fiberglass cloth.
Insulation:	Chilled water systems: 2" thick fiberglass insulation
Steam and Hot Water Systems:	2" thick 8# Ceramic-wool insulation.
Outer Jacketing:	18 oz. color-coded Teflon fiberglass cloth.
Sewing Thread:	.021-20# tensile strength Teflon coated fiberglass thread.
Steam Attachments:	18 oz., color-coded Teflon belts with stainless steel double D-rings and Velcro tabs.
I.D. Tags:	304 stainless steel plate with 1/4" embossed lettering. The tags shall be of sufficient size to allow imprinting of the vital identification legend and shall be permanently attached to the insulation cover with stainless steel rivets.

Terminal Ends: 18 oz. color-coded Teflon cloth flaps with
Nomex drawcord.
All Hardware: 304 stainless steel.

2. Innerjacketing, Gussets, Outer Jacketing, Seam Attachment and Terminal Ends

Material shall be of impregnated Teflon fiberglass cloth with a nominal weight of at least 18 oz. per square yard and a service temperature rating of at least 550°F. Teflon coated fiberglass cloth shall be orange, yellow, dark green and dark blue in color manufactured by one of the following:

Manufacturer: Trade Name:

Alpha Associated, Inc. FCF 1800
Textiles Coated, Inc. EJ 1800 TM

3. Insulation

Ceramic wool insulation shall be 2" thick and shall have a density of not less than 8# per cubic foot. Ceramic insulation shall be manufactured by one of the following:

4. Manufacturer: Trade Name:
5.

Premier Refractories & Chemicals Cerea-WoolR
Great Lake Textiles K-Lite RT

6. D-Rings

D-rings for use with seam attachment shall be welded double D-shaped rings of .12" or greater diameter Type 304 stainless steel wire.

7. Velcro

The Velcro fastening system for securement of loose strap ends and closing system for small covers shall be of heat and flame resistant nylon. This material shall be a minimum of 1" wide and suitable for attachment by sewing. The Velcro shall be manufactured by the following:

Manufacturer: Trade Name:

Velcro USA, Inc. Hook #80, LOOp#2000
Aplix, Inc. Aplix 820

8. Draw Cord

9. The draw cord for cinching of cover terminal ends around adjacent insulation, valve packing, etc., shall be of 3/16" braided Nomex cord.

10. Sewing Thread

11. This material shall be .021 – 20# tensile strength Teflon® coated fiberglass suitable for machine stitching, and have a service temperature rating of at least 600F. The thread shall be manufactured by one of the following:

Manufacturer: Trade Name:

Alpha Associates, Inc. Alpha D1-18
Filtech Style E-18

12. Identification Tags

13. The identification tags shall be of Type 302 or 304 stainless steel plate with 3 inch embossed lettering. The tags shall be of sufficient size to allow imprinting of the vital identification legend and shall be permanently attached to the insulation cover with stainless steel rivets.

C. Construction

1. Covers shall be constructed as a preformed single piece cover and the closing seam shall be located at the gravitational bottom.
2. All valves covers shall be manufactured as one (1) piece body and bonnet.
3. Individual covers thereof shall not weight more than 75#. All seams shall be sewn using a locked stitch with a minimum of eight (8) stitches per inch. The thread must be able to withstand the full process temperature without degradation.
4. Hog rings or staples shall not be used as a method of seam closure.
5. Insulation within the jacket shall be held in place with stainless steel quilt pins to prevent shifting.
6. Quilt pins shall not pierce the outer skin of the covers.
7. Cinch belts and Velcro flap shall be used to hold the cover in place. Belts shall be made of outer jacket materials and two stainless steel D-ring fasteners. Velcro hook and loop fasteners shall be used to secure end of belts to cover after cinching.
8. Belts and D-Rings and Velcro flaps shall be used on all parting faces. Securement of the belts and Velcro flap traps to the weather barrier (outer skin of the cover) shall be sewn to the cover and shall be sufficient to withstand the stress of removing and reinstalling the cover. Belts length and the number of straps utilized shall be sufficient to affect a snug and proper fit without gaps or sagging of the cover.
9. Each cover shall have a S.S. tag affixed to it identifying it's type, size and location.

2.5 FIRE WRAP

A. Product Description

1. When properly installed, 3M "Interam" Endothermic Mat E-5A-4 provides a uniform covering that, when exposed to high temperatures, releases chemically-bound water to cool the outer surface of the wrap material and significantly retard heat transfer.
2. Installation shall be in strict accordance with manufacturer's written instructions, as shown on approved shop drawings.
3. 3M "Interam" Endothermic Mat E-5A-4 shall be a flexible, endothermic (i.e., heat absorbing) mat with low smoke evolution capable of being layered for 1-, 2-, 3- and 4-hour structural steel applications; 1-, 2- and 3-hour electrical system applications.
4. The product shall be capable of achieving an equal F-Rating and T-Rating when applied to metallic utility boxes, which penetrate the membrane of a fire-resistive wall assembly.
5. When properly installed, 3M "Interam" Endothermic Mat E-5A-4 helps protect the encapsulated item(s) against heat penetration and flame spread.
6. 3M "Interam" Endothermic Mat E-5A-4 shall be listed by independent test agencies, such as UL, ULC, Intertek, or FM. Suitability for the intended application should be determined prior to installation.

B. Product Features

1. Provides up to four (4) hours' fire protection for structural steel applications, in accordance with ASTM E 119.
2. Provides up to three (3) hours' fire protection for electrical circuit applications^{1,2}, in accordance with ASTM E 1725.
3. Provides protection against large hydrocarbon pool fires, in accordance with ASTM E 1529 (UL 1709).
4. Chemically-bound water helps cool protective item(s) in the event of a fire.
5. Non-flame supporting.
6. Low-smoke evolution.
7. Flexible – can be installed on complex shapes and around corners.

8. Easy-to-cut for various shapes and sizes.
9. Non-corrosive.
10. For use in new or retrofit applications.
11. Easy-to-clean.

¹Specific fire-ratings are achieved via single layer or multiple layering of mat, per listed system requirements. Per system details, additional layers of vent increase the hourly-rating of the installation.

²Under normal operating conditions, the vent's ambient conductivity allows heat, such as that generated by power cables, to dissipate rather than be trapped by it.

C. Applications

1. 3M "Interam" Endothermic Mat E-5A-4 is a flexible and space-saving wrap system that protects against fire spread and smoke contamination in a wide range of new or retrofit applications requiring full envelope protection, including structural steel, electrical circuitry/raceways, cables, cable trays, conduits, equipment shrouds, steam lines and membrane penetrations (e.g., space containing electrical panels, elevator call boxes, safe deposit boxes, medical gas boxes).

2.6 ACCEPTABLE MANUFACTURERS

A. Insulation

1. Owens-Corning Fiberglass
2. Johns-Manville
3. Armstrong
4. Certain-Teed
5. Knauf

PART 3 - EXECUTION

3.1 INSTALLATION OF INSULATION - GENERAL

- A. Perform work in strict accordance with the manufacturer's recommendation and the best practice of the trade and the intent of this specification.
- B. Ensure that insulation is clean, dry, and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation.
- C. Apply insulation over clean dry surface, butting sections or surfaces firmly together and finishing as specified.
- D. Seal vapor barriers in a continuous manner throughout against moisture penetration.
- E. Insulation to be continuous through wall, floor and ceiling openings or sleeves. Do not cover any nameplates or identification tags.

3.2 INSULATION OF DUCT WORK AND FITTINGS

- A. No insulation shall be installed until ductwork has been pressure tested or leak tested as specified elsewhere to the satisfaction of the engineer.
- B. Before applying duct wrap, steel metal ducts shall be clean, dry, and tightly sealed at all joints and seams.

- C. All portions of duct designated to receive duct wrap shall be completely covered with duct wrap.
- D. To ensure installed thermal performance, duct wrap shall be cut to "stretch-out" dimensions as follows (P = perimeter of duct in inches/mm):

Labeled Thickness	Average Installed Thkns.	Thickness Calculation To Arrive at Correct Installed Thickness		
		Round Duct	Square Duct	Rectangular Duct
1-1/2" (38 mm)	1.125 (29 mm)	P+ 9.5" (241 mm)	P+ 8.0" (203 mm)	P+ 7.0" (178 mm)
2" (51 mm)	1.5" (38 mm)	P+ 12.0" (305 mm)	P+ 10.0" (254 mm)	P+ 8.0" (203 mm)
2-1/4" (57 mm)	1.69" (43 mm)	P+ 13.5" (343 mm)	P+ 11.5" (292 mm)	P+ 9.0" (229 mm)
2-1/2" (64 mm)	1.88" (48 mm)	P+ 14.5" (368 mm)	P+ 12.5" (318 mm)	P+ 9.5" (241 mm)
3" (75 mm)	2.25" (57 mm)	P+ 17.0" (432 mm)	P+ 14.5" (368 mm)	P+ 11.5" (292 mm)

- E. A 2" (51 mm) piece of insulation shall be removed from the facing at the end of the piece of insulation to form an overlapping stapling and taping flap
- F. Install duct wrap insulation with facing outside so that the stapling flap overlaps the insulation and facing at the other end of the piece of duct wrap. Adjacent sections of duct wrap insulation shall be tightly butted, with the 2" (51 mm) stapling and taping flap overlapping. If ducts are rectangular or square, install so insulation is not excessively compressed at corners. Seams shall be stapled approximately 6" (152 mm) on center, with 1/2" (13 mm) minimum, steel, outward-clinching, staples.
- G. Where a vapor barrier is required, seams shall be sealed with pressure-sensitive tape matching the insulation facing, either plain foil or fil-scrim-kraft (FSK). Seal all tears, punctures, and other penetrations of the duct wrap facing with tape or mastic to provide a vapor-tight system.
- H. Wherever external duct insulation is specified and internal acoustic treatment of equivalent insulating effect is also required (by Drawings or Specifications) for the same location, the external insulation may be omitted.
- I. Cover ductwork exposed to outdoor conditions, including spaces ventilated with outdoor air, with an additional 2-inch thickness of rigid glass fiber board 6 lbs./cu.ft., faced with factory applied all-service jacket, Johns-Manville Type 817 Spin-glas AP, or as approved.
- J. Apply vaporseal board by mechanical fasteners such as Graham pins and speed washers. Seal joints with an adhesive, as approved and reinforced with a glass cloth membrane over vinyl mastic, or self-sealing matching tape. Butter pinheads with an adhesive, as approved. If vaporseal board is wired, use tin edges to protect the corners of the board. Seal edges and joints.
- K. Enclose removable heads for equipment, (such as coolers, heat exchangers and horizontally split pumps) in aluminum sheetmetal boxes for easy removal with fiberglass board applied to

inside of sheetmetal boxes of thickness as described above. Provide lifting handles for removal of boxes.

- L. Install equipment insulation furnished loose by the equipment manufacturer in accordance with manufacturer's instructions.

3.3 PIPING INSULATION

- A. No insulation must be installed at fittings and joints until the piping systems have been hydrostatically tested as specified elsewhere to the satisfaction of the Engineer.
- B. Provide insulation for removable flanges of pipe strainers on cold services with built-up sections of glass fiber pipe covering, arranged to facilitate servicing of the strainer. Complete applications with vaporseals. Vapor barriers to be sealed and continuous through hangers, walls, sleeves, etc. Adhesives and coatings to be as noted herein.
- C. Insulate fittings, flanges, valves, etc. for services where calcium silicate insulation is specified with mineral wool cement of equal thickness to the pipe insulation and finished with glass cloth.
- D. Piping Exposed to Outdoor Conditions, Pipes in Spaces that are not heated and Pipes Subject to Freezing: Cover piping with an additional layer of 2 inches glass fiber insulation of the same finish as specified for the particular service in paragraph 2.1, but not less than 3 inches total thickness. All piping subject to freezing will be insulated with a minimum of 2" fiberglass.
- E. Insulate heat-traced piping as specified for piping exposed to outdoors. Cover with an aluminum jacket, as specified for piping exposed to the outdoors.
- F. Notify Mechanical Contractor of any leaks in pipe or joints. Do not insulate until leaks have been repaired. Replace all insulation dampened by leaks.
- G. Apply prefabricated sectional insulation for straight pipes neatly fitted around the piping, and sealed with adhesive. Apply adhesive to only one side of each joint and not to pipe surface.
- H. Seal all joints with Foster 30-35 fire resistant vapor barrier mastic. Where required, oversized pipe sections or board type insulation may be used to fabricate and install insulation around pipe specialties. All void space must be firmly filled with flexible insulation to support oversized pipe insulation.
- I. Maintain the integrity of factory-applied vapor barrier jacketing on all pipe insulation, protecting it against puncture, tears or other damage. All staples used on cold pipe insulation shall be coated with suitable sealant to maintain vapor barrier integrity.
- J. Secure sectional insulation with 0.02" thick by 1/2" wide aluminum bands manufactured by Childers, or Thomas & Betts "TY-RAP" nylon ties, on 24" centers for pipe sizes 2" and larger. Install at least two (2) bands per section of insulation.
- K. Insulate cold water ball valves with 3/4" thick flexible elastomeric sheet insulation (ASTM C534) or approved equal as detailed on the Drawings. Finish insulation with two (2) coats of Rubatex 374 coating.
- L. Insulate cold water vertical riser support clamps.

- M. Insulate and thoroughly vapor seal control valve bodies where the valve actuator penetrates the insulation.
- N. Replace any self-sealing insulation and/or lap that is found to be not sealing properly. Do not use staples to secure the insulation, lap, or coverings.
- O. Thermal Insulation for Engine Exhaust Piping
 - 1. Insulate entire engine exhaust pipe, from the engine expansion connection to the muffler to outside the building, with three (3) layers of 1½" thick hydrous calcium silicate non-asbestos insulation (ASTM C533), installed over spacers to allow a 1" air space between pipe and insulation.
 - 2. Stagger joints for the first, second and third layers.
 - 3. Apply aluminum jacket (ASTM B209) over outer layer of insulation as specified for piping exposed to weather.
 - 4. Insulate exhaust muffler in the same manner as the exhaust piping.
 - 5. Wrap or pack all protrusions through the insulation with refractory fiber. Seal all joints and cracks over 1/8" wide.
 - 6. Provide expansion joints in the insulation and aluminum jacket as recommended by the manufacturer to allow for differential expansion between the exhaust pipe, insulation and jacket.

3.4 FINISHING OF INSULATION

- A. Finish hot service pipe fittings and valve applications with open weave glass mesh adhered with I.C. 501 (or BF 30-35). Vaporseal for cold applications with I.C. 501 (or BF 30-35) adhesive with open weave glass mesh laid in while wet with final coat with I.C. 501 (or BF 30-35) adhesive. Overlap glass mesh and outer coat adjacent covering by at least 2 inches. Do not insulate flanges until systems are operational.
- B. Where insulation on kitchen exhaust ducts, diesel engine exhaust, boiler stacks and breeching is exposed, finish with two (2) coats of cement over hexagonal copper clad steel wire. Finish to be at least 1/2 inch thick.

3.5 PROTECTION OF INSULATION

- A. Protect pipe covering at hangers, guides, and roller supports with 16 gauge galvanized metal shields or saddles (at least 3 times the insulation diameter in length and 1/3 the insulation circumference in width) on the outside of the insulation and vapor barrier. Hold shields in place with straps. Do not pierce the insulation with hangers. Where glass fiber insulation is used on piping 3 inches and larger, provide half-section of calcium silicate covering of equal thickness at metal shields.
- B. Piping Exposed to Outdoors: Cover insulated piping exposed to outdoors or called for to be weatherproofed, in addition to finishes specified, with an aluminum jacket similar to Johns-Manville "Metal-Lok" or as approved, including all fittings.
- C. Exposed insulated piping in mechanical equipment rooms located 8 feet or less above the floor or where subject to traffic shall be provided with an aluminum insulation jacket similar to Johns-Manville "Metal-Lok".

3.6 INSPECTION

- A. Upon completion of installation of duct wrap and before system operation is to commence, visually inspect the system and verify that duct insulation has been correctly installed.
- B. Open all system dampers and turn on fans to purge all scraps and other loose pieces of material from the duct system. Allow for a means of removal of such material from the duct system.
- C. Check the duct system to ensure that there are no air leaks through duct joints.
- D. Fill surface imperfections such as chipped edges, small joints or cracks and voids or holes with insulation material and smooth all such areas with a skim coat of insulating cement.

3.7 SAFETY PRECAUTIONS

- A. Insulation contractor's employees shall be properly protected during installation of all insulation. Protection shall include proper attire when handling and applying insulation materials, and shall include (but not be limited to) disposable dust respirators, gloves, hard hats, and eye protection.
- B. The insulation contractor shall conduct all job site operations in compliance with applicable provisions of the Occupational Safety and Health Act, as well as with all state and/or local safety and health codes and regulations that may apply to the work.

END OF SECTION

SECTION 230800

COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. General

1. Work under this contract shall conform under requirements of Division 1, General Requirements, Conditions of the Contract, and Supplementary Conditions. This specification covers commissioning of mechanical systems which are part of this project.
2. Furnish labor and material to accomplish complete HVAC commissioning as specified herein. Complete interim commissioning if HVAC systems during initial season operation and follow-up commissioning of required HVAC systems during additional season operation.

B. Definitions

1. Commissioning: the process of ensuring that systems are designed, installed functionally tested and capable of being operated and maintained to perform in conformity with the design intent. The commissioning begins with planning and includes design, construction, start-up, acceptance, and training, and can be applied throughout the life of the building.
2. Commissioning Authority: the designated person, company, or agent who implements the overall commissioning process.
3. Commissioning Plan: A document defining the commissioning process, which is developed in increasing detail as the project progresses through its various phases.
4. Commissioning report: the document that records the results of the commissioning process, including the as-built performance of the HVAC system and unresolved issues.
5. Commissioning specification: the contract document that details the objective, scope, and implementation of the construction and acceptance phases of the commissioning process as developed in the design-phase Commissioning Plan.
6. Commissioning team: those people responsible for working together in carrying out the commissioning process.
7. Design intent: a detailed explanation of the ideas, concepts, and criteria that are defined by the Owner to be important. This typically is an expansion of the information provided in the Owner's Program.
8. Design intent document: a detailed written document, evolving throughout the commissioning process, clearly defining items and criteria of the design intent.
9. Functional performance testing (FPT): the process of determining the ability of the HVAC system to deliver heating, ventilating, and air-conditioning services in accordance with the final design intent.
10. Systems Manual: a composite document that expands the scope of the operation manual and maintenance manual by including the additional information gathered by the commissioning process.
11. Verification: that full range of checks and tests carried out to determine if all components, subsystems, systems, and interfaces between systems operate in accordance with the contract documents. In this context, "operate" includes all modes

and sequences of control operation, interlocks and conditional control responses, and specified responses to abnormal or emergency conditions.

C. Purpose

The commissioning is a process and its purpose is:

1. to verify that the systems installation and performance is in accordance with the plans, specifications and design intent.
2. to train the Owner's operators so that they fully understand the design intent and the operation and maintenance requirements of the equipment.

D. Commissioning work of Division 23 shall include, but not be limited to:

1. Testing and start-up of the equipment.
2. Testing, adjusting and balancing of domestic water system.
3. Cooperation with the Commissioning Authority.
4. Providing qualified personnel for participation in commissioning tests, including seasonal testing required after the initial testing.
5. Providing equipment, materials, and labor as necessary to correct construction and/or equipment deficiencies found during the commissioning process.
6. Providing operation and maintenance manuals and as-built drawings to the Commissioning Authority for verification.
7. Providing training and demonstrations for the systems specified in this Division.

E. Scope of Work during Construction Phase

1. review submittals;
2. finalize details of the Commissioning Plan;
3. conduct periodic commissioning team meetings;
4. observe construction, installation, start-up, operation, and testing and balancing; and
5. conduct O&M training.

F. Scope of Work during Acceptance Phase

1. verify the accuracy of the final TAB report,
2. verify that the HVAC system complies with the contract documents,
3. identify and document deficiencies,
4. remedy deficiencies and verify,
5. submit verification report to the commissioning team to review.
6. do functional performance testing,
7. identify and document deficiencies,
8. remedy deficiencies and retest,
9. submit functional performance tests to the commissioning team to review,
10. establish an as-built record of the HVAC system performance,
11. complete the as-built records,
12. complete the commissioning report,
13. complete the Systems Manual, and
14. turn over the building to the Owner

G. Systems to be Included in Commissioning Process

All HVAC systems, sub-systems, and equipment included in Division 23, and not only limited to the following, shall go through commissioning:

1. BMS
2. Fuel Oil Systems
3. Generator ventilation systems
4. Supply and exhaust air systems
5. Roof top packaged AC-Systems
6. Packaged refrigerant AC-systems
7. DDC / BMC control systems, hardware, software and documentation
8. Stand-By power system
9. Life-Safety system

H. Timely and accurate documentation is essential for the commissioning process to be effective. Documentation required as part of the commissioning process shall include but not be limited to:

1. Progress and status reports, including deficiencies noted.
2. Minutes from all meetings.
3. Pre-start, and start-up procedures.
4. Training agenda and materials.
5. As-built records.
6. Commissioning report.
7. Operational and maintenance (O&M) manuals.

I. Detailed testing shall be performed on all installed equipment and systems to ensure that operation and performance conform to contract documents. All tests shall be witnessed by the Commissioning Authority. The following testing is required as part of the commissioning process:

1. Verification tests are comprised of a full range of checks and tests to determine that all components, equipment, systems, and interfaces between systems operate in accordance with contract documents. This includes all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions.
2. Functional performance tests (FPT) shall determine if the Plumbing system is providing the required capacity of the various services in accordance with the finalized intent.

1.2 QUALITY ASSURANCE

A. Commissioning Authority shall meet the following qualifications:

1. Have a minimum of five (5) years of demonstrated Commissioning Authority experience in the commissioning of HVAC Systems similar in size and complexity to this Project.
2. Commissioning Authority shall hold a Certified Commissioning Professional (CCP) designation from the Building Commissioning Association.

B. Reference:

1. ASHRAE Guideline 1.1-2007: The HVAC Commissioning Process
2. ASHRAE Application Handbook 2007—: Chapter 42 – HVAC Commissioning.
3. ASHRAE Guideline 4-2008: Preparation of Operating and Maintenance Documentation for Building Systems.

1.3 ROLES AND RESPONSIBILITIES

A. Construction Manager or General Contractor

1. Contracting Office will advise HVAC Commissioning Authority regarding changes in building occupancy and/or usage.
2. Assign maintenance personnel and schedule them to participate in meetings, training session as follows:
 - a. Construction Phase coordination meeting.
 - b. Initial Owner training session at initial placement of major equipment.
 - c. Maintenance orientation and inspection
 - d. Piping and ductwork test and flushing verification meetings.
 - e. Procedures meeting for Testing, Adjusting and Balancing.
 - f. Owner's training session.
 - g. Verification demonstrations.
 - h. Final review at acceptance meeting.
3. Provide qualified personnel for videotaping and editing of training sessions.
4. Video tape construction process, hidden shafts, etc.
5. Provide any utilities required for the commissioning process.
6. Provide detailed program clearly stating the Owner's objectives, parameters, budgets, etc. for this facility.

B. Commissioning Authority

1. Develop the commissioning requirements and all related testing, verification and quality control sections.
2. Prepare the mechanical commissioning program required as part of the Commissioning Specification. Include lists of all contractors for commissioning events by name, firm, and trade specialty.
3. Execute the mechanical commissioning program, through organization of all tests, meetings, demonstrations, training events and performance verifications described in the Contract Documents and the approved HVAC commissioning program. Organizational Responsibilities include preparation of agendas, attendance lists; arrangements for facilities, and timely notification to participants for each commissioning event. The Commissioning Authority shall act as chairman at all commissioning events and assure the execution of all agenda items. The Commissioning Authority shall prepare minutes of every commissioning event and send copies to all those in attendance and the Owner within 5 work days of the event.
4. Review the design documents for their effect on the commissioning process and the final performance of the HVAC system. The includes ensuring that appropriate commissioning guidelines have been followed, and that there are adequate devices included in the design to ensure the ability to properly test, adjust and balance the systems, and to document the performance of each piece of equipment and each system. Any items required but not shown shall be brought to the attention of the Contractor prior to submittal of shop drawings.
5. Review all submittals (e.g. equipment, ductwork, piping, automatic controls, and TAB procedures) for their effect on the commissioning process and the final performance of the HVAC system.
6. Schedule the Construction Phase coordination meeting within 90 days of the award of the contract, at some convenient location and at a time suitable to the Contractor and Design Professional. This meeting shall be for the purpose of reviewing the complete mechanical commissioning program and establishing tentative schedules for

- mechanical system orientation and inspections, O&M submittals, training sessions, system flushing and testing, job completion, test, adjust and balance (TAB) work and verification and functional performance testing.
7. Schedule the initial Owner training session so that it will be held immediately before the mechanical system orientation and inspection. This session shall be attended by the Owner's O&M personnel, the mechanical Contractor, the Design Professional, and the Commissioning Authority. The Design Professional shall conduct this session giving an overview of the system, the system design goals and the reasoning behind the selection of the equipment.
 8. Conduct periodic inspections of work in progress to ensure that all systems are installed according to specifications.
 9. Conduct the Mechanical system orientation and inspection following the initial training session. The Mechanical system orientation and inspection shall be conducted by the mechanical Contractor. The emphasis of this Mechanical system orientation and inspection shall be an observation of the equipment location with respect to accessibility. Prepare minutes of this meeting, with separate summary of deficiency findings by the Owner and Commissioning Authority. Distribute to attendees and the Owner.
 10. Receive and review the Operation and Maintenance (O&M) manuals as submitted by the contractor, ensuring that they follow the specified outline and format. Insert systems description as provided by the Design Professional.
 11. Adequate accessibility for maintenance and component replacement or repair is the Contractor's responsibility and shall be checked by the Commissioning Authority.
 12. Witness equipment and system start-up and testing. Ensure the results are documented (including a summary of deficiencies), and incorporated in the O&M manuals.
 13. Prior to initiating the TAB work, the Commissioning Authority shall meet with the Owner, mechanical Contractor, Design Professional, and TAB Contractor. The TAB Contractor shall outline TAB procedures and get concurrence from the Design Professional and Commissioning Authority. Ensure that the TAB Contractor has all forms required for the job database and understands their importance and use.
 14. Schedule the O&M training sessions. These training sessions are to be attended by the Owner, Commissioning Authority, Design Professional, Contractors and equipment suppliers as necessary. The format shall follow the outline in the O&M manuals. This mechanical system orientation and inspection should include hands on training.
 15. Detailed verification test procedures and data sheets for review by the Design Professional.
 16. Submit detailed FPT procedures for review and acceptance by the Design Professional.
 17. Upon receipt of notification from the Design Professional that the mechanical systems have been completed and are operational, the Commissioning Authority shall proceed to verify the TAB report and operation of the control systems in accordance with the Commissioning Specification.
 18. Conduct Verification tests.
 19. Submit verification test data for review to the Design Professional for review and acceptance.
 20. Provide detailed checklists data sheets to document verification tests.
 21. Provide and install calibrated test instrumentation to monitor and record data as necessary.
 22. The Commissioning Authority shall certify that the mechanical systems are ready for Functional Performance Testing.
 23. Conduct Functional Performance Tests.
 24. Submit functional performance test report for review to the design professional.

25. Re-test if performance deficiencies are found, corrected and additional testing is requested.
26. Review as-built drawings for accuracy with respect to installed systems. Review revisions to achieve accuracy.
27. Ensure that the O&M manuals and all other as-built records have been updated to include all modifications made during the construction phase.
28. Repeat Functional Performance Tests to accommodate seasonal tests and/or correct any performance deficiencies. Revise and re-submit the commissioning report.
29. Prepare the final commissioning report.
30. Assemble the final project documentation which shall include the commissioning report and all as-built records. Submit this documentation to the Design Professional for review and acceptance.

C. Architect (Verify Scope with Design Architect)

1. Provide support to the Design Professional who must provide a service as a part of the commissioning process. This shall include providing adequate space for equipment installation and maintenance.
2. Conduct periodic inspections of work in progress to ensure that all systems and equipment are installed according to specifications.
3. Provide data on structure, building materials, interior finishes, and furnishings for their effect on indoor air quality.

D. Mechanical Design Professional

1. Provide construction documents.
2. The Design Professional shall specify and verify adequate maintenance accessibility for each piece of equipment in shop drawings and the actual installation.
3. The Design Professional retains responsibility for the system evaluation, adequacy of the system to meet design intent, capacity of the system, quality control check or any of the other elements of the system design.
4. Attend the Owner training sessions. Conduct the mechanical training session pertaining to the overview of the system design, the system design goals and the reasoning behind the selection of the equipment.
5. Participate in O&M personnel orientation and inspection at the final construction stage.
6. Attend initial meeting with TAB representative as scheduled by Commissioning Authority.
7. Review verification and functional performance testing procedures submitted by the Commissioning Authority.
8. Review TAB report and verification data sheets for system conformance to contract documents. Issue a report noting deficiencies requiring correction to the Commissioning Authority.
9. Review functional performance testing report for deficiencies in meeting the finalized design intent.
10. Review as-built records as required by contract documents and turn them over to the Commissioning Authority for inclusion in final project documentation.
11. Review and comment on the final commissioning report.

E. General Contractor

1. Include cost for commissioning requirements in the contract price
2. General contractor shall verify completeness of building envelope, perimeter and interior items which affect proper operation and control of HVAC equipment and systems.

3. Include commissioning requirements in the mechanical, electrical, and controls contracts, as well as all other sub-contractors, to ensure cooperation of all parties in the mechanical commissioning program.
4. Ensure acceptable representation, with the means and authority to prepare and coordinate execution of the mechanical commissioning program as described in the contract documents.
5. Issue a statement that TAB work has been completed, and submit the final TAB reports for review.
6. Issue a statement that control systems have been calibrated.
7. Remedy deficiencies identified in verification tests.
8. Evaluate any performance deficiencies identified in the FPT report for non-performance with contract documents.

F. Mechanical Contractor

1. Include cost of commissioning requirements in the contract price.
2. Include requirements for submittal data, O&M data, and training in each purchase order or sub-contract written.
3. Ensure cooperation and participation of specialty sub-contractors such as sheet metal, piping, refrigeration, water treatment, and TAB
4. Ensure participation of major equipment manufacturers in appropriate training and testing activities.
5. Attend Construction Phase coordination meeting scheduled by the Commissioning Authority.
6. Assist the Commissioning Authority in all verification and functional performance tests.
7. Prepare preliminary schedule for mechanical system orientations and inspections, O&M manual submissions, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up, TAB and task completion for use by the Commissioning Authority. Update schedule as appropriate throughout the construction period.
8. Attend initial training session.
9. Conduct mechanical system orientation and inspection at the equipment placement completion stage.
10. Update drawings to the record condition to date, and review with the Commissioning Authority.
11. Gather O&M data on all equipment, and assemble in binders as required by the Commissioning Specification. Submit to Commissioning Authority prior to the completion of construction.
12. Notify the Commissioning Authority a minimum of two weeks in advance, so that the witnessing equipment and system start-up and testing can begin.
13. Notify the Commissioning Authority a minimum of two weeks in advance of the time for start of the TAB work. Attend the initial TAB meeting for review of the official TAB procedures.
14. Participate in, and schedule vendors and Contractors to participate in the training sessions as set up by the Commissioning Authority.
15. Provide written notification to the General Contractor and Commissioning Authority that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.
 - a. HVAC equipment including all fans, air handling units, ductwork, dampers, terminals, and all Division 23 equipment.
 - b. Refrigeration equipment, pumping systems and heat rejection equipment.
 - c. Fire stopping in the fire rated construction, including fire and smoke damper installation, caulking, gasketing and sealing of smoke barriers.
 - d. Dedicated smoke control systems including atrium systems.

- e. Non-dedicated systems using the air handling units for smoke control.
- f. Fire detection and smoke detection devices furnished under other divisions of this specification as they affect the operation of the smoke control systems.
- g. That building control systems are functioning to control mechanical equipment and smoke control systems.

16. Provide a complete set of as-built records to the Commissioning Authority.

G. Test, Adjust, and Balance Contractor

- 1. Include cost for commissioning requirements in the contract price.
- 2. Attend initial commissioning coordination meeting scheduled by the Commissioning Authority.
- 3. Submit the TAB procedures to the Commissioning Authority and Design Professional for review and acceptance.
- 4. Attend the TAB review meeting scheduled by the Commissioning Authority. Be prepared to discuss the procedures that shall be followed in testing, adjusting, and balancing the HVAC system.
- 5. Participate in training sessions as scheduled by the Commissioning Authority.
- 6. At the completion of TAB work, and the submittal of the final TAB report, notify the Mechanical Contractor and the General Contractor.
- 7. Participate in verification of the TAB report, which will consist of repeating any selected measurement contained in the TAB where required by the Commissioning Authority for verification or diagnostic purposes.

H. Automatic Controls and Building Automation System Contractors

- 1. Include cost for commissioning requirements in the contract price.
- 2. Review design for controllability with respect to selected manufacturers equipment;
 - a. Verify proper hardware specification exists for functional performance required by specification and sequence of operation.
 - b. Verify proper safeties and interlocks are included in design.
 - c. Verify proper sizing of control valves and actuators based on design pressure drops. Verify control valve authority to control coil properly.
 - d. Verify proper sizing of control dampers. Verify damper authority to control air stream. Verify proper damper positioning for mixing to prevent stratification. Verify actuator vs. damper sections for smooth operation.
 - e. Verify proper selection of sensor ranges.
 - f. Clarify all questions of operation.
- 3. Attend initial commissioning coordination meeting scheduled by the Commissioning Authority.
- 4. Provide the following submittals to the Commissioning Authority.
 - a. Hardware and software submittals
 - b. Control panel construction shop drawings.
 - c. Narrative description of each control sequence for each piece of equipment controlled.
 - d. Diagrams showing all control points, sensor locations, point names, actuators, controllers, and, where necessary, points of access superimposed on diagrams of the physical equipment.
 - e. Logic diagrams showing the logic flow of the system.
 - f. A list of all control points, including analog inputs, analog outputs, digital inputs, and digital outputs. Include the values of all parameters for each system point. Provide a separate list for each stand-alone control unit.

- g. A complete control language program listing including all software routines employed in operating the control system. Also provide a program write-up, organized in the same manner as the control software. This narrative shall describe the logic flow of the software and the functions of each routine and sub-routine. It should explain individual math or logic operations that are not clear from reading the software listing.
 - h. Hardware operation and maintenance manuals.
 - i. Application software and project applications code manuals.
 - 5. Verify proper installation and performance of controls/BMCS hardware and software provided by others.
 - 6. Integrate installation and programming schedule with construction and commissioning schedules.
 - 7. Provide thorough training operating professionals on hardware operations and programming, and the application program for the system.
 - 8. Demonstrate system performance to Commissioning Authority including all modes of system operation (e.g. normal, abnormal, emergency)
 - 9. Provide control system technician for use during system verification and functional performance testing.
 - 10. Provide systems modifications as required.
 - 11. Provide support and coordination with TAB contractors on all interfaces between their scopes of work. Provide all devices, such as portable operators' terminals, for TAB use in completing TAB procedures.
 - 12. Additional trend logs may be required to facilitate the commissioning process.
- I. Equipment Suppliers and Miscellaneous Contractors.
- 1. Include cost for commissioning requirements in the contract price.
 - 2. Provide submittals, and appropriate O&M manual section(s).
 - 3. Attend initial commissioning coordination meeting scheduled by the Commissioning Authority.
 - 4. Participate in training sessions as scheduled by the Commissioning Authority.
 - 5. Demonstrate performance of equipment as applicable.
- J. Electrical Contractor
- 1. Include costs for commissioning requirements in the contract price.
 - 2. Include requirements for submittal data, O&M data, and O&M training in each purchase order or subcontract written.
 - 3. Enlist the support of the general contractor to ensure cooperation of other subcontractors such as the automatic controls and building automation systems contractor, fire detection, and security as necessary.
 - 4. Ensure participation of major equipment manufacturers through their representatives.
 - 5. Ensure coordination, installation, and operation interfaces between life safety and HVAC systems.
 - 6. Attend construction-phase coordination meeting scheduled by the Commissioning Authority. Prepare necessary preliminary schedule for O&M personnel orientation and inspections, O&M manual submission, training sessions, equipment start-up, testing and adjusting, and job completion for use by the Commissioning Authority. Update schedule appropriate throughout the construction period.
 - 7. Attend initial training sessions and conduct the electrical system orientation and inspection at the equipment placement completion stage. Update drawings to record condition to date, and review the Commissioning Authority.

8. Gather O&M data on all equipment and assemble in binders as required by the commissioning specification. Submit to Commissioning Authority prior to the completion of construction.
9. Notify the Commissioning Authority of the item for each required test.
10. Participate in and schedule equipment suppliers and contractors to participate in the training sessions as set up by the Commissioning Authority.
11. Conduct a maintenance orientation and inspection with hands-on-training. Update drawings to record condition to date and review with the Commissioning Authority prior to the orientation.
12. Provide written certification to the General Contractor and the Commissioning Authority that the work has been completed in accordance with the plans and specifications and that it is functioning as designed. Where the work has been subcontracted, the contractor shall be responsible for the initial certification, with the electrical contractor certifying that he/she has inspected the work and that it has been completed and is functioning as designed. This certification must be submitted to the Commissioning Authority prior to the final verification.
13. Demonstrate the operation of each piece of equipment to the Commissioning Authority. Schedule subcontractors as they apply to demonstrate the operation of the equipment and systems.
14. Turn over set of record mark-up drawings to the electrical design professional for final incorporation into record documents.

1.4 DOCUMENTATION

- A. The Commissioning Authority shall oversee and maintain the development of commissioning documentation. The commissioning documentation shall be kept in three ring binders, and organized by system and sub-system when practical. All pages shall be numbered, and a table of contents page(s) shall be provided. The commissioning documentation shall include, but not be limited to, the following:
 1. A detailed description of the design intent for the project, listing operating parameters, control sequences, occupancy conditions etc.
 2. A complete description of how the HVAC system is intended to operate.
 3. Approved test and balance report for the building being commissioned.
 4. All accepted shop drawings of mechanical equipment. Shop drawings shall be full size sheets folded as required to fit in binders.
 5. All pre-functional performance test checklists, signed by indicating personnel, organized by system and sub-system.
 6. All verification and functional performance test checklists/results, signed by indicated personnel, organized by system and sub-system.
 7. Three copies of the operation and maintenance (O&M) manuals specified in other sections of these specifications shall be included with the commissioning documentation. The manuals shall be incorporated in the commissioning documentation prior to commencement of O&M training required in this and other sections of the specification. Preparation of O&M manuals shall be as specified in section 3.07 of these specifications.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. The appropriate Contractor(s) shall furnish all special tools and equipment required during the commissioning process. A list of all tools and equipment to be used during commissioning

shall be submitted to the Commissioning Authority for approval. The Owner shall furnish necessary utilities for the commissioning process.

2.2 TEST EQUIPMENT – PROPRIETARY

- A. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.

PART 3 - EXECUTION

3.1 GENERAL

- A. A pre-construction meeting of all commissioning team members shall be held at a time and place designated by the Owner. The purpose shall be to familiarize all parties with the commissioning process, and to ensure that the responsibilities of each party are clearly understood.
- B. The Contractor shall complete all phases of work so the systems can be started, tested, balanced, and acceptance procedures undertaken. This includes the complete installation of all equipment, materials, pipe, duct, wire, insulation, controls, etc. per the contract documents and related directives, clarifications, and change orders.
- C. A Commissioning Plan shall be developed by the Commissioning Authority. The Contractor shall assist the Commissioning Authority in preparing the Commissioning Plan by providing all necessary information pertaining to the actual equipment and installation. If contractor initiated system changes have been made that alter the commissioning process, the Commissioning Authority shall notify the Contracting Officer.
- D. Acceptance procedures are normally intended to begin prior to completion of a system and/or sub-systems, and shall be coordinated with the Division 23 contractor. Start of acceptance procedures before system completion does not relieve the contractor from completing those systems as per the schedule.

3.2 PARTICIPATION IN ACCEPTANCE PROCEDURES

- A. The Contractor shall provide skilled technicians to start-up and debug all systems within Division 23. These same technicians shall be made available to assist the Commissioning Authority in completing the commissioning program. Work schedules, time required for testing, etc. shall be requested by the Commissioning Authority and coordinated by the contractor. Contractor shall ensure that the qualified technician(s) are available and present during the agreed upon schedules and of sufficient duration to complete the necessary tests, adjustments, and/or problem resolutions.
- B. System performance problems and discrepancies may require additional technician time, Commissioning Authority time, reconstruction of systems, and/or replacement of system components. The additional technician time shall be made available for subsequent commissioning periods until the required system performance is obtained.
- C. The Commissioning Authority reserves the right to question the appropriateness and qualifications of the technicians relative to each item of equipment, system, and/or sub-

system. Qualifications of technicians shall include expert knowledge relative to the specific equipment involved and a willingness to work with the Commissioning Authority. Contractor shall provide adequate documentation and tools to start-up and test the equipment, system, and/or sub-system.

3.3 DEFICIENCY RESOLUTION

- A. In some systems, improper adjustments, misapplied equipment, and/or deficient performance under varying loads will result in additional work being required to commission the systems. This work shall be completed under the direction of the Contracting Officer, with input from the contractor, equipment supplier, and Commissioning Authority. Whereas all members shall have input and the opportunity to discuss, debate, and work out problems, the Contracting Officer shall have final jurisdiction over any additional work done to achieve performance.
- B. Corrective work shall be completed in a timely fashion to permit the completion of the commissioning process. Experimentation to demonstrate system performance may be permitted. If the Commissioning Authority deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the Commissioning Authority shall notify the Contracting Officer, indicating the nature of the problem, expected steps to be taken, and suggested deadline(s) for completion of activities. If the deadline(s) pass without resolution of the problem, the Contracting Officer reserves the right to obtain supplementary services and/or equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner shall be the contractor's responsibility.

3.4 ADDITIONAL COMMISSIONING

- A. Additional commissioning activities may be required after system adjustments, replacements, etc., are completed. The contractor(s) suppliers, and Commissioning Authority shall include a reasonable reserve to complete this work as part of their contractual obligations.

3.5 SEASONAL COMMISSIONING

- A. Seasonal commissioning pertains to testing under full load conditions during peak heating and peak cooling seasons, as well as part load conditions in the spring and fall. Initial commissioning shall be done as soon as contract work is completed, regardless of season. Subsequent commissioning may be undertaken at any time thereafter to ascertain adequate performance during the different seasons.
- B. Heating equipment shall be tested during winter design extremes. Cooling equipment shall be tested during summer design extremes with a fully occupied building. Each contractor and supplier shall be responsible to participate in the initial and the alternate peak season tests of the systems as required to demonstrate performance.

3.6 ACCEPTANCE PROCEDURES

- A. Verification Tests
 - 1. Scope of verification tests
 - a. Operating tests and checks to verify that all components, equipment, systems, sub-systems, and interfaces between systems, operate in accordance with contract documents. These tests are to include all operating modes, interlocks, specified control responses, specific responses to abnormal or emergency

- conditions and verifications of the proper response of the building automation system controllers and sensors.
- b. Verify the validity of the TAB report.

2. Participants in verification tests

The Commissioning Authority shall be responsible for preparing the scope of these tests. The Commissioning Authority shall schedule the tests and assemble the commissioning team members who shall be responsible for the tests. Participating contractors, manufacturers, suppliers, etc. shall include all costs to do the work involved in these tests in their proposals. Following is a list of tasks and supporting information that shall be required.

- a. Mechanical contractor – provide the services of a technician(s) who is (are) familiar with the construction and operation of this system. Provide access to the contract plans, shop drawings, and equipment cut sheets of all installed equipment.
- b. Controls contractor – provide the services of a controls engineer who is familiar with the details of the project. Provide details of the control system, schematics, and a narrative description of control sequences of operation.
- c. Electrical contractor – provide a foreman electrician familiar with the electrical interlocks, interfaces with emergency power supply, and interfaces with alarm and life-safety systems. Provide access to the contract plans, and all as-built schematics of sub-systems, interfaces, and interlocks.

3. Documentation and Reporting Requirements.

- a. Provide checklists for each component, piece of equipment, system, and sub-system, including all interfaces, interlocks, etc. Each item to be tested shall have a different entry line with space provided for comments. Separate checklists shall be prepared for each mode of operation. Provide space to indicate whether the mode under test responded as required or not. Also, provide space for all necessary parties to sign off on each checklist.
- b. Data sheets used in verification of the proper operation of the control system shall include each controller to be verified, and its location. For each controller, provide space for recording the readout of the controller, the reading at the controller's sensor(s), and any comments. Also, provide space for all necessary parties to sign off on each checklist.
- c. All test procedures and data sheets shall be submitted to the design professional for review and acceptance.

4. Instrumentation

- a. The Commissioning Authority shall furnish all measurement instrumentation for the verification tests. All instruments will have calibrated within the six month period prior to these tests.

5. Verification Procedures

- a. The Commissioning Authority shall direct and witness the verification operating tests and checks for all equipment and systems.
 - 1) Set the system equipment (i.e., chiller, boiler, pumps, fans, etc.) into the operating mode to be tested, i.e. normal shut down, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions.

- 2) The Commissioning Authority shall inspect and verify the position of each device and interlock identified on the checklist. Each item shall be signed off as acceptable (yes), or failed (no).
 - 3) This test shall be repeated for each operating cycle that applies to the mechanical system being tested.
 - 4) Operating checks shall include all safety cutouts, alarms and interlocks with smoke control and life safety systems during all modes of operation of the mechanical system.
 - 5) If during a test an operating deficiency is observed, appropriate comments shall be added to the checklist data sheet.
 - 6) Verification of the interface of the monitoring and control system, and the TAB criteria shall include the following:
 - a) Verify supply and return flow rates for VAV and constant volume systems in all modes of operation of the HVAC system.
 - b) Verify operation of the terminal units in both heating and cooling cycles.
 - c) Verify minimum outdoor air intake air all modes of operation and at minimum and maximum total air flow rates.
 - d) Verify building pressurization.
 - e) Verify total exhaust air flow, and total outdoor air intake.
 - 7) Verification of the proper responses of monitoring and control system controllers and sensors shall be as follows:
 - a) For each controller or sensor, record the indicated monitoring and control system reading, and the test instrument reading.
 - b) If the initial test indicates that the test reading is outside of the control range of the installed device, the calibration of the installed device shall be checked and adjusted as required. The deficient device shall be re-tested and the results recorded on the checklist data sheet.
- b. The Commissioning Authority shall direct and witness the field verification of the final TAB report.
- 1) The Commissioning Authority shall select, at random, 10 percent of the report data for verifications.
 - 2) The TAB contractor shall be given sufficient advance notice of the date of field verification. However, they shall not be informed in advance of the data points to be verified. The TAB contractor must use the same instruments (by model and serial number) that were used when the original data were collected.
 - 3) Failure of an item is defined as:
 - a) For all readings other than sound, a deviation of more than 10 percent.
 - b) For sound pressure readings, a deviation of 3 decibels. (Note: variations in background noise must be considered).
 - 4) A failure of more than 10 percent of the selected items shall result in the rejections of the final TAB report.
- c. If the deficiencies are identified during verification, the General Contractor must be notified, and action taken to remedy the deficiency. The final tabulated checklist data sheets shall be reviewed by the Design Professional and the

Commissioning Authority, to determine if verification is complete, and the operating system is functioning in accordance with the contract documents.

B. Functional Performance Testing

1. Scope of Functional Performance Testing

- a. Functional performance tests shall determine if the HVAC system is providing the required cooling and heating services in accordance with the final design intent. They shall also determine the installed capacity of the cooling and heating plant, and heat transfer components. Following is a list of test examples:

- 1) Determine capability of chilled water system to deliver chilled water at the design supply temperature, and required rate of flow.
- 2) Determine capacity of electric heating system to deliver heating at the design temperature.
- 3) Determine the ability of the HVAC unit of deliver the cooling and/or heating services to the distribution system, at the design supply air temperature, required static pressure, and proper outside air ventilation rate.

2. Submittals

- a. Detailed procedures for each series of tests shall be submitted to the Commissioning Authority for review and acceptance. The procedures shall include samples of the data sheets that will be part of the reports.

3. Participants in Functional Performance Tests

- a. Participants in the functional performance tests shall be the same as those listed in the verification tests.

4. Instrumentation

- a. In addition to the instrumentation requirements detailed under verification, the Commissioning Authority may need to provide data acquisition equipment to record data for the complete range of testing.

5. Functional Performance Test Procedures

- a. The Commissioning Authority shall supervise and direct all functional performance tests.
- b. For each test, the Commissioning Authority shall install the measuring instruments and logging devices to record test data for the required test period. The instrumentation shall monitor and record all operating conditions to allow for complete evaluation of the test results.
- c. Measurement will be required to allow for calculation of total capacity of the system for each mode of operation under test.

6. Documentation and Reporting Requirements

- a. All measured data, data sheets, and a comprehensive summary, describing the operation of the HVAC system at the time of testing shall be submitted to the Commissioning Authority.
- b. A preliminary functional performance test report shall be prepared by the Commissioning Authority and submitted to the Design Professional for review. Any identified deficiencies need to be evaluated by the Design Professional and Construction Manager to determine if they are part of the contractor's contractual obligations. Construction deficiencies shall be corrected by the responsible contractor(s) and the specific functional performance test repeated.

- c. If it is determined that the HVAC system is constructed in accordance with the contract documents, and the performance deficiencies are not part of the contract documents, the Contracting Officer must decide whether any required modifications needed to bring the performance of the HVAC system up to the finalized design intent shall be implemented, or if the test shall be accepted as submitted. If corrective work is performed, the Contracting Officer shall determine if a portion or all required functional performance tests should be repeated, and a revised report submitted.

3.7 OPERATING AND MAINTENANCE MANUAL

- A. The operating and maintenance manual shall consist of a sturdy binder with 8-1/2" x 11" sheets containing the following major sections:
 - 1. System Descriptions:
 - a. Each major system shall be described, typewritten, in general terms, including major components, interconnections, theory of operation, theory of controls, unusual features and major safety precautions. This information should correlate with information provided in the manufacturer's instruction book. This section shall include, but not limited to, the following data:
 - 1) Detailed description of each system and each of its components showing piping, valves, controls, and other components, with diagrams and illustrations where applicable.
 - 2) Wiring and control diagrams with data to explain detailed operation and control of each component.
 - 3) Control sequences describing start-up, all modes of operation, and shut down.
 - 4) Corrected shop drawings.
 - 5) Approved products data including all performance curves and rating data.
 - 6) Copies of approved certifications and laboratory test reports (where applicable).
 - 7) Copies of warranties.
 - b. System diagrams, described in 3.7 B2 following, shall be incorporated in the appropriate systems descriptions. These should be reduced in size or folded to usefully fit into the manual.
 - 2. Operating Instructions:
 - a. Condensed, typewritten, suitable for posting, instructions shall be provided for each major piece of equipment. Where more than one (1) common unit is installed, one instruction is adequate. The instructions shall provide procedures for:
 - 1) Starting up the equipment/system.
 - 2) Shutting down the equipment/system.
 - 3) Operating the equipment in emergency or unusual conditions.
 - 4) Safety precautions.
 - 5) Trouble shooting suggestions.
 - 6) Other pertinent data applicable to the operation of particular systems or equipment.
 - b. The instructions shall be suitable for posting adjacent to the equipment concerned.

The Contractor shall provide instructions for:

- 1) (Electric heating equipment
- 2) (Hydropic distribution systems, including pumps.
- 3) Air handling units and exhaust fans.
- 4) DDC control systems.
- 5) Fan powered mixing boxes.
- 6) Emergency generating plants.
- 7) Domestic water pumps.
- 8) Variable frequency drive.
- 9) Other specialized or uncommon equipment.

3. Ongoing and preventive Maintenance

- a. Condensed, typewritten procedures for recommended ongoing and preventive maintenance actions shall be provided for each category of equipment/system listed in 3.7 A2 above.

This information shall include, but not be limited to the following:

- 1) Maintenance and overhaul instructions.
 - 2) Lubricating schedule including type, grade, temperature, and frequency range.
 - 3) Part list, including source of supply and recommended spare parts.
 - 4) Name, address, and 24 hour telephone number of each subcontractor who installed equipment and systems, and local representative for each type of system.
 - 5) Other pertinent data applicable to the maintenance of particular systems or equipment.
- b. These recommended preventive maintenance actions shall be categorized by the following recommended frequencies:
 - 1) Weekly
 - 2) Monthly
 - 3) Quarterly
 - 4) Semi-Annual
 - 5) Annual
 - 6) Other

B. Posted Operating Instructions and Diagrams:

1. Operating Instructions

- a. Copies of operating instructions provided in the operating manual (3.7 A above) shall be posted in the near vicinity of each piece of applicable equipment. The instructions shall be mounted nearly in frames under Plexiglas, where they can be easily read by operating personnel. Instructions mounted outdoors shall be suitably protected from weather.

2. Posted Systems Diagrams:

- a. Simplified one (1) line diagrams of the systems listed shall be developed and transcribed on transparent "D" sized erasable sepia film and posted neatly under Plexiglas in the main or most appropriate equipment room for each reference by operating and maintenance personnel. These drawings shall be done in a

professional manner which is acceptable to the Maintenance Division staff. The diagrams shall show each component including all valves installed in the system, with name and identifying number. If space does not permit valve numbers on the diagrams, valve charts shall be provided. Explanatory notes, where needed, shall be provided.

- 1) HVAC controls diagram
 - 2) Hydropic distribution system
 - 3) Electric heating system
 - 4) Air handling/ventilation system.
 - 5) Domestic water system.
 - 6) Emergency power generation.
 - 7) Other systems as applicable.
- b. These diagrams shall be suitable for reduction in size and use in the operating manual system descriptions previously covered.

3.8 OPERATING AND MAINTENANCE TRAINING

- A. The Mechanical Contractor, and appropriate sub-contractors, shall provide comprehensive operating and maintenance instruction on building systems prior to delivery. The instruction shall include classroom instruction deliver by competent instructors based upon the contents of the operating manual. Emphasis shall be placed upon overall systems diagrams and descriptions, and why systems were designed as they were. This overall systems instructions shall preferably be delivered by the consulting engineers. The classroom instructions shall also include detailed equipment instruction by qualified manufacturer representatives for all equipment for which operating instructions are provided. The manufacturer representative training shall emphasize operating instructions, and preventive maintenance as described in the operating manual. At a minimum, the training sessions shall cover the following items:
1. Types of installed systems.
 2. Theory of operation
 - a. Design intent
 - b. Occupied vs. unoccupied or partial occupancy
 - c. Seasonal modes of operation
 - d. Emergency conditions and procedures
 - e. Comfort conditions
 - f. Indoor air quality
 - g. Energy efficiency
 - h. Other issues important to facility operation.
 3. System operations.
 4. Use of control system.
 - a. Sequence of operation
 - b. Problem indicators
 - c. Diagnostics
 - d. Corrective actions
 5. Service, maintenance, diagnostics and repair.
 6. Use of reports and logs.
 7. Troubleshooting, investigation of malfunctions, and determining reasons for the problems.

- B. Each classroom training period shall be followed by an inspection, explanation and demonstration of the system concerned by the instructors. All equipment listed in 3.7 A shall be started up and shut down, with the exception of sprinkler system.
- C. The contractor shall be responsible for organizing, arranging, and delivering manner on a schedule agreeable to the Contracting Officer.
- D. The contractor shall provide, at or before substantial completion, a proposed agenda for each training session and schedule of the above training for approval by the Commissioning Authority and the Contracting Officer.
- E. No training will be scheduled until approved O & M manuals have been submitted.

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SECTION 230900

INSTRUMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide instruments in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Thermometers and Temperature Wells.
- B. Hydronic Pressure Gauges.
- C. Fuel Flow Meters.

1.3 SUBMITTALS

- A. Submit shop drawings of instrument display boards, along with other shop or field fabricated installations.
- B. Submit manufacturer's latest published data for instrument types, materials accessories and installation.
- C. Submit a schedule for each system (air and water) using system name instrument used, and instrument locations. Schematic flow diagrams may be used for this purpose.
- D. Submit a line-by-line statement of compliance or non-compliance with this specification section.
- E. Submit a sample air thermometer, water thermometer, air pressure gauge, water pressure gauge for approval.

1.4 QUALITY ASSURANCE

- A. Instruments are to be factory calibrated for the temperature and pressure of the systems in which they are installed.
- B. Instruments to be industrial quality.

PART 2 - PRODUCTS

2.1 THERMOMETERS AND TEMPERATURE WELLS

- A. Provide duct thermometers of the dial face type, 3½" diameter, liquid-filled with averaging bulb. Accuracy is to be factory calibrated to ±1°F, for the average temperature of the system in which it is installed.
- B. Provide pipe insertion thermometers of the 9" mercury red reading scale, separable socket, adjustable angle with brass stem. Provide the following socket lengths:

Pipe Size	Insertion Length
4" and 5"	2½"
6" and 8"	5"
10" and over	7"

C. Provide thermometers with ranges as follows:

1. Chilled Water Systems: 0-100°F
2. Condenser Water Systems: 0-160°F
3. Hot Water Systems: 30°-240°F

D. Acceptable Manufacturers

1. Trerice
2. Ernst
3. Weksler
4. Ashcroft
5. Taylor
6. Weiss

2.2 PRESSURE GAUGES

A. Provide gauges of the bourdon tube type with minimum 4½" dial and die cast aluminum case with black enamel finish. The movement to be all stainless steel with Grade A phosphor bronze bourdon tube brazed at socket and tip. Provide accuracy of the gauge within ½% of the scale range. The pointer will be the micrometer adjustment type recalibrated from the front.

B. Pressure gauges installed at pumps shall be liquid-filled type.

C. Provide needle-type isolation valves at each pressure gauge.

D. Acceptable Manufacturers

1. Trerice
2. Ernst
3. Weksler
4. Ashcroft
5. Taylor
6. Weiss

2.3 Fuel Flow Meters

A. Provide totalizing fuel oil flow meters so that the actual consumption of fuel oil can be determined.

B. The consumed fuel will be accomplished by subtracting the fuel oil supply valve from the fuel oil return valve.

C. The valves from the fuel oil flow meters should be able to be read at the BMS.

PART 3 - EXECUTION

3.1 Provide pressure gauges at the following locations:

A. Each Fuel Oil Pump.

3.2 Provide Fuel Flow Meters at the following locations:

A. Life Safety fuel oil supply.

B. Life safety fuel oil return.

C. Stand by generator fuel oil supply.

D. Stand by generator fuel oil return.

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SECTION 230923

BUILDING MANAGEMENT AND CONTROL SYSTEM (BMCS)

PART 1 - GENERAL

1.1 GENERAL

- A. The control system for this project shall be an extension of the existing Jacob K. Javits Center Building Management and Control System (BMCS).
- B. The controls contractor for this project shall be an authorized representative of the existing BMCS system manufacturer (Siemens), with authorized access to the existing system.
- C. The contractor shall submit an architectural diagram of the existing system, and highlight the additions to that system as a result of work to be performed under this project. Similarly, where points are brought to an existing DDC panel (if applicable), the entire panel with all connections (new and existing) shall be illustrated. All new wiring to the panel shall be highlighted in a manner to easily show the difference between existing and new work.
- D. New DDC controls provided for this project shall be fully compatible with the existing Jacob K. Javits Convention Center BMCS.
- E. The contractor shall update the existing system graphics and database as required to incorporate the new points added to the system by this work, so that all new points are available at the existing Operator Workstation(s) and via remote access clients.
- F. Provide a new Operator Workstation with all required graphics and software. Location of new Operator Workstation shall be the Control Room in the Transformer Building or as coordinated with the Owner.
- G. Upon approval of shop drawings, and completion of new work and the work on the existing system, the controls contractor shall append the existing O&M Manuals with updated control diagrams, revise all graphics in the system to reflect the additions and changes made to the system, program all alarm limits and alarm messages, and instruct the operating personnel on all additions, changes, and modifications.
- H. The BMCS contractor shall interface and coordinate with other trades on all aspects of the project. The entire process shall be governed by the contract documents.
- I. The BMCS contractor shall fully coordinate his work with the equipment specified and supplied under other specification sections. A review of all equipment schedules located on the contract drawings shall be performed. Coordinate this information with the actual approved equipment cuts/submittals. Provide all additional components which may be required to interface with the equipment as called for in this specification. The BMCS contractor shall detail, layout, and provide all components required for the BMCS criteria for each piece of equipment. The contractor must pay particularly close attention to areas which call for direct network integration, through the utilization of standard protocols, to devices furnished under other specification sections.
- J. The BMCS shall be DDC with electric actuation as specified herein
- K. The entire system shall be BACnet BTL Listed.

- L. The BMCS contractor shall extend 120 VAC emergency power to all BMCS equipment and devices supplied by the contractor except where specifically called for otherwise, including control panels, data gathering panels, , thermostats, etc. The BMCS contractor shall also provide all data cabling, conduit risers, and all layout work as required for the installation of his system. Provide sleeves for the fire-stopping at all cores, walls, and slabs, in the sequence in accordance with the project schedule and contract documents. All controlling and signal power (e.g. 4-20 mA control and status feedback wiring) shall be installed by this contractor.
- M. Miscellaneous wiring required for control devices and equipment provided by others shall be provided by the contractor furnishing the equipment.
- N. Provide all miscellaneous field device mounting and interconnecting wiring for all mechanical systems including fuel oil system, emergency generators, AC units, condensing units, VFD, unit heaters, electric heaters.
- O. All systems requiring interlock wiring shall be hardwired interlocked and shall not rely on the BMCS to operate (e.g. emergency generator to fuel oil pump interlock, emergency generator damper interlock, etc.) Interlock wiring shall be run in separate conduits from BMCS associated wiring.
- P. Provide open communications system. The system shall be an open architecture with the capabilities to support a multi-vendor environment. To accomplish this effectively, system shall be capable of utilizing standard protocols as follows as well as be able to integrate third-party systems via existing vendor protocols.
 - 1. The BMCS shall utilize high speed Ethernet communication using BACnet over IP protocol at the Management Level and Automation Level networks.
 - 2. System shall be capable of BACnet communication according to ANSI/ASHRAE 135-2012.
 - 3. System shall be capable of OPC server communications according to OPC Data Access 2.0 and Alarms and Events 1.0.
 - 4. System shall be capable of using the LonTalk and Modbus protocols.
 - 5. The system shall be also capable of supporting a range of vendor specific protocols to enable interoperability between a variety of existing and future third-party devices and legacy systems.
 - 6. System shall be capable of communication SNMP, SOAP, XML, and Web Services.
- Q. When conflicts occur in the specifications or on the drawings, or between either, the items of greater quantity or higher cost shall be provided.
- R. The contractor shall provide all items of labor or materials not specifically indicated, but required to complete the intended installation.
- S. This contractor shall be responsible for the completion and final acceptance of this work, and shall replace any of the same which may be damaged, lost or stolen, without additional costs to the owner/tenant.
- T. Provide all necessary permits, applications, filings and associated fees which may be required to perform the work called for in this specification.

1.2 WORK INCLUDED

- A. The work under this Section of the specifications includes all labor, materials, wiring, equipment and services to provide fully operational BMCS in strict accordance with these specifications and the Contract Drawings and subject to the terms and conditions of the Contract. The work in general consists of, but is not limited to, the following:
1. BMCS integration of the new Transformer Building BMCS with the existing Javits BMCS located in the Existing Javits Building.
 2. Extension of the existing Jacob Javits dedicated BMCS communications network to the new Transformer Building DDC controls as specified. This includes but is not limited to required cabling, network switches, repeaters, gateways, and electric isolation for processors and protection from electrical interference.
 3. One (1) Operators Work Station (OWS) consisting of a personal computer (CPU), 24" flat panel LCD monitor and printer. The (1) BMCS work station to be located in the Level 53'-6" Control Room. Provide one portable operator's terminal.
 4. BACnet BTL Listed Building Controllers, communicating BACnet/IP in a peer-to-peer fashion for all major HVAC equipment..
 5. Complete electrical installation including wiring, conduit, raceways and power wiring, except as noted.
 6. Software:
 - a. All software licenses, original installation disks, manuals, service packs, etc., utilized to install, configure and operate systems.
 - b. All programming routines, configuration files, utilities, etc. created specifically for the project. These include controller software & configuration utilities to implement the sequence of operations, GUI graphical screens, VB scripts, XML scripts, etc. Any compiled controller software resident in field controllers shall be supplied in its un-compiled format for future utilization by the owner.
 - c. System backups on CD to facilitate partial or full project software restoration.
 - d. Include licensing required for a system expansion of a minimum of 2500 points.
 7. BMCS equipment or platform capable of providing industry standard open protocol communication (BACnet, LonTalk, Modbus, OPC, SOAP, SNMP, XML) capability to other building systems.
 8. Full documentation for all software and equipment provided.
 9. Project management for managing system installation including, but not limited to:
 - a. Design installation, equipment delivery, coordination with other trades, labor management, commissioning and acceptance testing.
 - b. Provide manpower as necessary for assisting in the testing and commissioning of the following systems (as related to the BMCS):
 - 1) Fire Alarm System
 - 2) HVAC Systems (Air Conditioning Systems, Fans, pumps, motors, etc.)
 - 3) Smoke purge system.
 - 4)
 10. Miscellaneous work as indicated in these specifications and the contract drawings.
 11. Miscellaneous wiring as specified herein. All wiring associated with the installation of the BMCS and associated systems/equipment provided under this project's scope of work including but not limited to the following:
 - a. BMCS power, communication and control devices including actuators and sensors.
 - b. Data cables to remote buildings, DDCPs, etc.

- c. Smoke control system from fire alarm contacts or via standard communication protocol provided by the fire alarm system contractor to the DDCPs as required affecting the smoke control sequences.
 - d. Smoke Dampers and smoke damper end switches for HVAC system interlocks provided by Division 23 contractor. Fire Smoke Damper end switches for HVAC system interlocks provided by Division 23 contractor. Smoke damper and Fire Smoke damper actuator wiring by Division 26.
 - e. As a general rule, with the exception of the items above, if a device is furnished under this section, this section to provide all wiring and required conduit, rough in, etc. as required for installation of the device.
- 12. Complete operating and maintenance manuals and field training of operators and maintenance personnel.
 - 13. System commissioning and acceptance tests as specified.
 - 14. Provide service kit.
 - 15. Provide spare parts as noted in this specification.

1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Installation of the following items furnished under this Section but installed under Division 23 Mechanical.
 - 1. Automatic Control Valves
 - 2. Automatic Control Dampers
 - 3. Thermowells
 - 4. Temperature Sensor Wells and Sockets
 - 5. Air Flow Measuring Stations
 - 6. Liquid Flow Sensor Transmitters
 - 7. BTU Meters
 - 8. Liquid Flow Switches
 - 9. Refrigerant Pressure Sensors
 - 10. Factory Mounted DDC Controls and sensors.
- B. Designated circuit breakers shall be furnished by the Electrical Contractor in the distribution panelboards for BMCS power. BMCS contractor shall coordinate all requirements with the Division 26 contractor.
- C.).
- D. Supervise and coordinate the installation of equipment, instruments and materials furnished under this Section but installed under other Divisions of the specifications. All equipment and instruments shall be installed in strict accordance with the manufacturer's published installation instructions.

1.4 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Packaged AC unit wall thermostats, local panels
- B. Accessories of other packaged systems as listed under the Sequence of Operation section

1.5 PRODUCTS INTEGRATED TO BUT NOT FURNISHED OR INSTALLED UNDER THIS SECTION

- A. Variable Frequency Drives
- B. Fire Alarm System

- C. Emergency Generator
- D. Fuel Oil System
- E. ATS switches
- F. Packaged AC units and RTUs
- G. Electrical Power Monitoring System
- H. UPS (Uninterruptible Power Supplies)

1.6 RELATED SECTIONS

- A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are part of this specification and shall be used in conjunction with this section as part of the contract documents.
- B. The following sections constitute related work:
 - 1. 23 00 02 HVAC Special Conditions
 - 2. 13 00 03 Scope of Work
 - 3. 23 33 13 Dampers
 - 4. 23 62 10 Air Cooled AC Units
 - 5. 23 62 20 Rooftop Package Heating & Cooling Units
 - 6. 23 84 40 Space Heating Units
 - 7. 23 85 00 Variable Frequency Controllers

1.7 SYSTEM DESCRIPTION

- A. System Configuration
 - 1. The Building Management and Control System (BMCS) to perform both monitoring and control of HVAC and electrical equipment for building management, energy conservation, and environmental control.
 - 2. The BMCS control philosophy to be direct digital control and be implemented by a distributed direct digital control system.
 - 3. Both Central Processing Units (CPU) at the OWS to provide for central point of overall building data acquisition and transfer, report and alarm generation, historical data storage and retrieval, and operator interface. Both Operators Work Stations shall allow authorized access to the BMCS from a remote point specified elsewhere in this specification.
 - 4. The CPU and DDCPs to communicate through dedicated Ethernet communications network in a peer-to-peer fashion. All communications on network shall be by digital signals only. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. The failure of any single component or network connection shall not interrupt the execution of any control strategy, reporting, alarming and trending function, or any function at any operator interface device.
 - 5. Communication networks shall be designed by the BMCS contractor and fully comply with the manufacturers network topology guidelines.
 - 6. The Direct Digital Control and Processing Units (DDCP) to perform remote data acquisition and process control. DDCPs shall be locally mounted completely self-contained, field programmable, real-time microprocessor based controllers capable of standalone operation. The DDCP Controllers shall be able to access any data from, or

send control commands and alarm reports directly to, any other DDCP Controller or combination of controllers on the network without dependence upon a central or intermediate processing device.

7. Each DDCP to be connected to its particular controlled environment through field I/O instrumentation.

B. Design and Performance Criteria

1. Expansion Capability:

- a. The system to have an ultimate capacity and include licensing for not less than 2500 additional points with no hardware changes except addition of DDCPs and communications networks.
- b. System shall be modular in design, to allow change of function and operation in the field by plug-in module equipment and software change to expand system capacity while maintaining full on-line operation.

2. Response Time:

- a. Time between occurrence of alarm, status change or change of value and its processing, display or printout shall not exceed 10 seconds irrespective of other system activities.
- b. Time between an operators command and the associated system output shall not exceed the following times irrespective of other system activities.

Point Command (Start Stop, Setpoint, etc.)	5 seconds
Log Request	10 seconds
Graphics Request	10 seconds
Program or Database Modification	60 seconds

3. Provide stable control of all connected systems with a closed loop control accuracy not to exceed:

- a. Space Temperature: ± 2 Degrees
- b. Duct Temperature ± 1.5 Degrees
- c. Humidity: ± 5 percent
- d. Fluid Pressure: ± 1.5 PSI (0 to 150 PSI Range)
- e. Air Pressure: ± 0.2 " wg (0 to 6" span)
- f. Flow: ± 1 percent of sensor span

4. Environmental Conditions:

- a. The DDCPs, Field Equipment Panels, and other equipment shall operate under ambient environmental conditions of 32° to 122°F dry bulb and less than 93% relative humidity, noncondensing as a minimum. Sensors and control elements shall operate under the ambient environmental temperature, pressure, humidity, and vibration conditions encountered for the installed location. For locations requiring the use of a DDCP mounted in the controlled equipment, such as a rooftop unit, an extended temperature range unit shall be used capable of operating from -40° to 158°F and less than 93% relative humidity, noncondensing as a minimum.
- b. Other equipment, such as CPU, monitors and printers, shall, unless designated otherwise, operate properly under ambient environmental conditions of 50° to 95°F and a relative humidity of 10% to 95%.

5. Materials and Equipment:

- a. Where multiple units of the same type are required, the units to be products of a single manufacturer. However, the component parts of the system need not be

- the products of a single manufacturer. The components shall not require customizing other than setting jumpers and switches and adding firmware. Each major component of equipment shall be labeled with the manufacturer's name, address, model and serial number.
- b. All systems and components shall have been thoroughly tested and proven in actual use.
- 6. Total system shall be immune to internal and external generated sources of electrical noise.
 - 7. The system to be "Web-enabled" so that the system can be accessed through the internet provided the appropriate security protocols are met. When the BMCS is placed "On Line", WSP shall be given (read only) access to the system via the internet.

1.8 SUBMITTALS

A. General

- 1. Indicate at the beginning of each submittal, known substitutions and deviations from requirements of Contract Documents. Provide a marked up specification with "Comply" or "Don't Comply" next to each paragraph. If "Don't Comply" is noted, state how that requirement will be met.

B. Product Data

- 1. Technical bulletins and catalog data for all equipment and system components. Clearly identify, by use of symbol or tag number, the service of each item. All irrelevant information shall be marked out leaving only pertinent data. Number all pages of the data sheet section and provide a table of contents.

C. Shop Drawings

- 1. Shop drawing submittals to include sufficient data to indicate complete compliance with Contract Documents. Submissions in form of drawings, brochures, bulletins, catalog data, and/or narrative descriptions. As a minimum requirement submit:
 - a. Symbol and abbreviation lists including standard installation details.
 - b. System block diagram showing quantity and location of Operator's Work Station (OWS), Remote Operator's Workstation (ROWS) printers and all Work Station Equipment, DDCPs, Field Equipment Panels, physical communication cable routing between system components, sources for all power to each device (other than final control devices) and coordinated location of all major system components.
 - c. Network riser and communication map indicating all network resident devices (OWS, ROWS, DDCP controllers, intelligent sensors & actuators, routers, repeaters, gateways, connectivity to packaged systems, etc. If the project scope of work includes the expansion of an existing system, the existing components shall be shown on the riser diagram as well. The existing components to be detailed in light gray, dotted or some other fashion to delineate that the components are existing.
 - d. A network map clearly depicting the actual routing of all network wiring and location of all network resident devices.
 - e. Control diagrams for all systems controlled, including panel layouts and internal wiring details. Controls shall be shown on system flow diagrams, with sources of power for each device. Include a coordinated circuit summary showing the electrical panel supplying power, the breaker number and breaker size. Arrange all sub systems on the same set or series of drawings. Include associated wiring diagrams, bills of material, and DDC panel wiring and mounting details in the

- same section. It is the intent of this requirement that it is not necessary to page through the submittal to locate associated sub systems.
- f. Instrument air supply system: Distribution riser diagram, compressor and tank sizing calculations, run time calculations (design for 1/3) dryer and filtering station installation diagram.
 - g. Interfaces (software and hardware) with equipment provided in other sections of specifications. Show connection details based upon the approved submittals of the equipment being interfaced with. Comments such as "information to be completed with As Built Documentation" will not be acceptable.
 - h. Narrative description of operation for each system, enumerating and describing the function of each component. Include alarm and emergency sequences, and equipment interlocks.
 - i. Description of manual override capabilities.
 - j. Complete input output point schedule. Identify point function, type and location.
 - k. Spare capacity provisions.
 - l. Detailed bill of materials.
 - m. Valve and Damper Schedule: Provide identification numbers, location, system, dimensions and performance data. Damper schedule shall be based upon approved sheet metal shop drawings. Schedule shall show damper leakage rates. Valve sizing shall be based on approved equipment cut sheets and approved piping shop drawings.
 - n. Device mounting details. Include as a minimum:
 - 1) Sensing elements in ducts or casings.
 - 2) Sensing elements in piping.
 - 3) Freezestats mounted in factory assembled Air Handling Units
 - o. Ladder wiring diagrams.
 - 1) All panel to field wiring shall be illustrated in ladder wiring diagrams, especially from the field terminals to the panel terminals. Spreadsheets or details that have to be assembled to determine circuitry will not be accepted under any circumstances.
 - p. Data maps for network integrated components, indicating parameters and data being shared amongst systems.
 - q. Other information as requested herein.
2. Complete full size drawings, 11 in. x 17 in. minimum. Each system shall be submitted separately. Do not submit "typical" system as one drawing unless the systems depicted are identical with the exception of DDCP point addresses. In such cases, provide a schedule on the drawing with rows and columns for each device in each system detailing part numbers, point addresses, etc.

D. Programming

- 1. Point identification code.
- 2. System advisory messages, printouts, logging formats.
- 3. Drawings of system graphics showing monitored points.
- 4. Software flow charts for application and DDCP programs.
- 5. Person machine interface program, include commands, alarm annunciation, logs and programming capabilities.
- 6. Listing of all alarm messages (with their text) to be programmed for each alarm specified. Messages shall require system operator's or owner's representative's approval.
- 7. Description of system operation under failure conditions, including restart sequences and hierarchy for all systems.

E. Samples

1. Provide samples of the following wall mounted devices
 - a. Thermostats,
 - b. Temperature sensors,
 - c. Humidistats
 - d. Humidity sensors.
2. All devices mounted on finished surfaces.

F. Quality Control Submittals

1. U.L., New York City MEA/OTCR, FM, CSA listing compliance certificates.
2. Final calibration, commissioning and testing reports.

1.9 OWNER'S MANUALS

A. General

1. Submit 2 draft copies of owner's manuals for review. After review by authorized representative, the contractor shall incorporate review comments and submit 6 final paper copies and a set of manuals on DVD/CD.
2. Update manuals with modifications made to system during guarantee period. Provide replacement pages or supplements in quantity stated above.
3. Assemble owner's manuals into multi-volume sets as necessary and required by the Owner.
4. Protect each volume with a heavy-duty vinyl plastic binder. Volumes to have plastic printed dividers between major sections and have oversized binders to accommodate up to ½ inch thick set of additional information.
5. Each binder to be printed with project name and volume title on front cover and binder.
6. On the first page of each manual identify with project name, manual title, owner's name, engineer's name, contractor's name, address and service phone number, and person who prepared manual.

B. Operating manual to serve as training and reference manual for all aspects of day-to-day operation of the system. As a minimum include the following:

1. Control flow diagrams.
2. Sequence of operation for automatic and manual operating modes. The sequences shall cross-reference the system point names.
3. Description of manual override operation of control points.
4. System manufacturers complete operating manuals.

C. Provide maintenance manual to serve as training and reference manual for all aspects of day-to-day maintenance and major system repairs. As a minimum include the following:

1. Complete as-built installation drawings for each system.
2. Overall system electrical power supply scheme indicating "as-built" source of electrical power for each system component. Indicate which components are on emergency power and indicate all battery backup provisions.
3. Overall system shielding and grounding scheme indicating all major components and ground paths.
4. Photographs and drawings showing installation details and locations of equipment.
5. Charts showing normal operating conditions at significant points such as electrical test points.

6. Routine preventive maintenance procedures, corrective diagnostic troubleshooting procedures, and calibration procedures.
 7. Parts lists with manufacturer's catalog numbers and ordering information.
 8. Lists of ordinary and special tools, operating materials supplies and test equipment recommended for operation and servicing.
 9. Manufacturer's operating set up, maintenance and catalog literature for each piece of equipment.
 10. Maintenance and repair instructions.
 11. Recommended spare parts.
 12. Field test reports.
- D. Provide Programming Manual to serve as training and reference manual for all aspects of system programming. As a minimum include the following:
1. Complete programming manuals, and reference guides.
 2. Details of any special software packages and compilers supplied with system.
 3. Information required for independent programming of system.
 4. Documentation on application and DDCCP programs: Flow charts, equations, and parameters.
 5. Point schedule; include all points, real and virtual.
 6. Software troubleshooting procedures.

1.10 QUALITY ASSURANCE

- A. Contractor shall meet the following qualifications:
1. Have a minimum of 10 years of demonstrated technical expertise and experience in the installation and maintenance of Direct Digital Control Systems similar in size and complexity to this Project. Contractor shall be ISO 9001 certified (unless waived).
 2. The BMCS system shall be designed and installed, commissioned and serviced by factory trained personnel.
 3. Have maintained a service organization consisting of at least three competent servicemen, within 50 miles of this project, for a period of not less than three years.
- B. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.
- C. The Contractor shall provide an experienced Project Manager for this work, responsible for direct supervision of installation and startup of the system. Provide resume of designated project staff at the time of bid.
- D. Comply with all current governing codes, ordinances and regulations, as well as with requirements of NFPA, UL, MEA/OTCR and all other applicable codes.
- E. Due to the nature of rapid change in manufacturer specifications and BMCS software operating system requirements, submit at the time of bid and the time of engineering, a detailed BMCS system hardware and software specification conformance statement sheet clearly indicating deviations from the specification. Nonconformance with this requirement may result in the disqualifying of the bidder's offering.

1.11 WORK PERFORMANCE SCHEDULE

- A. A time-phased schedule for delivery, installation, and acceptance of components for the complete system shall be prepared in accordance with the requirements of the General Contractor or Construction Manager. Submit this schedule to the General Contractor or

Construction Manager or Owner within thirty (30) days after award of contract. Submit updates and changes to this schedule promptly to the Owner.

1.12 WARRANTY

- A. The Contractor shall warranty the BMCS to be free from defects in workmanship and material for a period of one (1) year from the date of final acceptance by the Owner. During this period, the Contractor shall furnish all labor to repair or replace all items or components, which fail due to defects in workmanship or material. Failures on control systems that include all computer equipment, transmission equipment and all sensors and control devices during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
- B. The Contractor shall also provide necessary preventive maintenance on the CPU and operator consoles during the warranty period. Provide updates to operator workstation software, project-specific software, graphic software, database software, and firmware that resolve Contractor identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with the above-mentioned items. Do not install updates or upgrades without Owner's written authorization.
- C. The BMCS contractor shall respond to service calls within four hours of the call either in person or through the dial up capabilities of the system. If the problem cannot be rectified on line, a physical presence shall be made within 8 hours of the initial call.
- D. The contractor shall update O&M manuals and system software backups to reflect any corrective measures taken during the warranty period, which impact the hardware, software or system configuration.

1.13 OWNERSHIP OF PROPRIETARY MATERIAL

- A. Project specific software and documentation shall become Owner's property. This includes, but not limited to:
 - 1. Graphics
 - 2. Record drawings (Linked to system as-builts)
 - 3. Database
 - 4. Application programming code
 - 5. Programming Tools
 - 6. Graphics modification tools
 - 7. Database editing tools

1.14 MAINTENANCE

- A. Submit an alternate price to perform complete preventative and emergency maintenance of the BMCS for a period of one (1) year beyond the warranty period, in accordance with the Subcontractor's recommended standards and schedule. This price shall be itemized to show material costs and labor costs. This price shall be based upon work being executed during normal working hours but shall include separate emergency callout provisions. Prices submitted should be based upon current price lists and labor rates, details of which shall be included with the bid and should be broken out into three categories:
 - 1. Computer hardware and associated equipment.
 - 2. Field equipment including DDCPs, sensors and final control elements.
 - 3. Software.

- B. The preventative maintenance contract may be renewed annually, at the option of the Owner, up to a total term of 10 years. The annual price shall be negotiated 3 months in advance of annual contract expiry and shall be at the mutual agreement of both parties. Variation in annual prices shall reflect only changes in material and labor costs as substantiated by Federal Guideline Consumer Price Indexes.

PART 2 - PRODUCTS

2.1 OPERATOR WORKSTATION (OWS)

- A. Provide one (1) operator workstation console as the interface for the day-to-day operation including command entry, information management, alarm management, reporting, and interface with the system servers.
- B. Provide a personal computer with hardware and software specifications that are recommended by the BMCS manufacturer for optimal system performance. Final approval of OWS shall be determined by the Owner and Engineer prior to installation. Minimum requirements shall be as follows: 16 GB RAM, hard drive of 320 GB available space, with a video card with 256 MB RAM capable of supporting a minimum of 1920 x 1080 resolution with a minimum of 32 Bit color, DVD-RW Drive, mouse and 101-key enhanced keyboard. OWS shall be a Windows 7 64-bit (or later), and shall include a dual core processor or better.
- C. Provide a wide screen, active matrix LCD, flat panel type monitor that supports a minimum display resolution of no less than 1920 x 1080 pixels, Energy Star compliant 32-bit color. The display shall have a minimum of 24-inch visible area in diagonal measurement. Separate controls shall be provided for color, contrasts and brightness. The screen shall be non-reflective.
- D. Provide a full color, high speed, high resolution, and energy efficient printer with high speed USB and built in Fast Ethernet connectivity. System printer shall be Hewlett Packard LaserJet or equivalent. The printer model/version shall be the most up to date available at the time of submission. Provide a set of replacement cartridges at the time of final acceptance.
- E. Locate the OWS consoles in a clean, secure, dry and temperature controlled environment. OWS consoles shall be located as indicated on the contract documents or as coordinated with the Owner.
- F. The Operator Workstations shall reside on the same BACnet/IP protocol network as the System Controllers.
- G. Provide software licenses for interfacing to the BMCS. Load software, configure and setup for viewing the BMCS system.
- H. Provide all necessary mounting hardware and cables for all components.
- I. Provide integrated sound card and speakers for the annunciation of audible alarms or pre-recorded messages.
- J. All BMCS operator workstations shall have , at minimum, the following functionality: Graphics editing, Graphics generation, Program editing, Program generation, Point database editing, Point database generation, System backup, Trend editing, Trend retrieval, Alarm editing, Alarm retrieval.

2.2 PORTABLE LOCAL OPERATOR'S TERMINAL (LOT)

- A. Provide a local operator's terminals (LOT) to allow local programming, control and monitoring at each DDCP. LOT shall be a fully configured laptop computer. Operating system shall be the same as provided with the Operator's Work Station.
- B. Provide a laptop computer with the following minimum performance requirements: Intel ® Core™ i5 or comparable, 8GB of RAM, DVD-RW Drive, 238 GB hard disk drive, 10/100/1000 Network Card, Minimum display resolution of 1920 × 1080 pixels, Built-in WiFi and Bluetooth®, carrying case, power supply and cables.
- C. Provide software licenses for interfacing to the BMCS. Load software, configure and setup for viewing the BMCS system.

2.3 ACCESSORY SOFTWARE

- A. Provide up to date versions of the software as described below for all Client installed consoles. Software shall include original discs, CDs, manuals and site and/or individual licenses.
- B. Provide, at minimum, the following: Operating System Software, Antivirus Software, Microsoft Office Professional including Word and Excel, Internet Explorer or equal browser, Acrobat PDF Reader, CAD Viewer, PC Anywhere or terminal services, Peripheral software as required for printer, graphics generation, system backup, recovery, and restore, etc.
- C. Set up an icon on the desktop to take the User directly to the BMCS system login page.

2.4 PRIMARY ETHERNET NETWORKING

- A. Fiber Optic Networking (DDCP and PC Network)
 - 1. Fiber optic cable (data transmission) shall meet, at minimum, the following requirements:
 - 2. 50 micron core (multi-mode/single mode fiber as necessary to match the fiber provided by the IT Contractor).
 - 3. 850 nm or 1300 nm LED compatible operation, as required.
 - 4. A Minimum 125 micron cladding.
 - 5. A Maximum attenuation of 4.5 db/km (850 nm).
 - 6. Outdoor and below grade Fibers shall be run in a gel-filled tube to protect against moisture and micro-bending. Tube and Fiber shall have a Kevlar braid surrounding, with suitable outside protective jacketing.
 - 7. Cable shall contain 100% more Fibers than required for a single point-to-point communication connection.
 - 8. Outdoor Fiber shall be equipped with a central non-conducting member for long pull applications.
 - 9. Fiber optic cable shall comply with ANSI/TIA/EIA-862 (Building Automation Systems Cabling Standard for Commercial Buildings) and all other applicable codes.
 - 10. Fiber Optic cable shall be run in conduit.
- B. Ethernet Networking (DDCP and PC Network)
 - 1. Provide Category 6 (CAT-6) Ethernet cable between Network Service Panels (NSP) and all Building Controllers responsible for AHU, chilled and hot water systems.
 - 2. Ethernet cable shall be run in conduit.
- C. Network Service Panel (Fiber and Ethernet Switch Housings)

1. Network Service Panels shall be provided by the BMCS contractor in each as required throughout each building to route fiber optic network between buildings or within buildings with network runs exceeding 300 feet. Route Ethernet CAT-6 cable directly to all Building Controllers from each NSP
 2. Communications between fiber panel and BMCS Building Controllers, mounted at each HVAC unit, are provided by 100-Base-TX Cat-6 Ethernet connections.
 3. Communications between each PC (Server/Clients) and the fiber ring are provided by 1000-Base-TX Cat 5e Ethernet connections
 4. UPS shall be contained within each Network Service panel
 5. Fiber/Ethernet Switch:
 - a. Ethernet switches shall be managed industrial class switches equal to Ethernet Direct.
 - b. Switches shall be provided with management capabilities including but not limited to: web browser, Telnet, SNMP
 - c. Ethernet switches shall be powered by local din-rail mounted DC power supplied contained within the Network service panel.
 - d. Provide Network Service Panels as located on system riser diagram. Network Services Panel (NSP) shall house the fiber switch and interface from Cat-6 Ethernet network to the redundant fiber ring. Network services panel shall be Siemens CP-567 with key lock.
 - e. Each NSP shall contain its own DC power inverter. A service switch and duplex receptacle shall be provided in each panel.
 - f. Each NSP shall contain a SIECOR fiber optic patch panel.
 - g. Each Ethernet switch required for each Ethernet drop (1 per HVAC equipment) shall be housed in the NSP
- D. RS-485 Networking (ASC and AASC Network)
1. RS-485 networks shall be limited to daisy chaining BACnet Application Specific Controllers and BACnet Advanced Application Controllers.
 2. RS-485 network shall extend from Building Controller to ASC and AAC controllers

2.5 SYSTEMS INTEGRATION

2.6 INTEGRATION BETWEEN SUB-SYSTEMS

- A. General: The BMCS is responsible for integration to all devices described within this section. The BMCS shall provide integration protocols of the type, quantity, redundancy, architecture as described in this section. Deviations are not acceptable. The BMCS contractor shall provide network wiring as described within this section.
- B. VFDs (Variable Frequency Drives)
1. Communication Medium: RS-485 Twisted Shielded Pair
 2. Required Architecture: VFD's shall be daisy-chained to an Ethernet based Building Controller. Up to 32 VFDs may be daisy chained on the same RS-485 network.
 3. Communication Protocol: BACnet MSTP of successful BMCS contractor's system protocol (N2 JCI, P2 Siemens, etc.)
 4. Wiring Responsibilities: BMCS manufacturer shall provide and install communication wiring, in conduit, between each VFD and BMCS panel.
 5. Points Monitored via integration:
 - a. Drive Status, Drive Speed, Drive KW, Drive KWH, Voltage, Amps, Common Fault Alarm, VFD in Bypass ,Temperature, 15 additional points mapped to the BMCS
 6. Hardwired Points:

a. Safety shutdown, Start/Stop, Speed Control Output.

C. ATSS (Automatic Transfer Switches)

1. Communication Medium: RS-485 Twisted Shielded Pair
2. Required Architecture: Provide Modbus RTU network to sitelink panels. No more than 6 Sitelink panels per BMCS Modbus Processor.
3. Communication Protocol: Modbus RTU over RS-485.
4. Wiring responsibilities: BMCS manufacturer shall mount and power all Sitelink panels. BMCS manufacturer shall run required Modbus RTU networks to Sitelink panels. BMCS manufacturer shall run Sitelink communication bus between Sitelink panels and STSS.
5. Points Monitored via integration:
6. Hardwired Points:

D. UPS

1. Communication Medium: RS-485 Twisted Shielded Pair
2. Required Architecture: Provide Modbus RTU network to sitelink panels. No more than 6 Sitelink panels per BMCS Modbus Processor. Provide UPS Phase A1, A2, B1, B2, C1, C2 integration and hardwired points on a single BMCS processor (PXC). Provide UPS Phase D1, D2, E1, E2, R1, and R2 on a second BMCS processor (PXC).
3. Communication Protocols: Modbus RTU over RS-485.
4. Wiring responsibilities: BMCS manufacturer shall mount and power all Sitelink panels. BMCS manufacturer shall run required Modbus RTU networks to Sitelink panels. BMCS manufacturer shall run Sitelink communication bus between Sitelink panels and UPS phases

E. PQM (Power Quality Monitoring System)

1. Communication Medium: RS-485 Twisted Shielded Pair
2. Required Architecture: Communicate Modbus TCP/IP to PQM System.
3. Communication Protocols: Modbus TCP over IP.
4. Wiring Responsibilities: BMCS shall install Cat-6 Wiring to PQM system
5. Points Monitored via integration:
6. Hardwired Points:

F. Generators

1. Communication Medium: RS-485 Twisted Shielded Pair
2. Required Architecture: Daisy chained RS-485 Twisted Shielded Pair.
3. Communication Protocols: Modbus RTU over RS-485.
4. Wiring Responsibilities: BMCS shall provide and install RS-485 wiring to Generator Panels
5. Points Monitored via integration:
6. Hardwired Points:

G. Fuel Oil System

1. Communication Medium: RS-485 Twisted Shielded Pair
2. Required Architecture: Daisy chained RS-485 Twisted Shielded Pair. Modbus must be a slave device as PLC system acts as Modbus Master to perform control functions. System must be proven not to interfere with PLC operations.
3. Communication Protocols: Modbus RTU over RS-485.
4. Wiring Responsibilities: BMCS shall provide and install RS-485 wiring to Fuel Oil System PLC's. Wiring between all PLC's is to be provided by BMCS. Miscellaneous low voltage wiring and interlock wiring is by BMCS.

5. Points Monitored via integration:
6. Hardwired Points:

2.7 DISTRIBUTED DIGITAL CONTROL PROCESSING UNITS

- A. GENERAL – Distributed Direct Processing Units shall provide functional capabilities as detailed herein. Alternate methods to facilitate the functionality of the DDCPs may be acceptable. Alternate methods must satisfy intent of this specification and deviations must be clearly indicated in engineering submittal.
- B. Distributed Digital Control Panels (DDCPs) shall speak peer-to-peer directly on the Ethernet network without the use of interposing routers or gateways.
- C. Cat 5e or 6 cable shall homerun to each Building Controller on the Automation Layer such that communication between major HVAC equipment and the BACnet AWS (Server) shall be direct without any single point of failure.
- D. The DDCP shall be Ethernet based BTL Listed Building Controllers (B-BC) with On-Board BBMD (BACnet Broadcast Messaging Device) capability. All BC's shall be provided with IP addresses.
- E. A BACnet/IP Building Controller (B-BC) with on board BBMD capability shall be provided for each
 1. AHU
 2. Chilled Water System
 3. Heating Plant
 4. Exhaust Fan Set
 5. Pump Sets
- F. Communications: Minimum speed 10/100 Mbps peer to peer.
- G. Control panels shall support as a minimum the following protocols on the Automation Level:
 1. BACnet/IP
 2. Modbus TCP
 3. SNMP
 4. HTML.
- H. Control panels shall include communication ports for the following Field Level protocols:
 1. BACnet MS/TP
 2. Modbus RTU
 3. LON
- I. DDCP application programs shall be resident in the DDCP at all times in Erasable Programmable Read Only Memory (EPROM) or in random access memory (RAM), IMB minimum and include a 100 hour minimum battery backup for data base. Database changes made at the OWS shall be downloaded from the OWS to any DDCPs. Likewise, database changes made at the DDCP shall be uploaded to the OWS. Once downloaded, a DDCP shall not require further communication with the OWS except for database changes, OWS commands, and requests from the OWS for DDCP detected changes of state. Panels using battery backed RAM for programming and database storage shall also have the capability to commit this information to EPROM / Flash ROM.

- J. The DDCP shall be microprocessor based with a minimum word size of 32 bits. They shall also be multi-tasking, multi-user, real time digital control processors consisting of modular hardware, communication controllers, power supplies and input/output point modules. Each DDCP shall have sufficient memory, a minimum of 16 megabytes, to support its own operating system and databases. The DDCP shall include one or more central processors as required for application processing and for communication processing. The DDCP shall have its database and program stored in its RAM, which shall include battery backup (minimum of 100 hours).
- K. Provide a minimum of 8MB EPROM and 16MB RAM dedicated to the master processor or a single processor as described above.
- L. Provide a master calendar/clock to be used by the system processor. The clock shall provide time to the second with a minimum resolution of 1 millisecond. All processors shall operate on the same clock frequency. DDCP panels shall have their clocks synchronized to the BMCS server at least once per day.
- M. Enclosures shall be rigidly secured to a wall or floor, as appropriate, allowing sufficient ventilation space at the back, sides or top as required. All components shall be totally accessible through the front door without the need to remove adjacent components, wiring or piping. All wiring shall enter the cabinets from the bottom or side with bushings. No openings shall be allowed in the top of the cabinet unless sealed water tight. All DDCP enclosures shall have cylinder locks all keyed alike.
- N. DDCPs and all associated components shall be suitable for operation in environmental conditions between 32°F and 122°F and less than 93% relative humidity non-condensing. Where internal air circulation fans are required for reliable operation, they shall be installed.
- O. All electronics in the DDCPs shall be constructed with modular based I/O modules or as specified below. The DDCPs shall be capable of, as a minimum, the following I/O functions:
 - 1. Point Modules: Multiple point modules using a maximum of 16-point multiples for digital inputs and outputs, analog inputs and outputs, and accumulator inputs shall be provided. These modules shall be able to be added to via expansion panels to provide a maximum of 500 direct connection points in a single DDCP. The modules shall be mounted in a pre-wired chassis for convenient mounting. Modules may utilize DIN rail mounting.
 - 2. Digital Inputs: All digital inputs shall be optically isolated and shall detect switch contact position. Digital excitation power shall be provided by the DDCP, separate and isolated from all other DDCP power and from earth ground. With the removal of a digital input module all field wiring for that card shall be disconnected from all DDCP circuitry including excitation power.
 - 3. Digital Outputs: Digital outputs shall operate at 24V dc. All output points shall be relay-isolated through interposing relays. Output points shall be selected by board jumpers or switches to be latched or pulsed. The DDCP shall have space within the high voltage enclosure (Field Equipment Panel) for a minimum of 56 interposing relays (if required) driven by the digital outputs. Each relay shall provide a form C contact rated at a minimum of 10 amps at 120V ac. Provide an LED indicator on each interposing relay provided and/or output point for indication as to the state of the relay and/or output. Power for driving the relays shall be provided by the DDCP and shall be isolated from earth ground. With the removal of a digital output module all power to the relays associated with that card from the DDCP shall be disconnected.
 - 4. Analog Inputs: The DDCP shall accommodate the following sensor inputs.

Sensor Type

10K Thermistor – Type II Curve	
100K Thermistor – Type II Curve	
100 ohm platinum RTD	20° to 100°F
100 ohm platinum RTD	-40° to 125°F
100 ohm platinum RTD	32° to 250°F
1000 ohm platinum RTD	20° to 100°F
1000 ohm platinum RTD	-40° to 125°F
1000 ohm platinum RTD	32° to 250°F
1000 ohm nickel RTD	
0-200 ohm rheostat	Assignable
Three-wire potentiometric	Assignable
Relative humidity	30 to 90%
Relative humidity	0 to 100%
Duct Static pressure	0 to 3 in. wc
Fluid Static pressure	0 to 40 PSIG
0-1 Volt dc linear floating	Assignable
0-5 Volt dc linear floating	Assignable
0-10 Volt dc linear floating	Assignable
4-20 mA dc linear floating	Assignable

5. Each point shall be assignable to one of the above sensor types and able to be reassigned at any time.
6. The analog-to-digital conversion shall be accomplished with a minimum of 16-bit resolution, plus sign and overflow. The sample shall be integrated over a period of 100 milliseconds for noise rejection. The A/D converter shall not require on-board calibration. The analog board shall continuously scan all points connected to it and place the converted data into on-board RAM memory. This memory shall be directly accessed by the DDCP application processor. The application processor shall never have to wait for analog-to-digital conversion in order to read an analog point. Signal conditioning and excitation shall be internal except for voltage and current inputs, which may be separate. All levels of analog excitation voltage shall be isolated from earth ground. With the removal of an analog input module all field wiring associated with that module shall be disconnected from all DDCP circuiting including excitation power.
7. Analog Outputs: The DDCP shall be capable of outputting a 0 to 10V dc analog signal and a 4 to 20 mA analog signal (10-bit resolution minimum) . The voltage and current outputs shall be able to be scaled individually by software to any range within the maximum output range. The analog output signals and the pulse signals shall both be capable of driving transducers to result in a modulating 3 to 15 psi pneumatic signal. I/P, E/P, or pulse/p transducers shall be mounted in the field equipment panel. With the removal of an analog output module all field wiring associated with that module shall be disconnected from all DDCP circuitry.
8. efPulse Accumulation: Pulses from power meters, turbine meters, or other pulse generating sensors shall be accumulated in the DDCP. Accumulator input shall be capable of a 20Hz pulse rate. Up to 65,000 pulses shall be accumulated before rollover to 0. Provide debouncing circuitry that shall filter out any pulse shorter than two milliseconds. The ability to reset the accumulated data shall be provided by software. No additional hardware shall be required to use a digital input as a pulse accumulation input.

P. Maintenance and Support

1. The following minimum features shall be provided to facilitate maintenance and support:

- a. All active circuit components shall be mounted on plug-in circuit cards for ease of removal and replacement.
- b. A mechanism to allow for disconnecting from the communications trunk. Additionally, the DDCP shall easily be able to be connected to field test equipment.
- c. Primary power, logic power and each level of excitation power "ON" indicator lights along with indicator lights which demonstrate that the DDCP is receiving and sending transmissions both on the communications trunk, and internally.
- d. An auxiliary 120V ac duplex power outlet shall be available in, or adjacent to the DDCP to connect test equipment.
- e. A reset switch in the DDCP to request both hardware and software restart and initialization from the OWS.
- f. An RS-232 port for the connection of a modem, printer or operator's terminal.
- g. A "Low Battery" status indication that will annunciate and alarm at the OWS when the battery requires replacement.

Q. Wiring Features

1. Incorporate the following design features to ensure failsafe operation of the system:
 - a. The multiplexing communications interface shall be electrically isolated from the communications trunk so that component failure within the DDCP will not affect the data traffic on the trunk for other DDCPs.
 - b. Digital input field electrical circuits shall be electrically isolated on individual circuit cards to minimize damage to DDCPs.
 - c. All field wiring to DDCPs shall be terminated at barrier type screwdriver terminal strips not directly to a controller I/O module. Terminal strips shall not be mounted either on the individual point cards or shall be mounted external to the cards and the signals internally routed to the point cards. Provide two screw connectors for each digital input, accumulator input, and analog output point. Four screw connectors shall be provided for each analog input point. Interposing relays where required shall have a terminal for normally open, for normally closed, and for common. Removable terminal strips built in to the DDCP shall be an acceptable alternative to separate terminal strips.

R. Power

1. The DDCP, in normal operation, shall require 120V ac and dissipate no more than 200 watts. A power-on indicator, power switch, power line filter, and power fuse shall be provided. Surge protection for the power lines and the communication lines shall be provided.
2. Provide coordination with the base building electrical contractor. The base building electrical contractor shall provide two, 120 VAC 20 amp circuit breakers for BMCS power at each emergency power panel. Additional circuit breakers, which may be required, shall be provided by the electrical contractor for use by the BMCS contractor, provided that the BMCS contractor states the exact number of circuit breakers required, beyond the above stated quantity at the time of bid so that the electrical contractor can include the requirements in his bid.
3. Provide coordination with the General Contractor or Construction Manager for the final coordinated location of each DDCP panel within the mechanical room spaces.

S. Battery Back-up

1. All DDCP memory and the DDCP calendar clock shall be battery backed for a period of at least seventy-two hours. The batteries shall be continuously trickle charged when

normal power is available. Batteries shall be Alkaline or Lithium and provide indication of the current level of readiness to the BMCS.

2. For DDCPs controlling critical equipment where the controller must be insulated from momentary power losses (when the system is between normal power going off and awaiting emergency power, and vice versa, provide an uninterruptible power supply for each DDCP OWS and ROWS. UPS shall allow for full and complete normal operation of the BMCS for a total of one half hour before the system performs a controlled shutdown. Whenever the DDCP is switched to battery power it shall transmit a message to the OWS when polled (indicating that power failure has occurred).

2.8 APPLICATION SPECIFIC CONTROLLERS

- A. The control program shall reside in the application specific controller providing control when host computer communication or DDCP panel communication is not possible. The application program shall be maintained at the application specific controller in ROM, PROM, EPROM OR EEPROM. The default database, i.e., setpoints and configuration information, shall be stored in Electronically Erasable Programmable Read Only Memory (EEPROM).
- B. Application specific controllers requiring the application or database to be downloaded from a host shall not be acceptable. The zone controller must run the control application using the default setpoints and configuration after a power failure with the host disabled.
- C. The controller address shall be set by a hand-held, digital service tool or dip switches. All remaining database parameters shall be set by service tool or host computer.
- D. Each communication trunk shall support up to 96 terminal unit controllers. Each controller shall be assigned an individual address as designated by the BMCS contractor. The address shall be set into EEPROM using the service tool.
- E. The network trunks shall be as required by the acceptable manufacturer's system requirements. The network may consist of coaxial cable (Beldon 9369, 9268, 9228, 82269, and 89269), twisted pair cable with 100% foil shield of the gauge recommended by the manufacturer (Beldon 1154A and 1155A) or optical fiber (62.5 microns, duplex). All cables used in plenums shall have a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 5 ft. or less.
- F. Each controller shall have the appropriate quantity and type of inputs and outputs to control and monitor the equipment served. At minimum, provide inputs for air flow sensor, supply air temperature (each TUC), input for thermostat, input for CO2 sensor (where required) and outputs for primary air damper, fan start/stop and speed control (for fan powered boxes ECM motor), zone humidifiers (if applicable), lighting control, and electric heat control (duct mounted reheat and/or baseboard radiation). Outputs shall be electrically isolated from the inputs and communications line.
- G. The controller shall be an electrical class-II device constructed from UL tested flame and smoke retardant materials to allow mounting in the return air plenum. The controller shall be listed UL-916. The controller shall be surface mounted within an electrical panel, or the controller shall be mounted to a 4 x 4 Junction box and completely enclosed in a dust-proof, flame and smoke retardant housing.
- H. All electrical connections shall be made to a combination base and terminal strip assembly. To ensure long-term reliability, all electrical connections shall be screw type.

- I. Provide isolation transformers to protect and provide surge-free power to the controller. Transformers may be centralized for several controllers or provided individually for each controller.
- J. Provide coordination with the terminal device manufacturer and air balancing contractor for the controllability of the minimum and maximum flows, and sound criteria with required CFMs. Controllers shall be sent to the air terminal manufacturer for factory mounting.
- K. Provide coordination with the engineer for the final layout of all MERs and equipment rooms where DDCP panels are located.

2.9 FIELD EQUIPMENT PANEL

- A. Provide field equipment panels.. The panels shall house, interface relays, DDC controllers, and other miscellaneous control components.
- B. Panel shall contain terminal strips mounted for input and output wiring terminations. Pneumatic piping internal to the panel shall be fire resistant polyethylene tubing.
- C. Identify all equipment internal to panel or face mounted with nameplates to match approved shop drawings.
- D. Field equipment panels shall be the same NEMA classification as all other panels located in the same environment, master key locked, hinged gasketed front door cabinet, construction to match DDCP enclosures. Take necessary precautions to protect installed equipment.
- E. If panel is located out of doors, its enclosure shall be NEMA 4. Provide auxiliary heating and/or cooling for components as required to keep the panel environment within the enclosed equipment's specifications.

2.10 SENSORS AND CONTROL DEVICES

- A. General
 - 1. Provide sensors and control devices as indicated on mechanical plans, control flow diagrams and as required to meet specified performance. Where performance specifications exceed capabilities of hardware specified, performance governs. The installation of such devices shall be the responsibility of this contractor.
 - 2. Where high accuracy is required (Laboratory environments, etc.) equip analog sensors with industry standard 4 to 20 mA or 0-10Vdc transmitters with built-in circuit protection against reverse polarity and supply voltage transients. The transmitters to be matched to the sensing element and compatible with the DDCP.
 - 3. All sensor/transmitters assemblies shall be factory calibrated.
 - 4. All sensor wiring, analog or digital, input or output shall be capable of sharing single conduit runs without affecting signal performance.
 - 5. The sensor range and type to be suitable to the application.
 - 6. Minimum contact rating of relays and switches shall be 4 amp 120 volts resistive.
 - 7. Devices UL listed for electrical safety where applicable.
 - 8. All components of sensors exposed to process shall be rated to withstand 150 percent of maximum process temperature and pressure.
- B. Temperature Sensors
 - 1. Temperature sensor assemblies shall consist of a 100 or 1,000 OHM platinum RTD sensor and a solid state, protected in a housing suitable for the environment in which it

is installed. Provide 2-wire, 4-20 mA transmitters where called for in the contract documents. Approved sensor - Control contractor's standard temperature sensor or Minco AS2 or AS3 series.

2. Outside air sensors shall be mounted on a northern exposure and mounted within a ventilated enclosure. Indicate exact location in shop drawings. Approved sensor - Control contractor's standard temperature sensor or Minco TT809PW4.0O1EN2.
3. Terminal unit space temperature sensors may be thermistor type, minimum 10K with and accuracy of +/- .5 deg. F and a stability of .25 deg F over a minimum of five years. Approved sensor - Control contractor's standard temperature sensor or Minco TT859PW1H1

C. Humidity Sensors

1. Humidity sensor assemblies shall consist of a transmitter protected in a housing suitable for the environment where it is installed. Approved sensor - Control contractor's standard temperature sensor or Minco HT2D1 for duct mounting, HT2O1 for outside air mounting, and HT2S1NT or HT2S1H for combo temperature and Humidity.
2. The sensor accuracy shall not exceed $\pm 2.0\%$ RH. Sensor span shall be 40 to 90% RH.

D. Differential Pressure Switch - Air

1. Shall be diaphragm operated and actuate a SPDT snap-acting switch. Operating point shall be adjustable. Range shall suit application.
2. High and low sensing ports shall be 1/8" NPT or 1/4" compression connected to angle type tips designed to sense pressure.
3. Switches used for fan shutdown shall be manual reset type.
4. Acceptable manufacturers:
 - a. Dwyer
 - b. Johnson Controls

E. Damper End Switch

1. Switch shall be actuated by the damper blade reaching the position specified in the sequences of operation required for the next step of control to be completed.
2. Provide encapsulated mercury type switch shall be model TS-470 or non-mercury TS-475 as manufactured by Kele.

F. Low Limit Thermostat

1. Shall have a 20-foot flexible vapor charged element. When temperature sensed by any 12 in. segment of the element falls below setpoint (usually 40°F), thermostat shall operate DPDT manual reset contacts.

G. Hydrogen Sensor

1. Pre-calibrated plug-in sensors, Built in 85 dBA audible alarm, 4-20mA and 2 relay outputs, Two-line LCD display, LED status indication, Password protected, programmable relay differential, 0% to 100% LEL range
2. Acceptable Manufacturers: Kele GDS Series Gas detector, or as approved.

2.11 AUTOMATIC DAMPERS

- A. Provide automatic dampers as indicated on contract drawings.

- B. Dampers to be low leakage type (10 CFM/sq. ft. at 4.0" W.G.) , with published leakage data certified under the AMCA Standard 500 Certified Ratings Program showing leakage at 1.0 in. wg. not greater than 4 CFM/sq. ft.
- C. Damper blades and frames to be fabricated from extruded aluminum, reinforced for rigidity. Blades to be of airfoil design with full-length edge seals with inflatable pockets to enable air pressure from either direction to assist in blade seal off. Edge seals to be mechanically locked without the use of cement to the blades, but easily replaceable in the field. Edge seal material to meet all local codes and requirements of authorities having jurisdiction. Bearings to be non-corrosive and axles shall provide positive locking connection to blades and linkage. Blades mounted vertically to be supported by thrust bearings. Jamb seals to be aluminum, flexible compression type.
- D. Dampers used for modulating control application are to be of opposed blade configuration and dampers used for open/closed applications are to be parallel blade type.
- E. The dampers to have a maximum blade length of 48" and a maximum blade width of 8". The maximum height of each damper section to be 72". Where greater length or height is required, make the assembly of multiple sections.
- F. Install damper actuators of sufficient quantity and size to limit leakage to specified rate. Damper assemblies consisting of multiple damper sections to be provided with at least one damper actuator per section or be connected with an approved jack shafting arrangement.
- G. Dampers used in smoke removal applications shall be UL rated smoke dampers.
- H. Where the return fan of an Air Handling Unit is used for smoke removal, the return air damper shall be a smoke damper. In these cases, the return air damper shall normally closed held open by the control signal. In the event of a fire alarm that shuts down the air handling unit, the fire alarm system will interrupt the power to the actuator, and the damper will close. Similarly, the spill air damper will be normally open, held closed by the control signal. In the event of a fire alarm that shuts down the air handling unit, the fire alarm system will interrupt the power to the actuator, and the damper will open. During all other times, the damper will be open, closed or modulating based upon the control signal to the damper. During normal shutdown, the return air damper will open and the spill air damper will close unless otherwise directed in the sequences of operation.
- I. Damper submittal shall be based upon and coordinated with the approved sheet metal shop drawings. Include in submittals actuator torque capacity.
- J. Manufacturers: Ruskin CD-60 or Arrow Air Foil, Model 206 or 207.

2.12 SERVICE KIT

- A. Provide three service kits for use by Owner's personnel in testing and making minor service adjustments to the system. Include as a minimum:
 - 1. All specialized nonstandard tools and adapters and fittings required for operating, maintaining, testing and adjustment of the system.
 - 2. Lubricant required for automatic valves and automatic dampers, one year supply.

2.13 SOFTWARE

- A. General

1. Fully implement, optimize, and commission all software described under this paragraph and required for a complete operable system.
2. Although "Program" implies software, hardware solutions may be acceptable after review and approval of authorized representative. Such differences are to be considered deviations and presented as such.
3. Software programs are described as to general intent. It is recognized that BMCS contractors' software differ; however, the programs that are provided shall incorporate the features described.
4. Each point shall be identified in software with a unique point name. Point names shall be logically and consistently coded to allow identification of the point location (e.g., Building, MER), associated HVAC system (e.g., AHS-1, Chiller-2), and point function (e.g., supply temp, freezestat) as a minimum.
5. Original copies of all software tools and programs utilized to program system shall be turned over to owner's representative at the completion of the project. This includes but is not limited to; operating system, GUI development software, controller programming software, network management and diagnostic tools.
6. Provide owner with all software license agreements.
7. Provide owner with complete system backup, including all user workstations, controllers, databases, etc. on CD format.

B. Executive Software

1. The executive software shall include all programs needed to manage the scheduling of both system and application programs. It shall also include all programs needed for use of the systems peripheral devices and communications networks. Parts of this software may be restricted from user modification to insure system integrity. However, the following user access to the executive software shall be provided.
 - a. Ability to switch failing output devices to another device without loss of data or otherwise handle device failures (e.g., jammed printers).
 - b. Ability to modify the priorities and scheduling of application programs.
 - c. Ability to add or delete peripheral devices.
2. Provide diagnostic programs to report and display DDCP system failures at all Operator's console both on LCD display and printer. Provide on-line error detection and messages.
3. Peripheral Equipment Selection:
 - a. Provide peripheral equipment selection control to apportion data to peripheral console as required (e.g., alarms to alarm printer).
 - b. Apportionment of Data and Control Functions shall be a programmable function by a high level operator at any console. Initialization of the apportionment of data shall be according to the description of the Functional Requirements stated under each Console Description. Contractor shall provide all software and programming time required to initialize the system. Submit initial apportionment for all monitored and control functions for review prior to final programming.
 - c. The graphics display shall be logically divided to allow the simultaneous occurrence of operator interaction and alarm indication with no interference to each other's screen display.
4. System Access Control: Provide a minimum of sixteen levels of access using selectable passwords to the system software. Each higher level will increase the allowed interaction by the user. Each password must be entered by the operator to access a particular level of system operation. The password shall not be displayed or printed. Each password shall be unique for each operator.
5. The system shall observe the following command priorities (from highest to lowest):

- a. Smoke Control and Life Safety
- b. Manual Operator Command
- c. Energy Management
- d. Automatic Control

C. Operator Interface Program

- 1. Provide a high-level language as the operator interface with the system for defining and selecting points, parameters, report generation, graphics, and all functions associated with day-to-day operation of the system.
- 2. Provide software to notify the operator (via his PDA – Blackberry, Iphone, etc.) of the occurrence of an alarm condition. All alarm messages shall be displayed on the monitor, on the local printer, and on the remote printer in simple English-language format. System shall print and sound an audible alarm at each occurrence. Operator acknowledgment shall silence the audible alarm. System shall print upon return to normal. The BMCS contractor shall set all alarm thresholds.
- 3. Report Generation Software shall be provided to present system information in an organized manner.
 - a. System Point Log - A log for each system, which shall include all points required for operation and monitoring of the system. Do not include points which are used in intermediate calculations and program logic or points used for system tuning and set up.
 - b. Display for each point: Point Name, Point Description, Current Value, Engineering Units, Alarm Status and Command Priority.
 - c. Application Program Logs - Log for each program shall include current values of all points and parameters used in application program.
 - d. Summary Logs - Logs, which summarize system status. Include as minimum:
 - 1) Alarm Summary
 - 2) Run Time Totalization Summary
 - 3) Disabled Point Summary
- 4. Provide fully implemented interactive graphics with latest available process data fully integrated with the display. Point values shall be dynamically updated at least every 20 seconds or based on change of value settings for the system.
- 5. Use different colors for the various system components to facilitate rapid recognition and ease of interaction. Colors shall be uniform on all displays, such as all master alarms red blinking with reverse field.
- 6. Graphics generation and editing shall be via a high level interactive programming language. The graphics program shall be provided with a library of standard symbols with the capability for user to add custom symbols.

Provide graphics for but not limited to the following:

- a. Graphics shall be arranged such that the opening screen is a representation of the building facade and shall contain depict the outside air temperature, humidity and weather data from NOAA and any other point specifically noted in the sequences of operation.
- b. Clicking on a particular floor will display that floor plan with space temperatures displaying actual space temperatures at the sensor location. If the space sensor is picked, the individual VAV box or associated control loop shall display. The floor plan shall also display the mechanical equipment rooms.
- c. Clicking on a mechanical room will display the equipment in the room. If the room contains only one fan for example, the graphic for that fan shall be displayed. If the room contains several fans, the different fans will display, and picking a particular fan will cause the system to display the flow diagram for that system,

with all associated points displaying their data in real time. Provide a pick point on the graphic, that when selected, will bring up the approved sequence of operation for the system. Provide embedded data sheets (PDF Files) for each device so that when the device is selected, its associated data sheet will be displayed.

- d. Floor plans showing status of associated points within area including but not limited to: smoke detectors, HVAC equipment, associated lighting contactors. Indicate locations of equipment within area such as DDCPs, FEPs, MERs, space temperature sensors, lighting control panels, etc. Where a floor has several zones, program the graphics to display a color indicating the space temperature with respect to drift from setpoint as follows:

Space Temperature	Zone color
4 or more degrees below setpoint	Dk. Blue
2 to 3.9 degrees below setpoint	Lt. Blue
At setpoint plus or minus 1.9 degrees	Green
2 to 3.9 degrees above setpoint	Orange
4 or more degrees above setpoint	Red

- e. Separate Air and Water Systems Riser Diagrams showing all systems in Block Diagram Form. System status (on, off, alarm) shall be indicated. Risers shall include common sensing points such as outside air and supply and return temperatures in main piping systems.
7. Provide software to output a user programmed message in response to an alarm or change of value of any system point. Message length shall be at minimum 4 lines of 80 characters each. All messages shall be submitted for approval, programmed by the BMCS contractor during start up, and demonstrated during acceptance.

D. Application Software

- 1. System shall contain all of the following application software whether implemented in the present scope of work or required in the future.
- 2. Time of Day Scheduling:
 - a. A comprehensive program shall be provided to automatically start and stop equipment based on the time of day and day of week, including holidays. The scheduled time-of-day program shall operate in conjunction with and shall be coordinated with optimized Start/Stop, program.
 - b. It shall be possible to individually command a point or group of points. For points assigned to one group it shall be possible to assign variable time delays between each successive start or stop command within that group. The system shall have the capacity to accommodate a minimum of 500 uniquely defined schedules. Each load group shall be capable of accommodating a minimum of 250 loads.
 - c. The operator shall be able to define the following information:
 - 1) Time, day, dates.
 - 2) Commands such as on, off, auto, etc.
 - 3) Load or loads assigned to groups.
 - 4) Time delays between successive commands.

There shall be provisions for manual overriding of each schedule by an appropriate operator.

- d. The following reports shall be provided:
 - 1) Report of any and all defined time schedules.

- 2) Loads assigned to each time schedule.
3. Start/Stop Time Optimization (SSTO):
 - a. The automation system shall include a software program to perform optimized start-up and shutdown of selected equipment and for all system with a design air capacity greater than 10,000 CFM. The SSTO program shall start HVAC equipment at the latest possible time that will allow the equipment to achieve the desired zone conditions by occupancy time. The SSTO program shall also shutdown HVAC equipment at the earliest possible time before the end of the occupancy period, and still maintain desired comfort conditions.
 - b. The SSTO program shall operate in both the heating and cooling seasons. It shall be possible to apply the SSTO program to all individual systems.
 - c. The SSTO program shall operate on outside weather conditions as well as inside zone conditions, and empirical factors. The empirical factors shall relate to the dynamic responsiveness of particular zones such as heat retention and transfer coefficients. The program shall be fine-tuned during the warranty period using empirical data compiled during operation of the building.
 - d. The program shall automatically adjust itself utilizing adaptive control techniques.
 - e. The system operator shall be able to, for each system under control of the SSTO program, establish and modify the following parameters:
 - 1) Occupancy period
 - 2) Desired occupancy temperature
 - 3) Heating/cooling transfer coefficients
 - 4) Heating/cooling retention coefficients
 - 5) Primary equipment lag time
 - f. A report shall be provided detailing SSTO parameters such as zone coefficients, zone occupancy time and temperature, activated/inactivated zones, etc.
4. Electrical Demand Limiting:
 - a. The BMCS shall include a software program to perform electrical demand limiting (EDL). The EDL program shall monitor the rate of electrical power consumption and forecast the total demand during each demand interval using a sliding window approach.
 - b. The program shall automatically shed and restore loads to prevent the electrical demand from exceeding and operator set level.
 - c. Kilowatt rating of each load stored in computer memory to ensure proper number of loads being shed when excessive electrical demand is predicted. For scheduling purposes, each load assigned to one of three priority groups:
 - 1) Priority Group 1 and 2 - Automatically shed as required.
 - 2) Priority Group 3 - Issue operator advisory to manually shed particular load by operator action at console.
 - d. When load shed condition exists, program begins searching for loads in Groups 1 and continues through Group 3 until necessary number of kilowatts have been shed. Loads within each group shall be shed on a round robin or fixed basis. Load restoration procedure is opposite of load shedding procedure.
 - e. Each load shall be programmed with maximum off time, minimum on time and minimum off time.
 - f. The operator shall be able to define the following information:
 - 1) Load KW and priority
 - 2) Maximum demand setpoint
 - g. The following information shall be available in report form:

- 1) Load Data
 - 2) Maximum Demand for a given period (day, week, month, etc.)
 - 3) Current demand and loads shed
- h. When maximum target is exceeded alarm shall sound, current demand in KW displayed and printed out with time of occurrence on alarm printer.
- i. Degraded Mode: Loss of all or part of data trunk cable shall not cause the shed loads to restart and the electrical load to exceed setpoint. DDCPs shall be capable of cycling connected loads in a stand-alone mode as to eliminate or reduce potential increases in maximum demand level.
5. Automatic Restart:
- a. During a power outage the DDCP operating programs and database shall be protected against loss by memory battery backup. (If the length of the power outage exceeds the battery backup capacity, the programs and database shall be automatically reloaded from the disk storage upon power restoration.) After power has been restored, the system points shall either be returned to the state they would be in if there were no power outage or remain off as defined by equipment and operational requirements. Points to be restarted shall start over a programmed time schedule to affect soft start.
6. On/Off normal alarm:
- a. If any device starts or stops as a result of a local event, overriding the last command of the BMCS, an alarm shall be sounded at the BMCS.
7. Automatic False Alarm Lockout:
- a. When systems are off, certain analog variables may drift past programmed alarm limits. Inhibit analog variable limit alarms until after system is restarted and stabilized.
8. Historical Trending:
- a. Any system point either real or calculated shall be assignable to the historical trending program. All changes in point value shall be recorded for points assigned. The trend interval shall be user selectable. All trend information shall be recorded in nonvolatile memory. Provide system capacity to trend a total of 300 points every 30 seconds without any notable system degradation. Field panels shall be able to store up to 2,500 trend samples per point and can be selected for intervals of 1 minute to 7 days.
9. Psychrometric Calculations:
- a. The system shall be equipped with a Psychrometric calculation module, which will calculate any point on the Psychrometric chart when supplied with two other points of data.
- b. The calculation shall operate in the dynamic mode, allowing system input points to be used as calculation inputs and the result used in control loops where required by the sequence of operation.
- c. The system shall be capable of calculating the enthalpy of a sampled air stream using temperature and humidity inputs. The system shall then be capable of comparing the inputs and initiate an action (such as closing the outside air dampers) as a result of the decision.
10. Demand Controlled Ventilation:
- a. The system shall be able to measure outside air CO₂ and indoor CO₂ (multiple locations) and override outside air damper control on applicable systems to increase O/A intake. Initiation trigger point shall be space concentrations in more

than 1,000 PPM above outside air ambient. Once triggered, the system will maintain a differential between outside air ambient and the space of [700 PPM (indicative of 15 CFM/person)][500 PPM indicative of 20 CFM/person] until the referenced space concentration drops below 800 PPM.

11. Custom Applications Program:

- a. Provide a real-time control programming capability to allow operator to create customized control strategies based on arithmetic, logical, conditional, and time logic.

12. LEED Measurement and Verification Protocol

- a. Provide system capability to perform long term measurement and verification of monitored points per Option B: Methods by Technology of the US DOE's International Performance Measurement and Verification Protocol objectives.

PART 3 - EXECUTION

3.1 LOCATION OF EQUIPMENT

- A. The drawings and specifications describe approximate locations of the work. Verify all locations in the field.
- B. Locate equipment and accessories to provide easy access for proper service and maintenance.

3.2 INSTALLATION OF WIRING

- A. Provide wiring for control devices, monitoring devices, instrumentation, and interlocks as required for a complete system. Coordinate with Plumbing, Electrical and HVAC specifications for devices requiring wiring under this Section.
- B. Run all wiring in compliance with the requirements of the electrical specification (Division 26) and in accordance with authorities and codes having jurisdiction. Provide separate conduit for control wiring under this Section.
- C. Level 1 data network cable shall be run in conduit. Level 2 networks shall be installed using plenum rated cable where allowed by code, but always in EMT where exposed to damage and in all mechanical equipment rooms.

3.3 INSTALLATION OF CONTROL EQUIPMENT

- A. Device locations are the responsibility of the BMCS Contractor. Group instrumentation on ductwork and fan casing in organized manner. Locations to be consistent for each type of system. Each control device, field or panel mounted, shall be identified by an engraved lamacoid nameplate permanently attached to its enclosure.
- B. Sensors mounted on air ducts having exterior insulation shall be provided with standoff spacers with insulating material firmly fitted around spacers.
- C. Averaging temperature and low temperature detectors shall be installed in serpentine fashion and supported by steel grid or multiple bulb holders. Minimum coverage for temperature sensors shall be 1 linear foot of sensor element per 4 sq. ft. of coil face area. For low limit (freezestats) 1 linear foot of sensor per sq. ft. of coil face area.

- D. The [electronic] [pneumatic] high limit humidity controller must be mounted in the supply fan discharge and at least 10 feet downstream of the humidifier.
- E. Wall mounted sensors shall be 5 ft. - 6 in. A.F.F. {4 ft'- 0 in for ADA Compliance} except in areas where subject to damage height shall be 7 ft., or if noted otherwise. Coordinate all locations with Architect. Provide insulated base where mounting on exterior wall is required. Provide metal guards where mounted in mechanical, electrical, storage and maintenance areas or in any area where subject to damage.
- F. Locate pressure transducers within 50 ft of sensing point. Connect to sensors with tubing of diameter recommended by sensor manufacturer and as required to prevent signal phase lag. Provide gauge tees at transducer for connection to pressure gauge.
- G. Digital Processing Units and Field Equipment Panels shall be located in approved locations adjacent to system served. Submit all locations for approval after coordination with all other trades.
- H. Panels shall not be located directly underneath valves or other areas where they may be subject to water or heat damage. In addition, panels shall be mounted with the bottom no lower than 3 feet and the top no higher than 7 feet above the floor, with a minimum of 3 foot clearance at the front.

3.4 TRAINING

- A. The Contractor shall furnish the services of competent instructors who will give instruction in the adjustment, operation and maintenance, including pertinent safety requirements, of the equipment and system specified. The training shall be oriented toward the system installed rather than being a general training course. Each instructor shall be thoroughly familiar with all aspects of the subject matter they are to teach. All equipment and material required for classroom training shall be provided by the Contractor.
- B. The training program shall be accomplished in two phases for the time interval specified for each phase.
 - 1. The first phase shall be given prior to the acceptance test period at a time mutually agreeable between the Contractor and the Owner, and shall be at least two (2) days (8 hours/day) in length. Operating personnel to be trained in the functional operations of the BMCS installed and the procedures that the operators will employ for system operation. The training shall include but not be limited to:
 - a. General BMCS Configuration
 - b. Operation of Computer and Peripherals
 - c. Command Line Mnemonics
 - d. Report Generation
 - e. Operator Control Functions
 - f. Graphics Generation
 - g. General equipment layout
 - h. Troubleshooting procedures
 - i. Preventive Maintenance procedures
 - j. Sensor maintenance and calibration
 - k. Proper use of service kit.
 - 2. The second phase shall be conducted after system acceptance testing for a period of one (1) days. The training shall include but not be limited to:
 - a. DDCP Programming

- b. Data Base Generation
- c. Supervisory Level Operator Commands
- d. Topics requested by Owner.

3.5 CALIBRATION AND COMMISSIONING

- A. Perform a three-phase commissioning procedure consisting of field I/O calibration and commissioning, system commissioning and integrated system program commissioning. Document all commissioning information on commissioning data sheets that shall be submitted prior to acceptance testing. Notify the Owner in writing of the testing schedule so that operating personnel may observe calibration and commissioning.
- B. Field I/O Calibration and Commissioning
 - 1. Prior to system program commissioning, verify that each control panel has been installed according to the shop drawings and test, calibrate, and bring on-line each control device. Commissioning to include but not be limited to:
 - a. Sensor accuracy at 10, 50 and 90% of range.
 - b. Sensor range.
 - c. Verify analog limit and binary alarm reporting.
 - d. Point value reporting.
 - e. Binary alarm and switch settings.
 - f. Actuator spring ranges.
 - g. Failsafe position on loss of [control signal] [pneumatic supply and/] or electric supply.
 - 2. Record calibration and test data on commissioning data sheets and submit. Data sheets shall include the device designation, the date of commissioning and the name of person who performed commissioning.
- C. Fan Speed Control Without Air Flow Sensors (If Applicable)
 - 1. The BMCS Contractor shall work closely with the Balancing Contractor to setup fan tracking per the following procedure.
 - a. With return fan at minimum speed, set supply fan to produce volume equal to system differential. Record SF output signal.
 - b. Increase supply fan output signal 20% and raise return fan speed until differential is once again obtained. Record return fan output signal.
 - c. Continue this procedure until the supply fan is at full speed. Set all values in a look-up table so fans will track accordingly.
 - d. Vary the speed of the supply fan and verify fans are tracking with the proper differential.
- D. System Program Commissioning
 - 1. After control devices have been commissioned, each DDCP program shall be put on-line and commissioned. The contractor shall confirm that the DDCP program logic follows the approved software flow chart and sequence of operation. Each control loop shall be adjusted to provide stable control and control within the specified accuracies. System program test results and loop adjustments shall be recorded on commissioning data sheets and submitted.
 - 2. The sequences of operation are subject to owner onsite approval, modification, and change. Owner changes to the sequences of operation shall be performed by contractor at no additional expense.
- E. Integrated System Commissioning

1. After all DDCP programs have been commissioned, the contractor shall verify the overall system performs as specified. Tests shall include but not be limited to:
 - a. Data communication, both normal and failure modes
 - b. Fully loaded system response time
 - c. Impact of component failures on system operation
 - d. Time/date changes
 - e. End of month/end of year operation
 - f. Global application programs
 - g. System backup and reloading
 - h. System status displays
 - i. Diagnostics
 - j. Power fail/restart
 - k. Battery backup

3.6 ACCEPTANCE TESTING

- A. The BMCS contractor shall provide all manpower as required to perform testing and coordinate with mechanical and electrical contractors to provide necessary support for complete testing of all system parameters.
- B. Submit a detailed acceptance test procedure designed to demonstrate compliance with contract requirements at least 4 weeks before the start of testing. This procedure to be approved prior to the start of the testing.
- C. During acceptance testing provide services of a fully qualified building automation technician who is knowledgeable of the project.
- D. Using the commissioning test data the Owner and/or his representative shall select, at random, functions to be demonstrated. These functions shall be demonstrated by the Contractor in accordance with the acceptance test procedure. At least 15 percent of the systems functions as selected by the Owner, or engineer shall be demonstrated. At least 95% of the functions demonstrated must perform as specified and documented on commissioning data sheets or the system must be retested.
- E. Furnish instruments required for testing. Submit catalog data on all instruments for approval prior to performance of tests.

Instrument Accuracy	
Temperature:	¼°F or 1/2% of full scale, whichever is less
Pressure:	½% PSI or 1/2% of full scale, whichever is less
Humidity:	2% RH
Electrical:	Class 0.5

- F. After the above acceptance tests are complete and the system is demonstrated to be functioning as specified, a thirty-day endurance test period shall begin. If the system functions as specified throughout the endurance test period requiring only routine maintenance and adjustment, the system shall be accepted. If during the endurance test period the system fails to perform as specified and cannot be corrected within eight hours,

the Owner may request that the endurance tests be repeated after problems have been corrected.

3.7 AUTOMATIC CONTROL SEQUENCES

A. General

1. Supply, install necessary sensing, controlling and controlled devices, piping, wiring and commissioning of automatic control systems, so as to provide a complete control system, meet requirements of control sequences hereinafter specified, as noted, and in accordance with Contract Documents.
2. Contractor to customize control strategies and control sequences and be able to define appropriate control loop algorithms and choose the optimum loop parameters for loop control. All control loops shall be tuned to stabilize within $\pm 1\%$ of setpoint within 5 minutes of setpoint change or system startup.
3. Safety devices shall be hardwire-interlocked with "hand" and "automatic" positions in series with motor controller holding coil circuit.
4. Startup sequences and automatic control sequences as described on hereinafter shall operate in both automatic and manual modes.
5. Smoke control and life safety sequences shall override other automatic control sequences including hardwired safety devices.
6. Reset schedules and setpoints shown in sequences are for initial programming and start-up, during system check out and through the warranty period, the reset schedules and setpoints shall be fine-tuned to obtain desired comfort and energy results.
7. The output of the reset schedules should be limited between maximum and minimum values. The intent of the reset schedules indicated is that the range of the output be limited between the minimum and maximum values indicated in the reset schedules.
8. All functions which use analog points to switch equipment on and off (e.g., fans, pumps) must be programmed with dead bands, and if necessary, time delays to prevent short cycling of equipment. Alarms generated through analog limits as noted in the sequence of operation and where required for proper annunciation of an alarm condition shall be programmed by the BMCS contractor at startup.
9. The following control sequences, control loops and operational data define the manner by which the project mechanical systems shall function to maintain the environmental conditions described herein.
10. The monitoring and control point list is the engineer's estimation of the points required to successfully control a particular system as specified. The BMCS contractor is responsible to provide all hardware, control loops, and point required to provide a complete and operational system as specified.
11. The specified control sequences refer to the application programs described above. Refer to that Section for more detailed information regarding the requirements of a specific application program.
12. All control setpoints and variables shall be fully adjustable in the field through the use of a portable engineering terminal or lap top computer.
13. On all systems containing both cooling and heating coils (except in reheat position), the heating coil control valve shall be closed whenever cooling coil is activated and vice-versa.
14. Variable frequency drives will start in minimum speed position and ramp up to speed over a two minute adjustable ramp time (minimum).
15. All zone loop controllers shall incorporate control error reduction. Where used to control heating and cooling, zone thermostatic control shall incorporate deadband control of at least 5 degrees F. where the heating and cooling energy to the zone is shut off or reduced to a minimum. Refer to individual sequences of operation for exceptions to this requirement (if any).
16. Motor status for all motors smaller than 1 HP shall be binary current switches mounted on the motor power leg. All motors 1 HP and above (unless otherwise stated) shall be

obtained via analog current sensors mounted on the motor power leg. The sensor shall be calibrated for normal operation and abnormal operation based upon low, normal, and high current sensed. The input from the sensor shall be programmed with analog alarm limits to indicate sensor failure or loss of power (0 mA), motor off (4 mA), motor running (mA = Normal Running Amps \pm 5 amps) and motor overloaded (mA = Normal Running Amps + 10 amps).

3.8 SEQUENCES OF OPERATION FOR SYSTEMS

- A. Refer to contract drawings for sequences of operation.

END OF SECTION

SECTION 232113
HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provide piping and accessories in accordance with the Contract Documents.

1.2 SUMMARY

- A. Pipe.
- B. Fittings.
- C. Unions and Couplings.
- D. Escutcheons.
- E. Sleeves.
- F. Welding Procedures.
- G. Pipe Stress Calculations.

1.3 DEFINITIONS

- A. No definitions are included in this section.

1.4 PERFORMANCE REQUIREMENTS

- A. Piping and piping auxiliary components shall meet or exceed the performance requirements specified in this specification section.

1.5 SUBMITTALS

- A. Submit AutoCAD R-2014 computer generated shop drawings indicating anchoring details, anchor points, guide details, etc.
- B. Submit AutoCAD R-2014 computer generated drawings of location and size of sleeves for openings in floors and walls
- C. Submit AutoCAD R2014, computer generated detailed piping layouts at 3/8" = 1'-0" scale for approval. Piping layouts shall be submitted for each individual construction phase, and for the entire completed project.
- D. Submit manufacturer's data for hangers and fittings.
- E. Submit dimensioned drawings to the Engineer for approval showing pipe penetrations through core walls, slabs and other structural elements, anchor and guide locations, etc.

- F. Submit a schedule for pipe fittings.
- G. Submit a schedule for pipe sleeves.
- H. Submit a set of welding procedures for each pipe service.
- I. Submit a list of pipe welders proposed for all shop and field welding.
- J. Submit mill certificates for piping and fittings.
- K. Submit an overall piping schematic drawing (similar to a riser or isometric diagram) showing entire installed system.
- L. Submit plan drawings showing piping point loads to structure and supplementary steel layouts for all systems.
- M. Submit a line-by-line statement of compliance or non-compliance with this specification section.

1.6 DESCRIPTION

- A. Provide piping and accessories in accordance with the Contract Documents.

1.7 WORK INCLUDED

- A. Pipe.
- B. Fittings.
- C. Unions and Couplings.
- D. Escutcheons.
- E. Sleeves.
- F. Welding Procedures.

1.8 QUALITY ASSURANCE

- A. All piping work to conform to the latest edition of the appropriate ANSI Code for Pressure Piping and Power Piping, including latest amendments.
- B. Employ only skilled welders, each holding a currently active certificate, dated within 12 months, from a recognized testing laboratory, indicating satisfactory welding test results per the American Welding Association or ASME Boiler and Unfired Pressure Vessel Code, Section IX, Welding Qualifications. Retest is required if welder has not performed welding for a period of 90 days. Maintain copies of certificates at the job site. Non-certified welders shall not be employed.
- C. The piping shown on the Drawings is indicated schematically to show the general distribution and system configuration. Coordinate with the work of other Sections and Divisions of the Specifications so as to provide a complete system, including approved rerouting, horizontal

and vertical offsets, etc., to make the piping distribution fit within the confines of shafts, ceiling spaces, chases, equipment rooms, etc., all to the satisfaction of, or as directed by, the Architect.

- D. All piping shall be sourced from the United States (domestic supply).

PART 2 - PRODUCTS

2.1 PIPING

- A. Piping, fittings and accessories to be suitable for the pressure and temperatures of the service. Ascertain system working pressure and provide piping accordingly, based on the systems to be tested at 150 percent of maximum system working pressure.
- B. Galvanizing: Hot process inside and outside of pipe with zinc coating, minimum 3 oz. per sq. ft.
- C. For butt-welded piping, bevel ends as specified under "Welding of Piping". For screwed joint connections, ream cut ends of pipe to full diameter. Socket welded piping shall only be permitted for 1-1/2 inches and smaller. Ends shall be without burrs or other inward projections at the cut ends.
- D. All steel pipe is ERW or seamless type ASTM A-53, Grade B, unless noted otherwise. Dimensions and weights of steel pipe to conform to ANSI Standard B16.10.
- E. High pressure steam piping installation shall conform to the latest edition of ANSI B31.1 Code for Pressure and Power Piping, including latest amendment. All other piping shall conform to the latest edition of ANSI B31.9 Code for pressure and power piping, including latest amendments.
- F. For welded pipe, fittings shall be welding fittings and all pipe flanges shall be welding neck type.
- G. Copper pipe to be hard drawn conforming to ASTM B-88.
- H. Refrigerant tubing shall be cleaned and dehydrated at the factory and shipped sealed with a holding charge of nitrogen.

2.2 PIPE FITTINGS

- A. Comply with latest edition of ANSI B16.3, B16.5, B16.9 and B16.11 standards.
- B. Provide steel elbows of long radius pattern.
- C. Fittings to be of the same schedule (weight) as the pipe to which it will be welded. Submit cut samples for approval if directed. Provide fittings which maintain full wall thickness throughout, ample radius and fillets, and proper bevels or shoulders at ends.
- D. Provide carbon steel welding flanges at all flanged valves and equipment, and as required for union connections. Flanges to be either slip-on type, bored to match diameter of pipe and front and back welded thereto, or welding neck pattern. Use flanges with a working pressure equal to 150 psi, or a minimum of 150 percent of the maximum system working pressure. Flanges for high pressure steam service to be 300 psi rating. High pressure steam service

as relates to piping, fittings, valves and accessories is defined under these Contract Documents as steam at an operating pressure of 15 psig or higher.

- E. Provide cadmium plated or galvanized machine bolts with heavy pattern semi-finished hexagonal steel nuts to join flanges. Use studs threaded both ends where necessary to facilitate removal of valves or disassemble flanged fittings. All bolts used shall be "B-7" bolts plus studs plus threaded rods, using "2H" nuts.
- F. Use Teflon tape on male threads of screwed pipe (female).
- G. Screwed fittings to be inside threaded with threads cut clean and true.
- H. Copper fittings to be brazed fittings conforming to ASTM B16.5, B16.18 and B16.22.
- I. Branch piping connections for all steam service piping, feed water piping and condensate piping shall utilize tee fittings, reduced elbows, or shaped nipples only. No Weld-O-Lets, Thread-O-Lets or "stab-in" connections are permitted.
- J. Provide reducing/increasing long radius elbows at pump inlet and outlet connections.

2.3 UNIONS AND COUPLINGS

- A. Provide unions where required for the removal of equipment. For piping 3" and smaller, use ground joint type of malleable iron with brass seats for iron pipe, and made of brass for brass pipe and copper tubing. For piping 4" and larger use 150 psi forged steel slip-on flanges for ferrous piping and bronze flanges for copper piping.
- B. Insulating Coupling Type: At each joint between steel or zinc (galvanized) and copper; up to 2" size, Capitol Series CS or Epco "Dielectric Union"; larger sizes, Capitol Series FG, flange type with insulator spacers and washers.

2.4 DIESEL ENGINE EXHAUST PIPING AND FITTING SCHEDULE

A. Piping:

- 1. 12" and larger will be Standard Weight A 53 Gr B ERW Pipe, Black Steel.
- 2. 10" and smaller will be Schedule 40 A 53 Gr B ERW Pipe, Black Steel.

B. Fittings:

- 1. 2 ½" and larger will be weld fittings same schedule weight as the pipe to which it will be welded. ANSI B 16.9 ASTM A 234.
- 2. 2" and smaller will be screwed cast iron fittings 125#.

C. Flanges:

- 1. 2 ½" and larger will be 150# Weld Neck or Slip On Flanges. ANSI B 16.5 ASTM 105.

2. Flat face flanges will be used when bolting to equipment with cast iron casings.

D. Joints:

1. 2 ½" and larger can be welded or flanged at the contractors option.
2. 2" and smaller will be screwed.

E. Branch Connections:

1. Where applicable branch connections to steel pipe will be made with tees, w olets, tolets, solets, or ½ couplings.

F. Bolts and Nuts:

1. ASTM A307 Grade B7 bolts, Grade 2H nuts.

G. Gaskets:

1. Garlock 3000 (Suitable for 1200° F).

2.5 FUEL OIL #2 PIPING AND FITTING SCHEDULE

A. Piping:

1. 12" and larger will be Standard Weight A53 Gr B Seamless Pipe, Black Steel.
2. 4"-10" and smaller will be Schedule 40 A 53 Gr B Seamless Pipe, Black Steel.
3. 3" and smaller will be schedule 80 A53 Gr B Seamless Pipe, Black Steel.

B. Containment Piping

1. 10 gauge minimum wall thickness two sizes larger than the fuel oil pipe.
2. 2-hour fire-rated enclosure consisting of:
 - a. 2" of calcium silicate.
 - b. Covering of an aluminum jacket.
3. See section 23 53 00, 2.7 for additional requirements.

C. Fittings:

1. 1 ½" and larger will be weld fittings same schedule weight as the pipe to which it will be welded. ANSI B 16.9 ASTM A-234
2. 1 ¼" and smaller will be Socket weld 300# fittings.
3. No Threaded fittings are permitted without approval by the Engineer and the Hospital.

D. Flanges:

1. 2 ½" and larger will be 300# Weld Neck or Slip On Flanges.
2. ANSI B 16.5 ASTM 105

E. Joints:

1. 2 ½" and larger will be welded. Tank and special oil handling fittings may be screwed.

2. 2" and smaller will be screwed or socket welded at Contractors Option.
- F. Branch Connections:
1. Where applicable branch connections to steel pipe will be made with Tees, weld-o-lets, thread-o-lets, socket-o-lets or ½ couplings.
- G. Bolts and Nuts:
1. ASTM A307 Grade B7 Bolts, Grade 2H Nuts
- H. Gaskets:
1. Flex Italic Type 'CG' or equal.

2.6 REFRIGERANT PIPING AND FITTING SCHEDULE

- A. Piping:
1. DHP Copper Tubing, ACR Cleaned and Capped.
- B. Fittings:
1. ANSI B16.22 Wrought Copper, ACR Cleaned and Capped.
- C. Flanges:
1. 125# Sweat Bronze Companion Flange ASTM B584 or Unions.
- D. Joints:
1. Brazed with bag silver filler metal.
- E. Branch Connections:
1. Will be made with Tee Fittings.
- F. Bolts and Nuts:
1. ASTM A307 Grade B7 Bolts, Grade 2H Nuts
- G. Gaskets:
1. Garlock 3000 or equal
 2. Isolation gasket sets where applicable.

2.7 VENTS AND EQUIPMENT DRAINS PIPING AND FITTING SCHEDULE

- A. Piping:
1. 10" and smaller will be Schedule 40 A53B ERW Black Steel Pipe.
 2. 2" and smaller can be L Copper Tubing Hard Drawn, Soft Annealed or A53B ERW Schedule 40 T&C Black Steel Pipe.
- B. Fittings:
1. 2 ½" and larger will be Weld Fittings the same schedule as the pipe to which it will be welded. ANSI B 16.9 ASTM A234.

2. 2" and smaller will be Threaded Black Cast Iron Fittings 125# or ANSI B16.29 Wrought Copper Fittings (Contractors Option to install larger sizes.)
- C. Flanges:
1. 2 ½" and larger will be 150# Weld Neck or Slip On Flanges ANSI B16.5, ASTM 105
 2. 2" and Down will be 125# C1 Screwed Flanges.
 3. Copper sweat will be 125# Sweat Bronze Companion Flange ASTM B584.
- D. Joints:
1. 2 ½" and larger will be welded.
 2. Copper systems Soldered with 95/5 SN/SB.
 3. Threaded 2" and down.
 4. Di-Electric Fittings or Isolation gasket sets will be used between Copper/Steel services.
- E. Branch Connections:
1. 2 ½" and larger will use fittings or fabricated laterals.
 2. Copper system will be made with Tee Fittings.
- F. Bolts and Nuts:
1. ASTM A307 Grade B7 Bolts and Grade 2H Nuts
 2. Exterior Cooling Tower will be hot dipped galvanized, all other exterior locations can be plated.
- G. Gaskets:
1. Garlock 3000 or Equal
 2. Isolation gasket sets where applicable.

2.8 ESCUTCHEONS

- A. Cast iron or cast brass, deep type, to cover sleeve hubs or fitting projections. Provide escutcheons for exposed piping through floors, ceilings, walls and partitions in finished areas, and piping through all fire rated separations. Attach escutcheon to building material, not to pipe.

2.9 SLEEVES

- A. Construct sleeves for pipes passing through partitions, hung or furred ceilings, etc., of not lighter than 18 gauge galvanized steel.
- B. Provide standard weight galvanized steel pipe sleeves at all penetrations of foundation walls, block walls, reinforced concrete walls, and all floor and roof slab penetrations.
- C. Provide 25 gauge waterproof galvanized sheetmetal counter-flashing at all pipe roof penetrations.

2.10 ACCEPTABLE MANUFACTURERS

- A. Pipe
1. U.S. Steel "National"
 2. Ohio Pipe

3. LTV-E
 4. Van Lewen
- B. Welding Fittings
1. Weldbend
 2. Tubco
 3. Cajon
 4. Naylor
 5. Ladish
 6. Van Lewen
- C. Copper Pipe and Fittings
1. Mueller Brass
 2. Nibco
 3. Reading Tube

PART 3 - EXECUTION

3.1 GENERAL

- A. Preparation
1. Ream and de-burr pipes and tubes.
 2. Clean of scale and dirt, inside and outside, before assembly.
 3. Remove welding slag or other foreign material from piping.
- B. Installation
1. General:
 - a. The drawings indicate generally the size and location of piping and while sizes must not be decreased, the Contractor may change locations of pipes in order to accommodate conditions at the job.
 - b. Closely plan and coordinate concealed piping and ductwork above suspended ceilings to avoid interferences, and install to maintain suspended ceiling heights shown on architectural drawings.
 - c. Install exposed work in a neat, workmanlike manner; parallel to the closest wall with maximum headroom. Avoid light fixtures.
 - d. Properly grade piping to secure easy circulation and prevent noise and water hammer. Pitch horizontal pumped water piping 1 inch in 60 feet upward in direction of flow. Pitch steam and condensate piping 1 inch in 40 feet downward in direction of flow. Pitch gravity water piping one foot in 100 feet downward in direction of flow.
 - e. Install (at traps, instruments, etc., and wherever else directed) approved unions, to permit easy connection and disconnection.
 - f. Make riser branches and other offsets with 4-elbow swings including copper risers and branches.
 - g. To meet job conditions offset water supply and return mains up and down. Provide drain cocks with hose connection and chained cap (minimum 3/4 inch) at low points and vent traps at high points.
 - h. After systems are in operation, if coils do not circulate quickly and noiselessly (due to trapped or airbound connections), make proper alterations in these defective connections including altering finished construction and refinishing without additional cost.

- i. Pipe Nipples: Pipe 3 inch in length and less is considered a nipple. Nipples to be of extra heavy construction. Do not use close nipples.
 - j. Do not use short lengths or nipples at locations where a full length of pipe will fit.
 - k. Make piping connections to coils and equipment with offsets provided with screwed or flanged unions so arranged that the equipment can be serviced or removed without dismantling the piping. Do not screw unions directly to coil header piping connections.
 - l. Cut screw threads clean and true. Do not use bushings. Make reductions with eccentric reducers or eccentric fittings to permit draining unless otherwise indicated. Ream out pipe 2 inch and less after cutting to remove burrs.
 - m. Make flanged connections with flange faces true and perpendicular to the center line of the pipe to which the flanges are attached.
 - n. Allow space for pipe insulation.
 - o. Provide dielectric couplings at all junctions of copper and steel or galvanized piping.
 - p. Provide for expansion and contraction of piping systems.
 - q. Use main sized saddle weld-o-lets or thread-o-lets, type branch connections for directly connecting branch lines to mains in steel piping if main is at least one pipe size larger than the branch for up to 6 inch mains and if main is at least two pipe sizes larger than branch for 8 inch and larger mains. Do not project branch pipes inside the main pipe. Use of welding tees are permitted for all sizes.
 - r. Cap all openings in pipes during progress of the work.
 - s. Do not connect bottom of pipe risers until riser is complete. Rod or tap to clear loose material before making bottom connection.
 - t. Correct leaks in piping immediately using new materials. Leak-sealing compounds or peening is not permitted.
2. Supports:
- a. Support or suspend piping properly on stands, clamps, hangers, etc., of approved design and make. Design supports to permit free expansion and contraction while minimizing vibration. Anchor pipes where shown or required by means of steel clamps, or other approved means, securely fastened to the pipe and the building construction. Follow MSS standards for supports of piping.
 - b. Provide structural pipe supports including supplemental steel channels, angles, columns, etc., necessary to complete the installation. The provision of structural supports over and above that required for the building structure is the responsibility of this Section.
 - c. Prior to installation of hanger rods and other pipe supports, obtain approval from the Architect/Engineer for proposed method of hanging and for exact location of all mounting points. Submit weights and location of all piping to the Architect/Engineer for approval well in advance of general construction work to allow sufficient time for structural redesign to accommodate the installation.
 - d. Place piping in proper alignment and position prior to connection to anchors, expansion loops, joints and equipment. Furnish jacking devices, temporary steel structural members and assembled structures as necessary. Remove temporary equipment and structures at the completion of the work.
 - e. Reinforce piping at anchor points.
 - f. For life safety systems only seismic supports are required as indicated in the 2016 NYS Uniform Code. Contractor shall provide signed and sealed calculations and submittals by a licensed professional engineer for proper seismically designed supports.
3. Sleeves:

- a. Provide sleeves for all pipes passing through floors, rated partitions and walls of sufficient diameter to accommodate pipe covering where such is required. Set sleeves for concrete floors, walls, and other masonry work in place before the floors or walls are poured or built. Locate sleeves secure in place so that space all around the pipes, after the pipes are installed in place is about equal. Anchor sleeves by use of anchor flanges embedded in concrete or at each end of sleeve. Properly firestop around sleeves after wall is constructed.
 - b. Provide sleeves for all pipes passing through non-rated partitions or ceilings. Size sleeves to accommodate pipe covering where applicable. Sleeve seam to be drive slip. Sleeve to be flanged 1" at each end to lock sleeve into penetration.
 - c. For sleeves at penetrations of the metal deck, attach to the deck prior to the pouring of the deck concrete. Set sleeves in such a manner so that no concrete fills their interior during the concrete pouring operations.
 - d. Caulk floor sleeves for exposed pipes watertight and project sleeve approximately 2" above the finished floor. Finish sleeves flush with the bottom of slab and also with the finished faces of wall.
 - e. Provide sleeves with an inside diameter at least $\frac{1}{2}$ " greater than outside of pipe served, including pipe insulation which must be continuous through sleeve, except as detailed on the Drawings.
 - f. Where piping penetrates non-rated walls, partitions, etc., pack space between piping and sleeve with mineral wool. At penetrations through foundation walls, rated walls, and floor slabs provide firestop material as specified and shown on the Drawings.
 - g. Do not support pipes by resting clamps on sleeves. Clamps must extend beyond sleeve and be supported outboard of sleeve in an approved manner. In no case shall sleeves be cut or slotted to accommodate pipe clamps.
 - h. Where space for future pipes and conduits is required, provide sleeves and fill with lightweight concrete.
 - i. Sleeves penetrating floor and roof slabs shall extend at least 2" above slab.
 - j. Cover all pipe/sleeve/firestopping gaps using escutcheons.
4. Drain Installation:
- a. Coils and vessels which contain water to have connections suitably located, and valved outlets, to permit individual venting and draining.
 - b. Provide valved drains with hose bibb at low points of piping systems and at the bottom of each riser.
 - c. Provide cooling coil condensate drains, fan drains, and all unit casing drains with 2-inch minimum trap seal, unless otherwise noted, to spill over floor drains.
 - d. Provide 1-inch minimum drain lines in sheet metal intake and discharge plenums not indicated to have floor drains. Pipe drains to nearest approved indirect waste.
5. Except as noted, make soldered joints with 95% tin and 5% antimony solder, having a melting point of not less than 460°F. Thoroughly clean solder joints before the application of the solder. Cut pipe square with burrs removed and apply flux before soldering.
6. Make brazed joints using brazing alloys with a melting point at or above 1,000°F.
7. Refrigerant Systems:
- a. Back purge refrigerant tubing with nitrogen during brazing operations.
 - b. Grade all refrigerant lines for proper oil return to compressor.
8. Install automatic valves, insertion pipe wells and energy meters in piping systems. Valves, wells and meters will be furnished under the work of other Sections or Divisions of the Specifications.

9. Steam Systems:

- a. Install steam pressure reducing valves and metering stations according to ANSI B31.1 and B31.9 standards.
- b. Pipe flashed high and medium pressure steam to flash tank.
- c. Provide drip trap assembly at low points and points where condensate may back up in front of control valves. Run condensate lines from traps to nearest condensate receiver. Where condensate lines form a trap, provide vent loop over the trapped section.
- d. Vent steam relief piping to atmosphere at locations approved by the Architect. Refer to exhaust head detail. Steam vents from flash tanks and condensate receivers shall be vented independently of pressure relief vents.

3.2 WELDING OF PIPING

- A. Where shown on drawings, specified or directed, use welded joints, outlets and flanges. Welded joints may also be provided elsewhere, at Subcontractor's option, except at points where it may be explicitly specified or directed to leave flanged joints.
- B. Whenever welded piping connects to equipment valves or other units needing maintenance, servicing, or possible removal, flange the connecting joints. Match the pressure rating of the pipe flanges with the pressure rating of the flanges on the equipment to which the piping connects. Provide flanged pipe sections to permit removal of equipment components.
- C. Welding Process: Sizes 4 inch and smaller, use either gas welding (oxyacetylene process) or metallic arc process; sizes above 4 inch, use metallic arc process.
- D. Preparation of Pipe Ends: For thicknesses up to 3/16 inch, ends shall be finished square or with 37½ degree bevel with a 1/16 inch band; for thicknesses 3/16 inch to 3/4 inch inclusive, ends shall be machined or ground to have a 37½ degree bevel with a 1/16 inch band per latest edition of ASTM B31.1.

END OF SECTION

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SECTION 232500

PIPE CLEANING AND CHEMICAL WATER TREATMENT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide flushing, cleaning and chemical treatment program in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Pipe Cleaning.
- B. Cleaning Chemicals.

1.3 SUBMITTALS

- A. Submit shop drawings listing chemicals and services provided for all systems.
- B. Provide layouts of feeding equipment, details of equipment and describing treatment program, including calculations and quantities of chemicals to be used. Calculations of required chemicals shall be based on an operation profile of 24-hours per day 365 days per year for equipment sizes scheduled.
- C. Provide calculations indicating the volume contained in each piping system. Calculations shall be based on approved shop drawings.
- D. Provide written report containing log and procedure of system cleaning, giving times, dates, problems encountered and condition of water.
- E. Submit written report containing results of tests and list of chemicals updated every 14 days during temporary use of treated systems.
- F. Provide inspections and submit written reports on a twice monthly basis. Provide for one (1) year after acceptance of system. Take samples of water at each inspection, analyze, and certify. Submit the analysis made on the water to the Engineer and the Owner. Include in the analysis report, recommendations as to any changes in water treatment required. Provide an initial dosage of 1.5 gallons of an aqueous solution of sodium nitrite base corrosion inhibitor (Nalco 2536), or approved equal, for each 100 gallons of water in the system.
- G. Provide written maintenance instructions to be included in Maintenance and Operating Manual.
- H. Provide certification of USDA approval.
- I. Submit an overall pipe cleaning and water treatment chart for all systems indicating pipe cleaning and water treatment procedures.
- J. Submit a written method statement describing the pipe cleaning, flushing, and water treatment procedures.

- K. Submit a line-by-line statement of compliance or non-compliance with this specification section.

1.4 QUALITY ASSURANCE

- A. Retain a chemical company, from approved list, to provide water treatment, feed equipment, testing equipment and chemicals for the systems as defined herein and as may be required to maintain the integrity of the piping systems and mechanical equipment.
- B. The water treatment chemical and service supplier must be a recognized specialist, active in the field of industrial water treatment for at least five (5) years, whose major business is in the field of water treatment, and who has full time service personnel within the trading area of the job site. Laboratory facilities must be available.
- C. Furnish and install all equipment and material on this project in accordance with the requirements of the authority having jurisdiction, suitable for its intended use on this project, approved by the U.S. Environmental Protection Agency (EPA), and local Department of Environmental Protection, and so certified by the manufacturer.
- D. Analyze water from the local water company to be used on the project, before establishing treatment procedures.
- E. Provide a two-hour training course to the Owner's operating personnel, instructing them clearly and fully on the installation, care, maintenance, testing and operation of the water treatment system. Arrange the training course at the startup of the system.

PART 2 - PRODUCTS

2.1 PIPE CLEANING

- A. Furnish all required pipe cleaning chemicals, chemical feed equipment, materials, and labor necessary to clean the piping as herein specified. In addition, permanently install necessary chemical injection fittings complete with stop valves and coupon racks, etc.
- B. Provide a pre-startup non-foaming, liquid detergent dispersant cleaner for cleaning of all systems to remove oil and foreign matter from the piping and equipment prior to the final filling of the systems. Use a chemical that is not injurious to persons, piping, pipe joint compounds, packings, coils, valves, pumps and their mechanical seals, tubes or other parts of the system.
- C. Furnish instructions dictating the quantities of the cleaner to use, methods and duration of the operation.

2.2 ACCEPTABLE MANUFACTURERS

- A. Water treatment program to be provided and maintained by:
 - 1. Nalco
 - 2. Tower Water Management

PART 3 - EXECUTION

3.1 GENERAL

- A. Install all equipment, chemicals, water devices, etc. in accordance with water treatment specialist's directions and drawings, for all systems previously noted. Contractor will provide 1-inch taps to bring system water to desired locations. Minimum 2 on each main supply and return on closed loop systems. Minimum 4 on each main supply and return on open loop systems.
- B. pH adjustment, inhibitor and dispersant tanks shall be shipped in use containers. Pump suction assemblies previously specified will pump directly from these shipping drums.
- C. Installation and startup shall be supervised by factory representatives of the equipment manufacturer and chemical manufacturer.
- D. Shipping containers shall be disposed of or refilled off the premises at no additional cost.

3.2 PRELIMINARY CLEANING

- A. Clean new piping internally by flushing prior to the application of pressure tests, and before the chemical cleanout procedures specified herein. Provide temporary strainers at the inlet to the chilled water, condenser water, and hot water pumps before the start of cleaning procedures.
- B. Block off and isolate circulating pumps, cooling coils, heating coils, heat exchangers, and steam traps during the preliminary flushing and draining process.
- C. Provide temporary by-passes to fully circulate through all branch piping.

3.3 PIPE CLEANING

- A. All Piping Systems
 - 1. Provide temporary connections with valves to fill and drain the piping and equipment after completion of the chemical cleanout procedure. Provide temporary blind flanges and/or caps to isolate the piping and equipment.
 - 2. Provide temporary piping connections, valves, strainers, bypasses, and blank connections where required to clean out systems.
 - 3. After each hydrostatic leak testing procedure is complete, drain the system until empty. The piping systems are internally chemically treated and protected during the hydrostatic testing procedure as described in the Section entitled "Testing, Balancing and Adjusting". Thoroughly clean the piping and flush as follows:
 - a. Cleaning will not take place more than 14 days prior to startup. Give the chemical manufacturer's representative at least 30 days' notice prior to startup.
 - b. Prior to the start of the chemical cleaning procedure submit three - two (2) foot lengths of the piping installed on this project to the chemical manufacturer for analysis of the interior coating on the piping. Refer to the Section entitled "Testing, Balancing and Adjusting" for additional requirements.
 - c. Before the chemical cleaning procedure is begun, install in each closed recirculating water system a temporary skid mounted portable side stream filtering system. The filtering assembly shall have 6" flanged connections and multiple cartridge filters capable of at least 600 gpm, an integral Barco type flow venturi, and be pressure rated for the system to which it is connected. Install the filter cartridges and change out until the system is clean. Initially provide twenty

- (20) micron cartridges, the intermediate set five (5) microns, and the final set one (1) micron.
- d. Add chemical pipe cleaning compound and corrosion inhibitor as recommended by the chemical manufacturer's representative to the system simultaneously with the filling of the system.
 - e. Circulate the cleaning compounds in the system for the time period specified by the chemical manufacturer.
 - f. Drain the system until empty from its lowest point.
 - g. Fill the system again with fresh water and flush thoroughly until clean water is obtained. (Maintain continuous blowdown and make-up as required during flushing operation). Use a one (1) micron cartridge type strainer element at end of drain hose to confirm that discharge water is free of foreign material.
 - h. The cleaning and flushing procedure must be approved in writing; by the chemical manufacturer. The chemical manufacturer's representative shall supervise and certify in writing the cleaning and flushing of the piping systems. The Contractor shall provide and install injection pumps, water meters, and coupon racks to control and monitor the cleaning process.

3.4 FILLING OF WATER SYSTEMS

- A. After completion of chemical cleanout, fill each water system with fresh water, air vent, and immediately add chemical treatment to passivate metal.

END OF SECTION

SECTION 233100

HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings, conditions of Contract (including General Conditions, Addendum to the General Conditions, Special Conditions, Division 01 Specification Sections and all other Contract Documents) apply to the Work of the Section.

1.2 SUMMARY

- A. This section includes the following:
 - 1. Sheet metal, ductwork, plenums and all accessories required for all duct systems.

1.3 DEFINITIONS

- A. No definitions are included in this section.

1.4 PERFORMANCE REQUIREMENTS

- A. Sheetmetal, ductwork, plenums and accessories shall meet or exceed the performance requirements specified in this specification section.

1.5 SUBMITTALS

- A. Shop Drawings
 - 1. Submit a chart listing each ducting system to be installed on the project listing the construction class of each duct system.
 - 2. Sheetmetal shop standards should include construction & installation details of the following: (low pressure duct construction table showing metal gauge, transverse joint type, & bracing, medium pressure longitudinal seam type, acoustic lining, fixing details, acoustic lining nosing details, plenum wall construction details, access doors, fire dampers, fire/smoke dampers, duct hanging method table showing duct size versus hanging method & materials, round elbows, square elbows, turning vanes (lined & unlined ducting), volume dampers, etc.
 - 3. Submit sheetmetal shop details for approval before any duct layouts are submitted for review. Shop drawings will not be acted on before shop details have been reviewed.
 - 4. Submit Autocad R-2010 computer generated layouts of all ductwork drawn to a scale of 3/8" to the foot for approval.
 - 5. Submit Autocad R-2010 computer generated drawing of location and size of sleeves for openings in floors and walls.
 - 6. Prior to ductwork fabrication, submit to the Engineer for review, complete certifications and data on all sheetmetal materials proposed for use (Mill certificates, galvanizing, etc.).
 - 7. Sheetmetal ductwork drawings serve as the base sheets for the Contractor Coordination Drawings specified in Section 230002.
 - 8. Submit ductwork shop drawings for review as specified in Section 23 0002.

9. Submit plan drawings showing duct point loads to structure and supplementary steel layouts for all systems.
10. Submit a line-by-line statement of compliance or non-compliance for each clause of this specification section.
11. Samples
12. Submit samples of sheetmetal (each gauge), flexible ducting and special materials, as required by the Engineer.

1.6 DESCRIPTION

- A. Provide all ductwork required to make the various air conditioning, ventilating and heating systems complete and ready for operation in accordance with the Contract Documents.

1.7 WORK INCLUDED

- A. General Ductwork.
- B. Round Duct.
- C. Duct Accessories.
- D. Flexible Duct.
- E. Belt Guards.
- F. Access Doors.
- G. Flexible Connections.
- H. Air Chambers.
- I. Plenums.
- J. Louvers.
- K. Drain Pans.
- L. Duct Sealant.
- M. Escutcheons.
- N. Sleeves.

1.8 QUALITY ASSURANCE

- A. Construct ductwork according to the pressure-velocity classifications established by SMACNA, and as called for on the duct drawings.
- B. Construct ductwork in accordance with Table 1-5 of the 1985 SMACNA Manual for 2" static pressure ductwork and Table 1-6 of the 1985 SMACNA Manual for 3" static pressure ductwork, with the exception that tie rods may not be utilized in ductwork 72" wide and smaller.

- C. Provide flexible duct assembly listed as Class 1 air duct by the Underwriters Laboratories under UL-181 "Standard for Factory-Made Air Duct Material and Air Duct Connections" at a flame spread of not over 25 and a smoke developed rating of not over 50 complying with NFPA Standard 90A.
- D. Flexible air ducts to have a heat loss per foot of duct as measured by Air Diffusion Council Flexible Air Duct Test Code FD 72-R1 and be UL listed as Class I under UL-181.
- E. Comply with OSHA standards and requirements.
- F. 1995 Edition of SMACNA duct construction standard as referenced by ASHRAE Energy Standard 90.1, 1999.

PART 2 - PRODUCTS

2.1 GENERAL DUCTWORK

- A. Construct sheetmetal ductwork of galvanized iron or aluminum of gauges specified in SMACNA Tables 1-4 to 1-9, unless otherwise called for on the Drawings.
- B. Unless otherwise indicated or specified, construct all sheetmetal ductwork in accordance with the HVAC DUCT CONSTRUCTION STANDARDS - METAL AND FLEXIBLE, First Edition, 1985, published by the Sheetmetal and Air Conditioning Contractors National Association, Inc., and herein referenced as the SMACNA Manual. Various page numbers, table numbers, plate numbers, detail numbers, and figure numbers herein cited refer to this edition of the SMACNA Manual. Install all ductwork in accordance with the arrangements and sizes shown on the Drawings and as specified herein.
- C. Construct low pressure ductwork of "lock forming quality" galvanized steel of the gauge thickness listed in Tables 1-5 and 1-6 for the pressure class indicated of the 1985 SMACNA Manual with gauge tolerances as listed in Appendix A-1 of the 1985 SMACNA Manual. Comply with ASTM A-525 for all steel with a hot dipped galvanized coating weight that complies with the G90 section of ASTM A525 and ASTM 90.
- D. Construct all ducts exhausting humid air from dishwashers, glasswashers, showers, driers, and as called for on the drawings of type 316 welded stainless steel. On horizontal ducts provide pan construction with longitudinal seams at the side or on top. Provide drainpipes to indirect waste at all low points of the ductwork.
- E. For rectangular ductwork, use radius elbows without vanes with centerline radius equal to 1½ times duct width. Where space is limited, use either curved elbow with single vane and with centerline radius not less than width of duct, or use square vaned elbow. For square elbows, use single thickness vanes for ducts up to 18 inches wide and double thickness airfoil vanes in ducts over 18 inches wide. Hold vanes in runners. See SMACNA Detail Fig. 2-3 and 2-4 of Standards. Construct turning vanes constructed of the same material as the ductwork in which they are installed.
- F. Alternative Joining
 - 1. At the Contractor's option, ductwork may be joined at the transverse joints with pre-fabricated galvanized Ductmate-35 sections, or with fabricated TDF or TDC T-24 type flanged transverse joints with bolted corners, gaskets, and sealants, constructed in

accordance with SMACNA Manual (1985), Table 1-12. Submit the joint packing material and joint construction details using this method and a 12" x 12" x 12" long duct sample to the Engineer for review. Plastic joint clips are not acceptable. Do not join flanged and prefabricated joints by different manufacturers.

2. Install Ductmate system according to manufacturer's instructions. Tables 12 and 13 of the installation instructions of September 1986 regarding the fastening of Ductmate angles must be observed. Bolting of corners is required.
3. TDC, TDF, and Ductmate flanges shall be installed in accordance with the manufacturer's recommendations.
4. All duct transverse joints longitudinal seams, and penetration shall be sealed.

2.2 ROUND DUCTWORK

- A. Provide round duct gauges in accordance with Table 3-2 of the 1985 SMACNA Manual. Provide girth reinforcing, girth joints, longitudinal seams, etc., in accordance with Figures 3-1, 3-2, 3-3, 3-4 and 3-5 of the 1985 SMACNA Manual. Snap-lock longitudinal seams are not acceptable. Draw band joint connection will not be acceptable. Use minimum 16 gauge galvanized steel with welded joint construction and companion flange joints for round duct over 52" in diameter.
- B. Use 5-piece or die-formed elbows up to 12 inch diameter. Use 7-piece on larger ducts with centerline radius equal to 1½ times duct diameter.

2.3 DUCT ACCESSORIES

- A. Provide spin-in fittings for connecting flexible duct to sheetmetal duct, incorporating die-formed locking groove with adjustable damper using spring loaded retractable bearing and positive locking regulator.
- B. Provide turning vanes in all 90° elbows where shown on the Drawings. Provide double fin type with 2" inside radius for small vanes (Figure 2-3) and 4½" inside radius for large vanes (Figure 2-3). Provide small vanes spaced no more than 2-1/8" apart for ducts up to 18" wide. Provide large vanes spaced no more than 3¼" apart for ducts 19" wide. Shop-fabricated turning vanes will not be acceptable unless they are machine shaped, punched and assembled. Use radius elbows where shown on the Drawings and for elbows 24" in width and smaller. Use radius elbows in accordance with Type RE-1 and RE-3, in Figure 2-2 of the SMACNA Manual.

2.4 FLEXIBLE DUCTWORK

- A. Provide flexible duct as a factory glass fiber insulated assembly with vapor barrier jacket and a maximum thermal conductance (C-factor) of 0.23 Btu per Hr per SF per °F at 75°F. Construct flexible duct of machine wound spiral aluminum helix, reinforced aluminum foil fabric mechanically locked into a spiral aluminum helix, or two-ply polyester core encapsulating a galvanized steel wire helix suitable for a positive working pressure of at least 10" w.c.
- B. Acceptable Manufacturers
 1. Genflex
 2. Thermaflex
 3. Flexmaster

2.5 BELT GUARDS

- A. Provide guards on all belt drives. Provide split type with tachometer opening at shafts fabricated from galvanized metal and braced to prevent rattling.
- B. Use solid or expanded metal on motors up to 5 horsepower.
- C. Use expanded metal on motors 7½ horsepower and up.
- D. Use angle frames on motors 25 horsepower and larger.
- E. Provide sufficient space so that sheaves can be changed to larger sizes.

2.6 ACCESS DOORS IN SHEETMETAL

- A. Where required in ductwork or casings, provide suitable access doors and frames to permit inspection, operation and maintenance of apparatus concealed behind the sheetmetal work. Provide access doors in insulated ducts of insulated double panel construction, not less than 20 gauge, galvanized steel. Provide access doors in uninsulated ducts of single panel construction not less than No. 18 gauge, galvanized steel. Provide all access doors with sponge rubber gaskets around their entire perimeter.
- B. Hang access doors in ductwork in separate frames and attached to duct with aircraft type cable. Provide "Ventlok No. 100" cast zinc latches one (1) per side.
- C. Install hinged walk-in type casing access doors where required and indicated on the Drawings. Construct casing access doors 57" high x 24" wide where possible and be complete with heavy duty hinges, hardware, and Ventlok #260 latch handles. See figures 6-11 and 6-12, and Table 6-2 of the 1985 SMACNA Manual.
- D. Where required in ducts carrying humid air, or grease laden air, locate access doors in the side of ducts.

2.7 FLEXIBLE CONNECTIONS

- A. Flexible connections shall be pre-assembled with sheetmetal end pieces connected to a flexible material. Minimum flexible connection length shall be 6 inches.
- B. Construct flexible connections of vinyl-covered fiberglass (or neoprene). Flexible connections must not contain asbestos and are to be suitable for the operating pressure and temperature of the system in which they are installed.
- C. Acceptable Manufacturers
 - 1. Durodyne

2.8 AIR CHAMBERS

- A. Provide air chambers of field assembled air supply apparatus, and as shown on the Drawings, entirely of "double-casing" construction.
- B. Construct the casing panels of two sheets not less than No. 20 U.S. gauge galvanized iron each: the outer sheet solid, the inner sheet perforated. Use "Fiberglass 704" (Owens

Corning) 4 inch thick fibrous glass, 6 pound per cu. ft. density insulating board between these sheets.

2.9 PLENUMS

- A. Provide air plenums for return and exhaust fans of "single casing" construction of No. 16 gauge galvanized iron braced and stiffened on outside by means of 2 inches by 2 inches by ¼ inch steel galvanized angles.
- B. Provide discharge and intake air plenums for connecting the fresh air intake and discharge openings to the various systems, as shown on the Drawings, of No. 16 gauge aluminum construction, braced and stiffened on outside by means of 2 inches by 2 inches by ¼ inch galvanized steel angles.

2.10 LOUVERS (PROVIDED BY OTHERS—FOR INFORMATION ONLY)

- A. All Louvers will be provided by the Architect. Coordinate all connections with the Architect.

2.11 AUXILIARY DRAIN PANS

- A. Construct drain pans of 16 gauge stainless steel with all joints welded. Construct pans watertight with hemmed edges.
- B. Under any equipment for which a pan is shown on the Drawings, and under all horizontal air handling units, duct mounted hot water or chilled water coils located above hung ceilings or electrical equipment, piping over electrical equipment, etc., furnish and install auxiliary drain pans. Extend the auxiliary drain pan at least 6" beyond the equipment it is serving and be at least 2" high.
- C. Provide drain pipe connections of at least 3/4", or as shown on the Drawings. Unless otherwise shown on the Drawings, route a 3/4" IPS galvanized steel or Type "L" copper tube to the nearest equipment room floor or hub drain independent of any air handling unit drains.

2.12 SCREENS

- A. Furnish and install all wire mesh screens indicated in the Construction Documents.
- B. Fabricate frame of extruded aluminum with mitered reinforced corners.
- C. Provide non-rewireable frame with permanently secured screen mesh.
- D. Provide mesh of ½ inch square, .063 inch intercrimped aluminum wire.

2.13 DUCT SEALANT

- A. Seal all joints and seams on medium and high pressure ductwork with an oil soluble elastomer sealant.
- B. Sealant to be fast curing to a firm rubbery seal and have gap filling properties with smooth easy caulking characteristics.
- C. Sealant to be gray in color.

D. Acceptable Manufacturers:

1. 3M Fastbond 900
2. Foster 32-14
3. MEI 44-50
4. Hardcast Sure Grip 404

E. The maximum allowable VOC content for field-applied duct sealant is 420 grams/Liter.

2.14 ESCUTCHEONS

- A. Cast iron or cast brass, deep type, to cover sleeve webs or fitting projections. Provide escutcheons for exposed duct through floors, ceilings, walls, and partitions in finished areas and ducts through all fire rated separations. Attach escutcheon to building material, not duct.

2.15 SLEEVES

- A. Construct sleeves for ductwork passing through blockwalls, partitions, wing or fulled ceilings, etc., of not lighter than 18 gauge galvanized steel.

PART 3 - EXECUTION

- 3.1 Execute the Work in strict accordance with the best practices of the trade and with these Specifications. Ductwork leakage in excess of SMACNA Standards for the seal class listed will not be acceptable. Seal ductwork with an approved U.L. listed water base sealant as required to comply with this leakage requirement.
- 3.2 Adhere to Drawings as closely as possible. The right is reserved to vary the runs and sizes of ductwork and to make offsets, where necessary to accommodate conditions arising at the building.
- 3.3 Make joints and seams smooth on the inside and a neat finish on the outside. Make duct joints airtight with laps made in the direction of air flow and no flanges projecting into the air stream. Provide ducts adequately braced to prevent vibration. Provide intermediate reinforcing and/or tie rod construction where necessary. Seal joints and seams according to SMACNA Standards.
- 3.4 Construct all longitudinal duct seams and joints as "Pittsburg Lock" or "Button Punch Snap-Lock" at the corners and Acme "Lock Grooved Seam" or "Automatic Seam Weld" in sides between corners. See Figure 1-5 of the SMACNA Manual. Provide sealant as required so that the leakage rates specified are not exceeded. Use Hard Cast CS-1001 sealer or equivalent for use in longitudinal duct seams, and Hard Cast IG-601 or Kingco 10-526 for external application on ductwork joints.
- 3.5 Wherever it may be necessary to make provision for vertical hangers of the ceiling construction passing through ducts, provide streamlined shaped sleeves around such ceiling construction hangers. Make all such streamlined sleeves airtight at top and bottom of ducts.
- 3.6 Suspend all ductwork properly supported from the building structure. The duct hanging system is composed of three elements; the upper attachment to the building, the hanger itself, and the lower attachment to the duct. Construct the attachments, hangers and supports for all ductwork in accordance with Figures 4-1 through 4-8 and Tables 4-1 through 4-3 of the 1985 SMACNA Manual. Submit the details for the upper attachment to the building to the Base Building Structural Engineer for review prior to submission to the Engineer.
- 3.7 Provide galvanized angle iron and bands for ductwork bracing and support.
- 3.8 Do not suspend ductwork or any device, or allow work installed by any trade to be suspended from ductwork (for example: lighting conduit, lighting fixtures, piping, ceiling construction, etc.)
- 3.9 Provide supplementary steel as required to support ductwork with a maximum deflection of 0.08" with the supported load acting at the mid-span of the steel.
- 3.10 Prior to mounting or hanging of mechanical equipment and ductwork, obtain approval from the Architect for proposed method of mounting and for exact location of all mounting points. Submit weights and location of all mechanical equipment and ductwork to the Architect for approval well in advance of general construction work to allow sufficient time for any structural analysis.
- 3.11 Replace, without any additional cost to the contract, any ductwork or components found to be noisy after installation, with said noise resulting from faulty materials or workmanship.
- 3.12 Cap openings in ducts during progress of construction tightly.
- 3.13 Where vermiculite, plaster, wire lath or lead wrapping is required to be applied completely about horizontal runs of ductwork (as indicated on the Drawings), provide all hangers and inserts for such

ductwork of extra strength and rigidity to support same. Provide hangers for such ductwork as specified hereinafter except that hanger spacing be one-half that specified.

- 3.14 Provide any ductwork passing through waterproof walls or roof construction with counterflashing.
- 3.15 Provide approved firestopping material around all ducts penetrating floors, walls, roofs, etc., in accordance with local codes, NFPA, and Architect's requirements.
- 3.16 All duct sheetmetal panels shall be cross-broken
- 3.17 RECTANGULAR SHEETMETAL DUCTWORK (CENTRAL PLANT SYSTEMS)

- A. The ductwork on this project falls into classifications as indicated below. Each classification has positive and negative requirements as shown.

Ductwork	Pressure Classification	Seal Class
Generator Room Supply Air	-2"/+2"	A
Generator Room Exhaust Air	-4"/+4"	A
Electric Room Supply Air	-2"/+2"	A
Electric Room Exhaust Air	-2"/+2"	A

- B. Comply with the pressure class, seal class and velocity class listed for the construction in each classification. Cross-break or use mechanical transverse beading on rectangular ductwork 12" and wider and install as indicated on the Drawings and as specified. Make beading at least 1/16" deep at the center of the bead and a maximum of 3/8 inch wide at the base of the bead.

- 3.18 Where tie rods are utilized, provide a fender washer and jam type lock on each side of the sheetmetal. Reinforce ductwork in accordance with Table 1-10. Construct ductwork over 96" wide with T-24 type flanged transverse joints with bolted corners. In lieu of using tie rods, this ductwork may be constructed as follows for the size ranges listed if carefully coordinated with all physical space limitations.

Dimension of Longest Side of Duct	Supply or Exhaust	Sheetmetal Gauge	Minimum Reinforcing Size*	Maximum Reinforcing Spacing
96" - 110"	Supply	18	2"	30" CC
111" - 160"	Supply	16	4"	24" CC
161" - 180"	Supply	14	6"	20" CC
181" and Larger	Supply	14	8"	18" CC
* 16 gauge "Z" bar or 12 gauge angle.				

Dimension of Longest Side of Duct	Supply or Exhaust	Sheetmetal Gauge	Minimum Reinforcing Size*	Maximum Reinforcing Spacing
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Dimension of Longest Side of Duct	Supply or Exhaust	Sheetmetal Gauge	Minimum Reinforcing Size*	Maximum Reinforcing Spacing
96" - 110"	Exhaust	16	2"	24" CC
111" - 160"	Exhaust	14	4"	20" CC
161" - 180"	Exhaust	12	6"	16" CC
181" and Larger	Exhaust	12	8"	14" CC
* 16 gauge "Z" bar or 12 gauge angle.				

Fasten reinforcing to ductwork on 12" centers by bolting or welding reinforcing to the ductwork.

- 3.19 Install duct connected grilles, registers and ceiling diffusers shown on the Drawings. Exact dimensions of openings must await approval of registers and diffusers. Submit exact locations for approval. Do not cut joints for the installation of outlets.
- 3.20 Where possible, fabricate all ductwork in such a manner that seams and/or joints will not be cut for the installation of grilles, registers, or ceiling outlets. If cutting of seams or joints is unavoidable, properly reinforce the cut portion to original strength.
- 3.21 LOUVERS (PROVIDED BY OTHERS—FOR INFORMATION ONLY)
 - A. Coordinate all Louver sizes and connections with the Architect.
- 3.22 DUCT MOUNTED SMOKE DETECTORS
 - A. Duct mounted smoke detectors are provided by Division 26 and installed by Division 23. Locate duct mounted smoke detectors in the ductwork in accordance with the manufacturer's recommendations, the requirements of NFPA, and the authorities having jurisdiction.
- 3.23 FLEXIBLE CONNECTIONS
 - A. Flexible connections to be approximately 6 inches long, after installation is complete securely held in place with heavy metal bands to prevent any leakage. Align ductwork and fans to be plumb prior to connection. Allow at least 1 inch of slack.
 - B. Provide flexible connection in ductwork connected to the inlets and/or outlets of all air handling units, fans, etc., except fan air handling units with internal isolators and flexible fan connections. Overlap ends of fabric 2" and glue with R-H Products Company, Inc., Number XL8 contact glue. Sewing or stapling will not be permitted. Allow at least one inch slack in all flexible connection installations to insure that no vibration is transmitted.
- 3.24 ACCESS DOORS IN SHEETMETAL
 - A. Provide access doors not smaller than 18 inches by 18 inches. Ducts smaller than 18 inches are to be provided with access doors 2 inches smaller than the width by 18 inches long. Provide access to all fire dampers as required by code and local authorities.
 - B. Where removable hung ceiling panels are installed below access doors, provide markers showing the access door location clearly.

3.25 AIR CHAMBERS

- A. Butt top edges of vertical panel into the bottom of the horizontal or sloping top panels with the joint fully caulked. Form the interior top and bottom edges of the casing with continuous angle, caulked where it adheres to casing. Form panels occurring at corners of casings to "L" shape so that no joint occurs at such corners. Make vertical and horizontal seams (connecting any panels) with caulked 1½ inches by 1½ inches by ½ inch angles. In addition provide necessary internal structural bracing members.
- B. Caulk joints to make them airtight. Gasket the bottoms of air chambers at the curb to prevent air leakage. Provide knee braces and additional bracing for chamber roofs, as required, to prevent sagging.
- C. Place longitudinal reinforcing angles on the inside of the casing in accordance with the following schedule:

Height of Side Walls or Width of Roof	Number Angles	Angle Spacing
Up to 6 feet	0	--
6 feet to 8 feet	1	Middle
8 feet to 12 feet	2	1/2 points
Over 12 feet	Variable centers	4 feet

- D. Provide angle size of 1½ inches by 1½ inches by 1/8 inch to 12 feet casing length, and 1-3/4 inches by 1-3/4 inches by 3/16 inch over 12 feet casing length.
- E. Size mixed air plenums for air handling units to prevent stratification across coils. Install baffles as required to maintain plus or minus 5°F temperature variation across coil face area.

3.26 PLENUMS (GENERAL EXHAUST PLENUMS ONLY)

- A. Provide standing seams with additional right angle bend and cap with No. 18 gauge galvanized "U" cap galvanized steel plenums for in-line centrifugal and axial flow fans.
- B. Provide the number of access doors as shown on the Drawings, minimum of one (1), for each sheetmetal plenum.
- C. Provide drain pan construction for air intake and discharge plenums; apply two (2) coats of mastic sealant to all joints; pitch bottoms for effective drainage.

3.27 DUCT SEALANT

- A. Clean and dry all surfaces thoroughly prior to application.
- B. Apply with caulking gun, trowel or spatula.
- C. Join surfaces to be sealed immediately after application of sealant.
- D. Follow manufacturer's instructions carefully for application, storage and cleanup.

- E. Do not use sealant which is beyond manufacturers recommended shelf life.

3.28 DAMPER CONNECTIONS

- A. Damper connections shall be rigid type unless local authority requires break-away type. This requirement shall be confirmed in writing, by the Contractor.
- B. Large dampers may need to be assembled from multiple damper sections jointed together into one assembly using mullions if the size and manufacturer requires. Should this be the case, provide all mullions and duct inlet and outlet transitions required to connect into a UL rated damper installation.

END OF SECTION

SECTION 233300

DAMPERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings, conditions of Contract (including General Conditions, Addendum to the General Conditions, Special Conditions, Division 01 Specification Sections and all other Contract Documents) apply to the Work of the Section.

1.2 SUMMARY

- A. This section includes the following:
 - 1. Supply of fire dampers, fire/smoke dampers, smoke dampers, volume dampers, and backdraft dampers for all duct systems.
 - 2. Installation of automatic control dampers provided by the Building Management and Control System (BMCS) 23 09 23 contractor.

1.3 DEFINITIONS

- A. No definitions are included in this section.

1.4 PERFORMANCE REQUIREMENTS

- A. Dampers shall meet or exceed the performance requirements specified in this specification section.

1.5 SUBMITTALS

- A. Submit complete manufacturers data on all dampers required by this section, including sizes, location, quantity, and construction details.
- B. Submit a schedule of all dampers utilized for this project indicating tag, type, location, mounting detail, size, actuator type, and handing. Final approval of dampers will not be granted without this schedule.
- C. For smoke damper, fire/smoke dampers, and automatic dampers, submit wiring diagrams to facilitate coordination with other trades.
- D. Submit the following fire/smoke damper, smoke damper, and fire damper mounting details.
 - 1. Damper in a slab.
 - 2. Damper in a block wall.
 - 3. Damper in a drywall partition.
 - 4. Unlined duct-to-damper connection.
 - 5. 1" and 2: acoustically lined duct-to-damper connection.
 - 6. Large damper mounting (including frame to create a large damper from smaller ones).
- E. Submit fire/smoke damper wiring diagram showing actuator motor, heat sensitive elements, end switches, and terminations into factory supplied terminal block.

- F. Submit 12 x 12 samples of fire dampers and fire smoke dampers proposed for use.
- G. Submit a line-by-line statement of compliance or non-compliance with this specification section.

1.6 DESCRIPTION

- A. Provide dampers in accordance with the Contract Documents.

1.7 WORK INCLUDED

- A. Fire Dampers.
- B. Ceiling Radiation Dampers.
- C. Combination Fire/Smoke Dampers.
- D. Combination Heat/Smoke Dampers.
- E. Smoke Dampers.
- F. Volume Dampers.
- G. Backdraft Dampers.
- H. Automatic Damper Installation.

1.8 QUALITY ASSURANCE

- A. Fabrication testing and installation to be in compliance with U.L., NFPA and local authorities. Fire dampers to be U.L. labeled for 1½ or 3 hour rating as indicated on the Drawings. Refer to architectural drawings for fire ratings of slabs and partitions being penetrated.
- B. Comply with Sheet Metal and Air Conditioning Contractors National Association (SMACNA) Details and details as shown on the Drawings.
- C. For positive smoke control, dampers shall conform to U.L. Standard 555S.
- D. All fire dampers, smoke dampers and fire smoke dampers shall be recognized by the state of New York and IBC 2008 for use as fire protection and smoke control components.

PART 2 - PRODUCTS

2.1 FIRE DAMPERS

- A. Provide fire dampers in ducts piercing fire rated walls, and floors, as required by NFPA, local codes and local authorities having jurisdiction. All fire dampers are to comply with latest UL-555 Standard.
- B. Fire dampers designated as FD on the Drawings are 1½ hour rated; FD-3 are 3 hour rated. Dampers to be of the curtain type with frames of 18 gauge steel and blades of 21 gauge steel. All dampers shall be approved for use in dynamic system. Dampers to be stainless

steel spring loaded for closure. Provide U.L. rated 160°F 250 °F fusible link. Dampers must lock in closed position.

- C. Fire dampers designated as FD-H on the Drawings are operated through an integrally mounted heat sensor in lieu of a fusible link. These dampers will be wired for 24 volt operation.
- D. All fire dampers blades shall be out-of-the airstream.
- E. Fire dampers shall be installed within galvanized wall sleeves appropriately sized for fire damper, wall thickness, & retaining angles.
- F. Acceptable Manufacturers
 - 1. Ruskin
 - 2. Imperial
 - 3. Prefco

2.2 CEILING RADIATION DAMPERS

- A. Conform ceiling radiation dampers for ceiling opening protection to NFPA Pamphlet No. 90A and U.L. listed. Use Ruskin ceiling fire damper Model CFD (R), 2, 3, or CFD4 for surface mounted diffusers and Model CFD (R) 5 for lay-in type diffusers. Install ceiling fire dampers in a manner acceptable to the authorities having jurisdiction.

2.3 COMBINATION FIRE/SMOKE DAMPERS

- A. Provide combination fire/smoke dampers as shown on the Drawings in ducts piercing fire rated walls and floors, and where shown on the Drawings.
- B. Provide normally closed dampers that are fusible link operated or heat sensor activated to close above 165°F. Fusible link and heat sensor temperature setting should comply with IBC 2008 requirements.
- C. Provide a 120 volt (UL 555 rated) actuator(s) for each damper that is factory mounted.
- D. Provide each damper with two (2) sets of independent end switches factory pre-wired.
- E. Provide each damper with a factory installed 120V disconnect switch, and fuses.
- F. Provide a junction box disconnect switch, fuses and terminal strip for each damper (and each damper section of a multi-section damper). The damper power wire, neutral wire, earth wire, and four (4) end switch wires shall terminate at this terminal strip for connection by other trades.
- G. Provide two (2) spare terminals in each terminal strip.
- H. Label all terminal strip connections to correspond with wiring diagram.
- I. Damper and damper actuators to be of opposed multi-blade construction and classified in accordance with U.L. Standard 555 and 555S.

- J. Damper construction to be minimum 16 gauge galvanized steel frame and blades. Side seal to be Type 304 flexible stainless steel with bronze or stainless steel shaft bearings in end plate. Damper linkage to be outside air stream.
- K. Provide dampers designated as "FSD-FL" with a fusible link which will close and lock damper on increased air temperature over 165 F. Fusible link temperature setting should comply with IBC 2008.
- L. Provide dampers designated as "FSD" with an electrically resettable link which will close and lock damper on increased air temperature over 165°F. The link to be manually resettable at the damper linkage without need of link replacement. Provide damper position indicator external of damper. Fusible link temperature setting should comply with IBC 2008.
- M. Provide dampers designated as "FSD-HS" as normally closed and provided with a means of automatically opening dampers remotely from the Fire Command Center when the air temperature is below the damper linkage degradation temperature of 250°F. This will be accomplished by a thermal link which will disengage the damper actuator at or above the degradation temperature of the damper. The release of the link will cause the damper to close and lock until the link has cooled to below the degradation temperature. Activation of the actuator will re-engage the damper linkage in this situation.
- N. Provide dampers designated as "FSD-RA" as normally open and provided with a means of maintaining damper closed during "normal" situations. Provide means to automatically open dampers remotely from the fire command center, or as described in the controls specification.
- O. Fire/smoke dampers shall be installed within galvanized wall sleeves appropriately sized for fire/smoke damper, wall thickness and require retaining angles.
- P. Large dampers may need to be assembled from multiple damper sections joined together into one assembly using mullions if the size and manufacturer requires. Should this be the case, provide all mullions and duct inlet and outlet transitions required to install the damper in accordance with UL requirements.
- Q. Fire/smoke dampers shall be installed within galvanized wall sleeves appropriately sized for damper, wall thickness, and retaining angles.
- R. Acceptable Manufacturers
 - 1. Ruskin Model FSD60 (Class 1)
 - 2. Greenheck
 - 3. Nailor
 - 4. Imperial

2.4 COMBINATION HEAT/SMOKE DAMPERS

- A. Provide combination heat/smoke dampers designated as "HSD" on the Drawings in ducts which are used for venting of shaftways, stairwells, elevator hoistways, etc.
- B. Construct dampers as described for combination fire/smoke dampers except that dampers will be normally open.

2.5 SMOKE DAMPERS

- A. Provide smoke dampers as shown on Drawings designated as "SD".
- B. Construct dampers as described for combination fire/smoke dampers except that no fusible link or heat activated sensor is required.
- C. Acceptable Manufacturers
 - 1. Ruskin - Model SD36 (Class 2)
 - 2. Nailor-Hart
 - 3. Greenheck
 - 4. Imperial
 - 5. Arlan

2.6 VOLUME DAMPERS

- A. Provide volume dampers as shown on the Drawings and as required for proper balancing and distribution of air, in the various branches of the ductwork for use in balancing the system. Dampers to be installed separately and independently of the registers hereinafter specified to be set behind supply, return and exhaust air grilles. Provide multi-blade dampers in ducts above 24 inches in width or 16 inches in height. Coordinate with the air balancing subtrade specialist and provide all additional dampers required for proper air balance.
- B. Provide volume dampers of the quadrant type, of heavy construction, pivoted to turn easily and provided with approved operating and locking devices mounted on outside of the duct in an accessible place.
- C. For all volume dampers located above inaccessible ceilings, provide remote cable operators. Anemostat type OB-ASL complete with fastening device and hex key operator.

2.7 BACKDRAFT DAMPERS

- A. Provide balanced, tight closure, 1/8-inch thick aluminum backdraft dampers of the self-operating type where indicated on the Drawings. Fabricate damper frames from extruded aluminum with mitered corners. Blades to be extruded aluminum with extruded vinyl edge seals. Blade/frame assembly to be weather resistant with blades overlapping the frame. Damper bearings to be bronze oilite nylon or cyclox. Provide bird screen over opening.
- B. Acceptable Manufacturers
 - 1. Ruskin
 - 2. Prefco

2.8 AUTOMATIC DAMPER

- A. Install all automatic dampers being supplied by Building Management and Control System Contractor (23 09 23).

PART 3 - EXECUTION

3.1 FIRE DAMPERS AND FIRE/SMOKE DAMPERS

- A. Provide conveniently located access doors, of ample size for resetting the dampers. Duct mounted grilles, registers or diffusers can be used for access as long as such access is readily available as determined by the Architect.
- B. Galvanize or paint with one coat of rust inhibiting paint the entire fire damper assembly before installation.
- C. In the open position with damper shutter stored, provide 95 percent free area.
- D. All actuators of automatic fire dampers (FD-H) and combination fire/smoke dampers (FSD), are factory installed and pre-wired to a terminal strip. If local union regulations require otherwise, this contractor shall supply all conduit materials, and labor to complete this installation on site.
- E. Fire/smoke dampers designated as FSD-HS will be installed in ducts and penetrations of rated walls and floors which are part of a smoke control and/or evacuation system. These dampers may be controlled during normal operation by the Building Management and Control System (BMCS); however, during a smoke or fire emergency, these dampers will be openable from the Fire/ Command Center.
- F. Design dampers incorporating multiple sections in such a way that the actuators are readily accessible. Coordinate locations so as not to be necessary to remove damper sections, structural, or other fixtures, to facilitate removal of damper motors. Provide access doors where necessary to meet this requirement. In particular, ensure that where in-air stream actuators are provided, they are readily accessible.
- G. Do not install Class 1 fire/smoke or smoke dampers in ducts with any dimension smaller than 12". Expand duct to 12" prior to installation.

3.2 FIRE SMOKE & SMOKE DAMPER WIRING

- A. Two distinct type of damper control and wiring configurations exist for this project. These are described in detail on the electrical drawings.
- B. It is the intent that all dampers are to be wired from their field locations back to their respective system's motor control center or motor starter.
- C. A power supply and interface with the building control system and fire alarm system will be achieved at the motor starter.

3.3 ALL DAMPERS

- A. Mount dampers plumb and level. Provide additional duct bracing and supports to properly support dampers.
- B. Provide duct access doors for internal access to all fire dampers, combination fire/smoke dampers, smoke dampers, automatic dampers, and backdraft dampers.

- C. Damper construction to be similar to that of the ductwork to which it connects (i.e., galvanized to galvanized, stainless steel to stainless steel).
- 3.4 Provide on all dampers, extractors, etc. mounted on externally insulated ductwork, 16 gauge elevated platform at least 1/8" higher than the thickness of the insulation. Provide damper shaft with Ventlok No. 607 bearing mounted on ductwork within elevated platform.
- 3.5 Large dampers may need to be assembled from multiple damper sections joined together into one assembly using mullions if the size and manufacturer requires. Should this be the case, provide all mullions and duct inlet and outlet transitions required to install the damper in accordance with UL requirements.

END OF SECTION

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SECTION 233400

HVAC FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings, conditions of Contract (including General Conditions, Addendum to the General Conditions, Special Conditions, Division 01 Specification Sections and all other Contract Documents) apply to the Work of the Section.

1.2 SUMMARY

- A. This section includes the following:
 - 1. Supply of ventilation and exhaust air fans.

1.3 DEFINITIONS

- A. No definitions are included in this section.

1.4 PERFORMANCE REQUIREMENTS

- A. Fans shall meet or exceed the performance requirements specified in this specification section.

1.5 SUBMITTALS

- A. Submit an overall fan schedule for this project.
- B. Submit fan curves, fan dimensions, fan selection point, fan motor location, motor selection; bearing selection, drive selection (type & quantity) for each fan.
- C. Fan selections shall demonstrate requirement of clause 2.1.c.
- D. Submit fan/motor starting calculations for each fan.
- E. Submit full technical rating data based on tests in accordance with current AMCA standards and in an AMCA approved laboratory. Include manufacturer's certified fan performance curves, and certified sound power ratings. Correct all ratings and curves for altitude and temperature where applicable.
- F. Furnish a copy of AMCA certified rating certificate for all fans.

1.6 DESCRIPTION

- A. Provide centrifugal and axial fans in accordance with the Contract Documents.

1.7 WORK INCLUDED

- A. Centrifugal Fans
 - 1. Scroll
 - 2. Cabinet
 - 3. Tubular Centrifugal
- B. Axial Fans
 - 1. Propeller
 - 2. Vaneaxial - Fixed Blade
 - 3. Vaneaxial - Adjustable Blade
- C. Roof Exhaust Fans.

1.8 QUALITY ASSURANCE

- A. Construct all fans to comply with the requirements of the latest editions of the Air Moving and Conditioning Association (AMCA) Standards and Bulletins. Certify these fans by AMCA for performance ratings and provide the AMCA Performance and Construction Seal.
- B. Install fans, with their accessories, to comply with state and local Codes and with the recommendations of the National Fire Protection Association (NFPA).

PART 2 - PRODUCTS

2.1 GENERAL - ALL FANS

- A. Unless noted otherwise, provide discharge direction and drive arrangement to suit space conditions and conform as closely as possible to the layouts shown on the Drawings.
- B. Provide fans that are quiet operating and non-overloading over the entire range of operation.
- C. Provide fan motors in accordance with section entitled "Electric Motors." Size motor to drive its respective fan when the fan is operating at a speed 5% in excess of that required to meet the scheduled fan performance. Do not select motors within the service factor for this range.
- D. Provide fan starters in accordance with section entitled "Motors Controllers" for installation by Division 14.
- E. Statically and dynamically balance fan wheels/impellers at the factory and so certify.
- F. Provide precision self-aligning bearings designed to prevent leakage of oil or grease. Provide cups, oil chambers, Zerk or Alemite lubrication fittings in accessible locations for ease of lubrication. Provide heavy duty split pillow block bearings with tapered, double-row spherical roller assemblies. Provide bearings with service life in excess of 200,000 hours L-10 at maximum cataloged fan operating conditions.
- G. Provide copper lubrication leads, for lubrication of internal motors and bearings, extending to a capped termination point external to the fan casing.

- H. Extend wire leads on fans driven by direct motor drive from the motor in air tight rigid walled conduit, to a junction box mounted external to the fan casing.
- I. On fans driven by belt drive provide standard "V-groove" type belts and sheaves suitable for the service intended. Fan sheaves are non-adjustable type with removable machined bushings. Provide adjustable pitch type motor sheaves (for all fans 10 HP and less) with double locking feature, to 10% above and below the rated fan speed. Provide a second set of fixed pitch motor sheaves for installation by contractor after system balancing. Dynamically balance sheaves with over three grooves. Provide at least two belts for all fans. Design multiple belt drives capable of carrying the entire load with one belt broken. Provide preformed expanded metal or sheetmetal belt guards, with grommets tachometer ports at the fan and motor shafts, for all exposed sheaves and belts.
- J. Provide premium efficiency motors for all fans.
- K. Provide solid hot rolled steel drive shafts, accurately turned and polished to a close tolerance where in contact with bearings. Secure fan wheels/impellers to the drive shaft by a key and keyway assembly.
- L. Manufacture fans of materials and finishes suitable for the service intended.
- M. Construct wheels/impellers & casings exposed to normal atmospheres of mild steel, hot dip galvanized before assembly, and finished with two layers of factory applied non-scaling paint.
- N. Construct fans exposed to corrosive atmospheres of corrosion resistant materials suitable for intended use, and factory finished with epoxy, other approved corrosion resistant coatings, or hot dipped galvanized after fabrication.
- O. Provide fans exposed to elevated temperatures with components rated for high temperature service. Do not use belt drive assemblies exposed to the airstream. Use direct drive motors certified for high temperature service.
- P. Construct fans used to convey flammable vapors of non-sparking (non-ferrous) materials, and use explosion proof motors.
- Q. Electrically ground fan and drive to prevent accumulation of static charge.
- R. Completely house fan assemblies exposed to weather in weatherproof enclosures including motor and drive.
- S. Fan wheels/impellers and casings shall be relieved of residual stresses produced in the forming process.
- T. Provide fans used to exhaust grease laden vapors with motor drive and bearings completely external of air stream.
- U. Provide housings with integral inlet and discharge flanges, complete with bolt holes for duct connections.

- V. Provide variable frequency drive as specified in section entitled "Adjustable Frequency Controllers." Fans using Variable Frequency Drives shall have motors which are compatible with the drives.
- W. Provide gasketed access doors to permit routine maintenance and inspection of motor and internal components.
- X. Provide suitable guards on all open fan inlets or outlets.

2.2 CENTRIFUGAL FANS

A. Scroll Type

- 1. Airfoil (AF), fan wheels, and single width single inlet (SWSI), or double width double inlet (DWDI), as indicated on the Drawings, enclosed in a scroll shaped fan housing with the class construction as shown on schedule.
- 2. Weld or securely rivet fan blades to the hub plate and rim.
- 3. Rigidly build and brace curved scroll shaped housings with continuous welded seams and joints. Lockseam construction may be accepted for smaller fan sizes where it is standard construction for models listed on Drawings.
- 4. Fans larger than 30" wheel diameter shall have horizontal split housing. The splits shall have 3 x 3 x 3" angle iron welded to the housing with minimum 4" bolts on 12" centers.
- 5. Provide all floor mounted centrifugal fans room with engineered, steel construction, inlet air boxes to allow for a compact unit footprint. Inlet boxes shall be fabricated of 8 gauge steel minimum.

B. Tubular Type

- 1. Provide backward inclined or airfoil fan wheels as indicated on the Drawings, in a cylindrical housing, with integral inlet venturi and airflow straightening vanes, arranged to impart unidirectional air flow.
- 2. Weld fan blades to the hub plate and rim. Backward inclined blades may be securely riveted to the hub plate and rim. Precisely cast aluminum fan wheels and machine finish.
- 3. Match the wheel inlet ring to a close tolerance with integral deep spun aerodynamic venturi inlets.
- 4. Provide radial air flow straightening vanes at the fan discharge.

C. Cabinet Type

- 1. Provide scroll type centrifugal fans, factory installed within a cabinet enclosure, and comply with the requirements of Scroll Type Centrifugal Fans.
- 2. Internally isolate fan and motor assemblies from the cabinet.
- 3. Provide gasketed access doors and panels for inspection and routine maintenance of the internal components.
- 4. Provide solid state variable speed controllers for small ceiling mounted direct driven exhausters and transfer fans.

D. Acceptable Manufacturers (Free -Standing Centrifugal Fans)

- 1. Bayley
- 2. Chicago Blower
- 3. New York Blower

4. Greenheck

2.3 AXIAL FANS

A. Propeller Type

1. Include propeller type impellers, complete with motors, and panel or ring mountings.
2. Vary fan blades in camber and twist from base to tip.
3. Construct impellers of die formed steel or aluminum attached to a central hub mounted on the fixed drive shaft.
4. Rotate fan hub on the fixed drive shaft using sealed ball bearings.
5. To eliminate overhang load on belted units, design to apply belt load to the hub in the same plane as the bearings.
6. Direct drive fans are acceptable where belt driven units do not meet the criteria.
7. Provide wall louver, backdraught damper, wall sleeve, and inlet wire mesh screen for each fan.
8. Provide basket type fan guards for exposed inlets and discharges.
9. Acceptable Manufacturers
 - a. Bayley
 - b. Greenheck
 - c. Penn

B. Vaneaxial Fixed Blade Type

1. Include impeller, motor, drive and cylindrical housing.
2. Construct fan blades, airfoil cross section, varying in camber and twist from base to tip, of cast aluminum.
3. Fixed pitch fans shall have form impeller blades and hub in a single casting, or precision weld blades to the hub assembly.
4. Mount impeller directly on the drive shaft and secure in place with locking keyway assembly. Design motor and impeller to be removable from the inlet side of the fan.
5. Cross brace motor support base on direct drive fans to the fan housing for structural rigidity to prevent motor misalignment.
6. On belt drive fans protect belts and bearings from the airstream in an air insulated enclosure. Design to apply belt loads to the hub in the same plane as the bearings to eliminate overhang load.
7. Construct cylindrical fan housings of heavy gauge hot rolled steel with continuous weld seams.
8. Provide venturi inlet bell and discharge diffuser accessories of the same gauge and material as the fan housing.
9. Acceptable Manufacturers
 - a. Bayley
 - b. Greenheck
 - c. Penn

C. Acceptable Manufacturers

1. Woods - Type JM
2. Chicago - Design 47

2.4 ROOF EXHAUST FANS

- A. Provide roof exhaust fans of the centrifugal, belt-driven type. Construct fan housing of heavy gauge aluminum.
- B. Construct all spun parts with a rolled bead for added rigidity and spun so as to seal the pores of the aluminum providing greater resistance against oxidation and deterioration.
- C. Provide all-aluminum fan wheel of the centrifugal blower type backward inclined blades and a tapered inlet shroud. Statically and dynamically balance wheels.
- D. Provide inlet cone of aluminum centrifugal blower type.
- E. Enclose motor and drives in a weather-tight compartment, separate from the airstream. Design to provide air for cooling the motor to the motor compartment by way of an air passage from an area free of contaminated exhaust fumes.
- F. Provide motors of the heavy duty, permanently lubricated, sealed ball bearing type. Size drives for 165% of motor horsepower capabilities and of the cast iron type, keyed to the fan and motor shafts. Provide variable pitch drives.
- G. Construct fan shaft of steel construction, turned, ground and polished to precise tolerances in relationship to the hub and bearings.
- H. Provide drive belts of the oil-resistant, non-static, non-sparking type with life expectancy of over 24,000 hours.
- I. Provide bearings flanged and of the permanently lubricated, permanently sealed, ball bearing type capable of over 200,000 hours bearing life.
- J. Design the entire drive assembly and wheel removable, as a complete unit, from the support structure without disassembling the external fan housing. Mount the complete drive assembly on rubber vibration isolation.
- K. Provide direct drive units of identical construction as belt drive units, except for drives, belts, and fan shaft bearings.
- L. Construct units of Type B construction and carry a one-year warranty.
- M. Construct all belt drive units requiring Type A construction, interior and exterior parts, including wheel, wheel hub, supporting posts, fan shaft, drive assembly, and all outside fasteners, of aluminum or non-ferrous material. Include a five-year warranty.
- N. Provide fans licensed to bear the AMCA ratings seal for air and sound performance.
- O. Acceptable Manufacturers
 - 1. Loren Cook
 - 2. Greenheck
 - 3. Penn
 - 4. Aerovent

5. Peerless

PART 3 - EXECUTION

- 3.1 Install fans in accordance with manufacturer's recommendations and as shown on the Drawings. Follow SMACNA and AMCA recommended procedures for fan installations, belt guards, duct connections, etc.
- 3.2 Provide flexible connections as described in specification section entitled "Sheetmetal" to provide sufficient separation of ductwork from fan assembly to prevent metal-to-metal contact. Flexible connections at fan inlets shall be firmly installed so there is little distortion during operation.
- 3.3 Install fans and motors with proper support and vibration isolation as specified in section entitled "Vibration Isolation". Fans used for smoke control to be seismically mounted.
- 3.4 Provide sufficient clearances around fans for access and servicing of components. Install fans such that access doors, motors, belts, lubrication lines, electrical connections, etc. are readily accessible and not obstructed by other installations or structures.
- 3.5 Bump start fans to check that fan wheel/impeller rotation corresponds to the desired direction of air flow. Correct fans found to be rotating in a direction opposite to that desired.
- 3.6 Tighten belt drives, taking into account the service factor and any other design of the drive. Exercise care not to overtension belts.
- 3.7 Check all bolts and fasteners to ensure proper tightness. Do not overtighten nuts and bolts.
- 3.8 Check bearings and motor for proper lubrication, taking care not to overlubricate. Use only lubricants recommended by the manufacturer.
- 3.9 Provide a drain at the bottom of the housing for fans discharging upward from the roof. Pipe drains from housings of interior fans discharging directly up through the roof indirectly to a floor drain. Pipe drains from housings of kitchen grease exhaust fans to a grease interceptor.
- 3.10 Replace all adjustable motor sheaves with fixed pitch shown after system balancing.

END OF SECTION

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SECTION 235300
FUEL HANDLING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide fuel oil handling systems in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Fuel Oil Storage Tanks
- B. Leak Detection System.
- C. Fuel Oil Tank Gauging, Leak Monitoring and Overfill Prevention
- D. Triplex and Duplex Fuel Oil Pump sets
- E. Fuel Oil Filtration and Polishing Systems
- F. Double Wall Day Tank
- G. Piping, Valves and Accessories.
- H. Fuel Oil Piping.

1.3 SUBMITTALS

- A. Submit full technical rating data, catalog cuts, model numbers, dimensional installation details, capacities, construction details, piping details, wiring diagrams, and installation instructions.
- B. Submit shop drawings of the day tank for approval. The shop drawings shall indicate the size, construction data, tapping connections and location of the tapings.
- C. System vendor shall coordinate product data presented by leak monitoring system and fuel storage and forwarding system to provide a comprehensive set of interfaced drawings which will serve as the basis for system evaluation by Engineer and installation by Mechanical Contractor designated by Owner.
- D. Installation Plans: Provide Owner accurate as-built plans which show the size and location of any new underground or above ground tank and piping system. These plans must include a statement by the installer that the system has been installed in compliance with the State and local standards as well as the Department of Environmental Protection.

1.4 QUALITY ASSURANCE

- A. Comply with the following governing standards:
 - 1. Underwriters' Laboratories, Inc.
 - 2. National Fire Protection Assoc. (NFPA 30) Flammable and Combustible Liquids Code and (NFPA 31) Standards for Installation of Oil Burning Equipment.

3. National Sanitation Foundation Testing Laboratory, January 1984, listing of Plastic Piping System Components and Related Materials, Standard 15.
 4. Steel Tank Institute.
- B. Construct, test and install the tanks in accordance with NFPA recommendations and furnish with Underwriters' label.
- C. Comply with all governing Federal, State and local requirements and with the Department of Environmental Protection.
- D. All tanks, pumps, piping and fuel oil accessories shall comply with all governing Federal, State and local codes and all regulations of authorities having jurisdiction. Comply with Underwriters' Laboratories requirements and Department of Environmental Protection.
- E. Factory test all fuel tanks at 25 psig after fabrication.
- F. Furnish major elements of the fuel systems by a single source vendor to assure design, installation and service interface and to provide in-warranty and post-warranty unified responsibility for training of personnel and supply of replacement parts to Owner.
- G. One-year warranty

PART 2 - PRODUCTS

2.1 FUEL OIL TANK

- A. Single Wall Steel Aboveground Storage Tank (AST)
- B. Supply (5) cylindrical NYC Building Code 1305.14 "ALTERNATE" tank design, factory built above ground single wall steel fuel oil storage tanks with structural steel saddles. Tank design suitable for a 25 psig working pressure.
- C. Tank shall comply with the latest edition of National Fire Protection Association NFPA 30 Flammable and Combustible Liquids Code and tested at factory at 25 PSI.
- D. Exterior Protective Coating:
- E. Exterior Protective Coating:
1. Two coats of Rust proof prime paint.
 2. Two coats of protective Epoxy paint over the prime paint
- F. Tank Capacity
1. Life Safety Tanks = (4) tanks each 20,000 Gallons; 8'-0" diameter; approx. 60 Feet long
 2. Life Safety Tank = (1) Tank; 8,000 Gallons; 8'-0" diameter; approx. 20 Feet long
- G. Tank Details
1. Lifting lugs shall be provided at balancing points to facilitate handling and installation.
 2. Connections supplied as follows - Threaded fittings shall be supplied with thread protectors, Flanged connections shall be supplied with plastic flange connectors.
 3. All fittings must be located on tank top per UL, all fittings threaded unless noted otherwise:
 4. Detailed Fittings – Life Safety Generator Tank
 - a. One (1) – 4" Spare
 - b. One (1) – 3" Normal Vent (sized per UL142)

- c. One (1) – 10" Emergency Vent, (sized per UL142)
 - d. One (1) – 3" Product Fill
 - e. One (1) – 2-1/2" Pump set return
 - f. One (1) – 2" Pump set supply
 - g. One (1) – 2" Filtration set return
 - h. One (1) – 2" Filtration set supply
 - i. One (1) – 4" flanged Electronic Level Gauge
 - j. One (1) – 2" Backup high level switch
 - k. One (1) - 30" Manway
 - l. One (1) – 2" Pump set relief valve return
 - m. One (1) – 3" Spare – Fill
 - n. One (1) – 4" Spare
5. Detailed Fittings – Stand-By Generator Tanks
- a. One (1) – 4" Spare
 - b. One (1) – 3" Normal Vent (sized per UL142)
 - c. One (1) – 10" Emergency Vent, (sized per UL142)
 - d. One (1) – 3" Product Fill
 - e. One (1) – 3" Pump set return
 - f. Two (2) – 3" Pump set supply
 - g. One (1) – 2" Filtration set return
 - h. One (1) – 2" Filtration set supply
 - i. One (1) – 4" flanged Electronic Level Gauge
 - j. One (1) – 2" Backup high level switch
 - k. One (1) - 30" Manway
 - l. One (1) – 2" Pump set relief valve return
 - m. One (1) – 3" Spare – Fill
 - n. One (1) – 4" Spare
6. All fill, fuel oil supply and fuel oil return connections will be supplied with drop tubes in the tank and weep holes to prevent surging or air encapsulation.
7. Additional Equipment
- a. External Ladder.
 - b. Walkway(s) with Handrails.
 - c. Internal Ladder
8. Execution:
- a. Tank shall be installed on a reinforced concrete base constructed by the owner. Installation and testing shall be in strict accordance with Steel Tank Institute Installation.
 - b. Tank to be supplied by Analytical & Combustion Systems Phone # 800-545-2514
 - c. Approved Manufacturer: Mass Tank, or equal.

2.2 FUEL OIL LEAK DETECTION SYSTEM

- A. Provide a continuous leak detection system utilizing electro-optic technology. The continuous leak detection system will be integral to the fuel oil management control system provided with the fuel oil transfer pump sets

2.3 GENERATOR FUEL OIL DAY STORAGE TANKS

- A. Life Safety Generator = ~~275~~ 330 gallon single wall day tank (Provided by the mechanical contractor). Day tank to be built to NYC Building Code 1305.14 "ALTERNATE" tank design standards and tested to a working pressure of 25 psig.

B. Tank Connections

1. 6"x6" Inspection port

2. 1" – Fuel oil inlet with drop tube
3. Vent connections as required by code
4. 1" - Manual fill
5. 1" - Overflow
6. 1" - Engine supply with drop tube
7. 1" - Engine return with drop tube
8. 2" - Level control
9. Vent sized per UL142
10. All piped with reinforced, welded pipe adapters
11. Fuel inlet and return must be supplied with factory installed drop tubes to prevent surging and foaming in the day tank.

C. Rupture Basin

1. The Rupture Basin shall consist of an open-top, welded heavy gauge steel structure sized for 200% capacity of tank.
2. The Rupture Basin shall consist of a welded heavy gauge steel structure
3. Exterior shall be finished in an oil resistant, textured gray enamel.
4. Provide a factory installed rupture basin leak detector for alarming and fuel supply pump shut down. Electrical connections shall be contained in a weatherproof junction box. Switch shall be a Preferred Model RBS

D. Level Control

1. Level Controls shall have four (4) float operated switches rated at 100 watts at 120VC and factory installed in the day tank.
2. Levels of control: emergency high-level alarm and total pump shutdown (90% capacity),
3. Pump off (80% capacity)
4. Pump on (50% capacity)
5. Emergency low-level secondary pump on and annunciation (40% capacity).
6. Unit shall be suitable for pressures to 150 psi, and shall be made entirely of non-ferrous material.
7. Electrical connections shall be contained in a weatherproof junction box.
8. Level Control shall be Preferred Model PLS-xx-4.

E. Emergency High-High Level Switch

1. Day tank shall be provided with a float operated switch to be mounted in the vent line (shipped loose) to indicate the occurrence of a tank overflow into the vent line.
2. Switch shall be mounted in a tee connection as close to the day tank as possible. Switch shall be redundant sealed against vapors and fluids, lever float operated and magnetically actuated.
3. Electrical connections shall be contained in a weatherproof junction box.
4. Switch shall be as manufactured by Preferred Utilities Mfg. Corp. Model: RBS

2.4 FUEL OIL TRANSFER PUMPS AND STRAINING SET

A. General

1. Provide and install a factory- assembled "Packaged" Automatic Fuel Oil Transfer and Monitoring System to ensure a reliable supply of fuel oil to the emergency generators included in this project. System to be factory fabricated/ tested and certified as a complete unit. Field assembled units are not acceptable. All wiring and piping shall be covered by labels of nationally recognized Trade Unions.
2. All piping and fittings on the fuel oil pump set shall be socket welded construction.
3. The triplex pump set shall be suitable for three (3) independent power supplies (one for each pump).
4. The duplex pump set shall be suitable for two (2) independent power supplies (one for each pump).

5. The system pump set control panel features shall include automatic pump set lead/lag, storage tank and day tank level monitoring and leak detection. SEE SECTION 2.5 FOR DETAILED DESCRIPTION OF THE FUEL OIL MANAGEMENT CONTROL CENTER
 6. The Automatic Fuel Oil Transfer Pump and Straining Set and monitoring system shall be Preferred Utilities.
 - a. Stand-By Generators = Triplex Pump = Model #ATPSF-205 rated 1000 GPH of Diesel oil against a discharge pressure of maximum 50 PSIG for each pump (3000 GPH for all three (3) pumps).
 - b. Life Safety Generators = Duplex Pump = Model #ATPSF-100 rated 300 GPH of Diesel oil against a discharge pressure of maximum 50 PSIG for each pump (600 GPH for all two (2) pumps).
- B. Pump System Piping and Mounting
1. Provide a triplex or Duplex pump and straining set that is factory assembled with components piped and mounted on a common baseplate.
 2. Pump suction and discharge connections to the pump set piping shall be through high pressure stainless steel braided flexible hose
 3. Pipe shall be schedule 40 ASTM A-53 Grade "A" with ANSI B16.3 Class 150 socket weld threaded fittings.
 4. Baseplate shall include 3" steel side rails continuously welded for containment and to contain potential leaks shall extend beyond any fitting, valve, pump, strainer, or selector valve.
 5. Provide a ½" containment basin plugged drain connection.
- C. Positive Displacement Pumps
1. Provide and mount three (3) positive displacement, internal gear rotary type pumps, with cast iron housing, self-adjusting mechanical, Carbon ring seals.
 2. The pump shall be capable of developing 25" Hg. Vacuum at 0 PSIG as factory tested, however, for normal operation, vacuum shall not exceed 15" Hg. Pump to have 3- bolt mounting foot.
 3. Pumps that have aluminum, brass, or bronze housings or rotors are not acceptable.
 4. Packing gland equipped pumps, close-coupled pumps, Carbonator shaft mounted pumps or centrifugal pumps are not acceptable.
- D. Motors
1. Provide and mount three/two (3)/(2) TEFC, rigid base, standard NEMA frame, premium efficiency, motors. Motors sized to develop no less than:
 - a. Stand-By Generator = 2 HP at 1140 RPM using 460V, 3 P, 60 Hz electric
 - b. Life Safety Generator = 1 HP at 1725 RPM using 460V, 3 P, 60 Hz electric
 2. Motor shall have copper windings, a dynamically balanced rotor, ball bearings and a heavy gauge steel NEMA Frame.
- E. Pump and Motor Assembly
1. The pumps shall be connected to the piping in the set through stainless steel flexible metallic braided jackets, and the pump and motor assemblies shall be welded to the base plate. Pumps and motors shall be mounted on a structural steel channel and equipped with flexible coupling and full OSHA approved coupling guard. Pumps and motors shall be mounted with bolts threaded into the steel channel for ease of maintenance. Mounting bolts shall not penetrate the secondary containment basin.
 2. The pump shall be connected to the motor by an elastomeric jaw type flexible coupling that does not require lubrication. The coupling wear member shall be replaceable without disturbing the alignment of either the pump or motor. Sizing of the flexible coupling shall be based on motor horsepower and rpm. Materials of construction: The

coupling body shall be sintered iron and cast iron. The elastomeric wear member shall be NBS Rubber.

F. Pump Isolation and Check Valves

1. Provide and install pump isolation valves. Locate one (1) valve on the suction and discharge side of each pump. Isolation valves will allow off-line pump maintenance without system loss of availability.
2. Isolation valves shall be ball type, rated 400 WOG, include stainless steel ball and Teflon seat. Valve to provide full flow while open and positive shutoff when closed. Additionally, two (2) class 150 swing check valves shall be provided and mounted, one (1) located on the discharge of each pump. Valves to have a re-grindable bronze seat and a threaded cap.

G. Fuel Oil Strainer

1. Factory install, one (1) Duplex strainer, basin mounted, on the suction side of the pumps. Strainer to be sized for less than ½ psi of mercury drop through a clean strainer basket with the maximum anticipated flow in the suction line.
2. Strainer shall be one piece cast iron body and shall be suitable for 200 psi.
3. Strainer baskets shall be 40 mesh stainless steel. Strainer shall come complete with lever wrench handle and be bolted in place without bolting through pan. Strainer shall be Preferred Utilities Model 53.

H. Relief Valves, External Piped

1. Provide and mount for each pump a relief valves sized to relieve the full outlet flow of the pump without causing the pump motor to overload or any component's pressure rating to be exceeded if the discharge is inadvertently valved off.
2. Relief valves must be externally mounted from the pumps and piped to the return line in the field according to NFPA 30.
3. Pump internal relief valves shall not be accepted. Relief valves shall be Preferred Model R.

I. Compound and Pressure Gauges

1. Provide and mount a compound gauge on the suction side of the strainer. The gauge shall read 30" vacuum -15 psig.
2. Provide and mount a pressure gauge on the discharge side of each pump.
3. Each gauge shall be equipped with an isolation ball valve.

J. Containment Basin Leak Detection Switch

1. Provide a factory mounted and wired float operated containment basin leak detection Switch to shut off the pumps and energize an audible and visual alarm should a leak be detected. The leak sensor shall be a plasma welded stainless steel construction.
2. The leak sensor shall be internally mounted within the pump basin. Electrical connections shall be contained in a factory installed weatherproof junction box.

K. Pump Automatic Sequencing Flow Switch

1. Provide a time delayed flow sensing switch on the discharge of each pump set to bring on the lag pump should the lead pump fail to maintain flow. Flow switch shall be vane operated to actuate a single double throw snap switch. Switch shall be factory wired to the control cabinet for alarm and backup pump operation. Switch shall be rated for 1450 psig. Provide a flow switch outlet isolation valve for maintaining the flow switch without draining the fuel system.

L. Factory Testing

1. Pump Sets must be fully tested prior to shipment as follows: Testing shall include both a pressure and vacuum testing period. First, the complete pump set shall be pressure tested to rated pressure using an air pressure source. The test shall confirm that the pump set piping system can maintain rated pressure for 4 hours. Next, the complete pump set shall be brought to a vacuum greater than 25"Hg. The test shall confirm that the pump set piping system can maintain vacuum for 4 hours. Following a pressure and vacuum test the pump set shall be given a full operational test. The pump set shall be connected to a fuel oil supply and return. The pump set shall be operated normally. Motor amps shall be noted at no load and full load for each motor. The motor amps shall be within 10% of rated motor amps. During the test the relief valve shall be set and tested. Operation of pump set instrumentation shall be tested. A copy of the test procedures shall be sent to the consulting engineer and owner. The owners and or the consulting engineer, at their discretion, shall observe this and all other tests. A certificate of factory testing, together with a copy of the wiring and arrangement diagrams shall be placed in the control cabinet prior to shipment.
- M. A copy of the test procedures shall be made available. The owners and or the consulting engineer, at their discretion, shall observe this and all other tests. Factory must be local to NYC area for ease of travel regarding observation for consulting engineer or owner

2.5 FUEL OIL MANAGEMENT CONTROL CENTER

- A. Provide two (2) fuel oil management control cabinets as follows:
1. Life Safety Generator System
 2. Standby Generator System
- B. Each Fuel Provide a Fuel Oil Management Control Cabinet factory mounted on the respective fuel oil pump set. The Control Cabinet shall be completely pre-wired, factory programmed and tested to ensure job site reliability. The pump sets and control cabinets shall be the product of one manufacturer for single source responsibility. Cabinet to be manufactured by nationally recognized trade union personnel and be approved by a nationally recognized independent testing laboratory, equal to UL- 508A.
1. The control panels shall be constructed of UL listed, electronic components in a NEMA 4 steel enclosure.
 2. All components shall be mounted on a factory installed sub-plate.
 3. Each panel shall include a NEMA 4 alarm light mounted on top of the panel. The alarm light shall be visible from all angles.
 4. Include an isolated 120V GFCI duplex receptacle with faceplate.
 5. Provide a sub plate mounted power isolation switch for the PLC.
- C. Control and Monitoring Hardware and features
1. System shall be custom designed to accomplish the control strategy as outlined. The control strategy shall be microprocessor-based. The control strategy shall be factory configured and stored on an EEPROM, and shall be password protected from re-configuration by unauthorized / un-qualified personnel.
 2. NodeNet communications for redundant optically isolated RS485 Peer to Peer communications between fuel oil system controllers
 3. The pump set control hardware shall include a Microprocessor based Configurable Controller (PLC), 10" Operator Interface Terminal (OIT). The system shall be capable to communicate to a Supervisory Control and Data Acquisition (SCADA) monitoring and control system via Modbus and BacNet IP protocols.
 4. The control system shall be a microprocessor-based design with field expandable Input/Output modules.
 5. The controller shall be designed so that it will "fail safe" in the event there is a microprocessor failure. RELAY LOGIC SHALL NOT BE ACCEPTABLE. Control

hardware shall include combination magnetic motor starters with overload protection and circuit breakers.

6. Provide safety interlocks to shut down all pumps during any of the following conditions: day tank "leak detected", containment pipe "leak detected", day tank "high-high" level, day tank "high level", ~~main storage tank "high and high-high"~~, and respective pump fire safety lever gate valve closed. These interlocks must continue to ensure safe pump operation even if the controller has failed or is out of service and the pump set is operated in manual "hand" mode.

D. Control Cabinet Components:

1. Microprocessor based Programmable Logic Controller (PLC) for all fuel oil handling system alarms and control functions.
2. Combination magnetic motor starters, circuit breakers, with overload protection, and disconnect switch.
3. Control power on switch.
4. Control power fuse.
5. Hand-off-auto switches for each pump
6. Open-close switches for each motorized valve
7. Digital tank gauge and leak detection system, flush mounted on the cabinet front.
8. Control circuit transformer.
9. Isolated contacts for output for alarm to interface with the BMCS (23 09 23).
10. Press to test button for all alarms and indicating lights.
11. Dry contacts for interface with BMCS to indicated:
 - a. Each pump run.
 - b. Each pump trip.
 - c. Generator System on/off.
 - d. Tank leak.
 - e. Pump area leak.
 - f. Tank high.
 - g. Tank low.
 - h. Power supply on.
 - i. Fire valve open/closed.
 - j. Containment piping leak.
12. Disconnect for each pump motor.
13. Power source for fuel oil leak system and circuit breaker(s).
14. Lamp test pushbutton.

E. Sequence of Operation

1. Provide automated Fuel Oil storage tank selection
 - a. Under standard operating conditions the operator must select which Main Storage tank is to be lead tank for fuel supply. Once the operator selects the tank, the PLC will automatically align the Main Tank supply and return valves as required.
 - b. Should the selected storage tank experience a low level condition, the Pump Control Panel PLC will automatically align the backup tank for operation. Once the supply and return valves for the backup tank prove the fully open condition, the PLC will close the valves to the tank being taken out of service. The PLC will also sound the alarm bell and energize the respective main tank low level light. Should both tanks experience a low level condition, the PLC will sound an extreme low level condition.
 - c. While the automatic valves are in the transient state, the respective valve symbols on the HMI will flash. Once the valve reaches the intended position, the HMI icon indicate open. Should a valve not prove a required position an alarm will sound and the Pumpset will not be allowed to run until another tank is selected or the respective valves are manually positioned.

2. Provide automatic header "call for operation" control (FOP1-1,2,3)
 - a. When any of the three Generators Call for Operation closes, the selected fuel storage tank supply and return valves shall be commanded to open, once the valves are proven open the lead pump will be energized.
 - b. The Lead pump will continue to run until the Call for Operation is removed, a shutdown occurs or the operator manually stops the pump.
 - c. When two or more generators call for oil the lead and lag1 pump will be energized.
 - d. The Lead and Lag1 pumps will continue to run until the Call for Operation is removed, a shutdown occurs or the operator manually stops the pump.
 - e. Upon detection of lead pump loss of flow or thermal overload the control system shall automatically energize the first lag pump and de-energize the lead pump.
 - f. Upon detection of first lag pump loss of flow or thermal overload the control system shall automatically energize the second lag pump and de-energize the lead pump
 - g. Upon the next call for operation, the lead pump shall be automatically alternated.
 - h. If the header level should drop as sensed by the header low level switch while the commanded pump(s) are running, then an alarm will sound and the lag1/lag2 pump will be commanded to start.
 - i. The selected tank supply and return valves will close once the call for operation is removed.
3. Provide automatic, microprocessor-based day tank level control (FOP1-4,5)
 - a. The lead fuel pump shall be energized when Day Tank oil level falls below 50%. The lead pump shall continue to operate until the day tank level is greater than 80%.
 - b. Upon the next call for fuel, the lead pump shall be automatically alternated.
 - c. The control system shall automatically energize the back-up pump upon detecting a low level condition (40% full condition). Both pumps shall then continue to operate until the level of oil reaches the high level point (90% full condition).
 - d. Upon detection of loss of flow or lead pump thermal overload the control system shall automatically energize the backup pump and de-energize the lead pump.

F. Operator Interface

1. The control system shall include a 10" Operator Interface with time and date stamped alarm and event summaries.
2. Provide dedicated pushbuttons for Alarm Silence and for the Home Page display and a "Hand-Off-Automatic" control switch for each fuel pump.
 - a. In "Hand" position the pump shall be capable of manual operation in the event of a controller failure.
 - b. The control system shall monitor the position of each "Hand-Off-Automatic" control switch. Should a switch be put into the "Off" position, the controller shall log the event with a Time/Date stamp and store within the controller memory.
3. Provide an Elapsed Time Recorder (ETR) to measure running time for each pump.
4. Provide a Fuel Oil Overview Display (Home Page) capable of simultaneous viewing of pump set status, day tank status and main storage tank status. The Fuel OIT shall display the following status, alarms and have the following "soft" control devices:
 - a. Lead Pump Selection – Auto/Manual
 - b. Pump Status – Off/Run/Standby
 - c. Each pump run
 - d. Each pump trip
 - e. Pump(s) elapsed run time
 - f. Generator(s) run
 - g. Tank selector valves position
 - h. Pump area leak.

- i. Main tank(s) leak.
 - j. Main tank(s) level
 - k. Main tank(s) high level
 - l. Main tank(s) high-high level
 - m. Main tank(s) low level
 - n. Fire valve(s) open/closed
 - o. Containment piping leak.
 - p. Day tank(s) leak.
 - q. Day tank(s) high-high level
 - r. Day tank(s) high level
 - s. Day tank(s) low level
- 5. All alarm and status points shall be available to the BMCS via a Modbus or BacNet IP protocols.
 - 6. Power source for fuel oil leak system and circuit breaker(s).
 - 7. Alarm and Event Logs
 - a. Provide an alarm display page for viewing the most recent 8 alarms/events with scrolling capability to view the complete 200-point alarm/event memory.
 - b. Each event and alarm condition shall be displayed with a distinct, descriptive, English language description and time and date stamp.
 - c. New alarms shall trigger the common alarm output relay. Events shall be recorded, but shall not trigger an alarm.

G. Fuel Oil Tank Gauging and Leak Monitoring

- 1. Fuel oil tank gauging and monitoring will be provided by microprocessor based tank gauging and leak detection system mounted on the front of the respective fuel oil management control cabinet.
- 2. The digital tank gauging systems shall have the following features:
 - a. Provide a microprocessor-based tank gauging, leak detection, and overfill prevention system per NFPA 30 Flammable and Combustible Liquids Code, NFPA 31 Standard for the Installation of Oil-Burning Equipment, and NFPA 110 Standard for Emergency and Standby Power Systems
 - b. The tank gauging system shall include main storage tank level sensor and discriminating leak sensor monitoring.
 - c. Provide a continuous display of tank content, in both gallons and inches of product, within the main storage tank.
 - d. Provide data recall of the instantaneous display of tank content at the time of leak alarm condition and "last delivery" indication.
 - e. The gauging system shall include an overfill alarm circuit test pushbutton to provide instantaneous proving of audible and visual alarm circuitry associated with instrument overfill alarm contact.
 - f. The controller must be field able to monitor up to 2 storage tanks and 6 discriminating leak sensors.
 - g. The tank gauge shall be provided with printer a RS485 Modbus interface to the BAS
 - h. The display, level sensors, leak sensors, and overfill alarm station shall be supplied by one manufacturer.
 - i. The display and sensors shall be intrinsically safe for Class 1, Division 1, Group D hazardous locations as defined by the National Electric Code.
 - j. The monitoring panel shall display the tank volume in gallons.
 - k. The indicator shall have a bright 4" bargraph display that is clearly visible from 20-foot viewing distance and shall be able to monitor either 1 or 2 tanks.
 - l. All sensors signals shall be either 4-20 mA or contact closure for easy interchangeability of field devices.
 - m. All leak sensors shall be automatically tested by the digital gauging/leak detection system on a daily basis.C

- n. Continuous sensor wiring fault detection (open or shorted) shall be provided.
- o. The gauging system shall have automatic delivery detection
- 3. The system shall be fully field configurable
- 4. The tank gauging and leak detection system shall be a Preferred Utilities model TG-EL-D4A-E

H. Quality Assurance

- 1. The Control Cabinet shall be manufactured and labeled in accordance with UL508A (CSA C22.2 #14 for use in Canada). Simply supplying UL recognized individual components is not sufficient. The assembled control cabinet, as a whole, must be inspected for proper wiring methods, fusing, etc., and must be labeled as conforming to UL508A. Inspection and labeling shall be supervised by UL or other Nationally Recognized Test Lab (NRTL). The system must be manufactured by a nationally recognized Trade Union (IBEW or similar trade union). Lack of an NRTL certified UL508A wiring methods inspection and label or lack of a Trade Union label will be grounds for rejection.

2.6 FUEL OIL TANK GAUGING, LEAK MONITORING, AND OVERFILL PREVENTION FIELD DEVICES

A. Provide Two (2) Systems as follows:

- 1. Life-Safety generator system
- 2. Stand-By generator system

B. Liquid Level Sensor

- 1. Shall consist of an aluminum, submersible (NEMA 6P) electronics head external to the tank and float internal to the tank. The float shall be connected to the sensor head by a flexible stainless cable. The flexible cable shall allow installation or removal when overhead obstructions are present. The sensor shall include an external test mechanism to allow overfill alarm and full tank calibration checks without removing the sensor from the tank.
- 2. Tests that electronically simulate a high tank level instead of physically moving the float are not acceptable. The sensors operation shall be unaffected by internal tank obstructions located outside of a 14" diameter cylinder extending from the tanks top to its bottom, and centered on sensor's mount. The assembly shall mount to the tank through a standard 4" 125/150 lb. Flat faced flange opening with standard bolt pattern. The mechanism's control head shall be constructed of ¼" cast aluminum. This sealed transducer housing shall encapsulate all transmitter electronics in a non-conductive oil and be moisture tight. Sensors assembly shall be water resistant and capable of operating in a submerged or manhole environment without damage.
- 3. The unit shall be capable of easy installation and maintenance with only 14 inches of clearance between the flange and any overhead obstructions. If buried suitable access for removal of the wire float assembly must be provided. Tank gauge calibration shall be possible at any tank fluid level (empty, part full, or full). The sensor operation and accuracy shall be unaffected by changes in the specific gravity of the tank liquid, and be suitable for use with non-corrosive fluids and fuels up to an including No. 4 fuel oil. The level sensor shall be a Preferred Instruments, Model TG-EL-WF, or approved equal.

C. The Leak Detector

- 1. Provide for hydrostatic leak detecting from the main tank area and the pump area.
- 2. Detectors shall be solid state and discriminate between oil and water, display the leak with (2) LED's on its indicating transmitter, and send an appropriate alarm signal to the instrument. All leak sensors shall be intrinsically safe, have continuous electronic checking, fail safe to an alarm condition, and have indicating transmitters with a magnetic test mechanism at grade level to exercise the bypass the sensors or rely only

on electronic simulation are unacceptable. Leak sensors shall be mounted piping sump, or floor mounted within tank vault as shown on the drawing. All sensors shall be provided with guards.

3. Provide 20 gauge wiring and tape all exposed shields. Connect shields only where shown on the electrical submittals supplied by the manufacturer. Do not run low voltage wiring in conduits with high voltage (i.e., 110 volts).

D. Overfill Prevention

1. High Level Switch shall be arranged to sound an alarm and activate the overfill alarm via the Fuel Oil Management Center PLC logic when the liquid level reaches 90 percent of tank capacity. Unit shall be float operated, suitable for #3 oil at 150 psi, have brass and Buna N wetted parts, and be mounted in a 1-1/4" tapping in the tank top. Switch shall be hermetically sealed and fully isolated from tank contents and external atmosphere. Electrical connections shall be made externally to the tank in an explosion-proof head assembly approved by UL for Class 1, Group D applications. Switch shall be Model: HLS-12.

E. Installation Requirements

1. Contractor must adhere strictly manufacturer's installation procedures. Factory startup and calibration to be included for tank gauging and leak detection system by Gauge manufacturer.
2. Letter from the tank gauge and leak detection systems manufacturer shall be provided to the mechanical engineer stating that the system was checked out and calibrated by factory trained representative and that all components are in working order.

- F. Tank manufacturer's certified tank print and stick chart must be provided to properly calibrate and manufacture gauge. This information must be provided to the tank gauge and leak detection manufacturer at the time of order.

2.7 FUEL OIL FILTRATION AND POLISHING SYSTEM

- A. The Fuel Oil Filtration systems shall be supplied by one Original Equipment Manufacturer and shall be external to the fuel oil transfer system. The Fuel Oil Filtration System shall be Preferred Utilities Mfg. Corp. Danbury, CT

1. Pipe shall be schedule 40 ASTM A-53 Grade "A" with ANSI B16.3 Class 150 malleable iron threaded fittings
2. Pump and Motor Assembly: An internally mounted, TEFC motor and positive displacement pump with cast iron housing shall be provided. The pump shall be industrial grade and intended for continuous heavy-duty service.
3. (FOTP-1-2) System to include a water removal tank and pump.
4. Primary Filter: Primary Oil strainer shall have cast iron body, threaded connection; size shall be suitable for the required flow and suitable for working pressures to 150 psi. Clamped cover and handle shall permit easy removal of the basket. Basket shall 100 mesh stainless steel.
5. Secondary Filtration: Multi- purpose filter element shall provide both particulate and water removal. Filtration provided to 5 micron. No special tools required to replace the element.
6. Filter Monitoring: Each filter stage shall have a differential pressure switch piped across them to indicate when the filter (s) require maintenance or replacement. Indication at the main filtration control cabinet to alert operators and sound horn. The differential pressure switch shall provide clear indication of strainer obstruction status with the use of a Tri-Colored Scale Plate with GREEN denoting Clean, YELLOW denoting Change and RED denoting dirty clogged strainer. This shall have one piece cast-iron body and shall be suitable for pressure to 200 psi.
7. Control and Monitoring Hardware.

- a. The control strategy shall be a microprocessor-based controller with color touch screen. The control strategy shall be factory configured and stored on an EEPROM, and shall be password protected from re-configuration by unauthorized personnel. The controller shall be designed so that it will "fail safe" in the event there is a microprocessor failure.
 - b. Control hardware shall include a combination magnetic motor starter with overload protection and a circuit breaker. The control system shall provide common alarm dry contacts to be interfaced with the Building Maintenance System.
8. Automatic Operation
 - a. The filtration system shall have an adjustable automatic start and run time set points. The operator shall be able to set the system to run at a certain time daily, weekly, or monthly.
 - b. The Filtration system PLC will open the supply and return valves for the selected tank and upon proof of valves "open" the Filtration cycle will begin.
 - c. Provide a safety interlock to shut down the pump when an internal leak is detected.
9. Operator Interface: All operator interface components shall be door mounted. As a minimum, the following indications, alarms, control switches and pushbuttons shall be provided:
 - a. Alarm Silence, Manual Reset, Lamp/Alarm Test Pushbuttons
 - b. Pump "Hand-off-Auto" control switch
 - c. "Pump On", indicator
 - d. "Filter Saturated", "Filter Water Level High", "System Basin Leak Detected".
 - e. Leak Detection Switch Water Storage Tank "High Level", Filter "High Differential Pressure" for each filter and High Discharge Pressure.
10. Quality Assurance Inspection, Labeling and Testing
 - a. The Control Cabinet shall be manufactured and labeled in accordance with UL508A.
 - b. Simply supplying UL recognized individual components is not sufficient and grounds for rejection. The assembled control cabinet as a whole, must be inspected for proper wiring methods, fusing, etc., and must be labeled as conforming to UL508A. (CSA C22.2 #14 for use in Canada).
 - c. Inspection and labeling shall be supervised by UL or other OSHA approved Nationally Recognized Test Lab (NRTL).
11. Provide two systems as follows:
 - a. FOT1-1, 1-2, 1-3, 1-4 Model #PF-505-WR-01
 - b. FOT1-5 Model PF-503S-Z1121

2.8 OTHER FUEL STORAGE TANK ACCESSORIES

A. Life Safety Generator Wall Mounted Spill/Fill Box with Integral Overfill Alarm

1. Install for the Life Safety oil tank and where shown on the drawings a Preferred Utilities Mfg. Corp. Danbury, CT. Model 2-SS3-3 Fill Station.
2. The Fill Station shall have a minimum of a 5 U.S. Gal. holding capacity and include: an internal overfill alarm system, locking handle, NEMA 4 rated construction and oil connection fill adapter for gravity fill.
3. The fill station shall have the capacity for two (2) 3" fill connections
4. The fill Station shall be 304 stainless steel 12-gauge construction, and equipped with 1/2" NPT drain connection.

5. The door shall match the Fill Station construction and will include a neoprene gasket around the entire door.
6. The door shall mount to the Fill Station with a full length stainless steel piano hinge on the swing side and a three-point latch with locking handle on the access side.
7. The interior component mounting panels shall be prime coated and painted with white enamel.
8. Provide an Overfill Alarm Station integral to the Model 2 spil/fill container to be activated by the Fuel Oil Management PLC. The overfill alarm station shall consist of an explosion proof "Overfill Alarm" light (one per tank), alarm horn and "Alarm Silence" pushbutton.
9. The light and bell shall be automatically silenced in 90 seconds or instantly silenced when the operator selects the "Alarm Silence" button.
10. Provide permanently mounted and prominently displayed inside the Fill Station a durable nameplate displaying the main oil storage tanks inventory capacity in US Gallons
11. For the fill line connection, include a composite top-seal, tight fill adapter and lockable fill cap
12. The system shall include a Preferred FA-L Caution Sign. The Caution Sign shall read as follows: CAUTION WHEN ALARM BELL SOUNDS, OIL TANK FILLED TO CAPACITY, DO NOT OVERFILL

B. Standby Generators Wall Mounted Spill/Fill Box with Integral Overfill Alarm

1. Provide a custom 4 port wall mounted spill/fill port for the 4 Standby Generators tanks and where shown on the drawings a Preferred Utilities Mfg. Corp. Danbury, CT. Model 2-SS3-3-ACS Fill Station with features identical to 2.7.A (1-12), with one high alarm per tank.

C. Tank Vent Protector

1. Fuel oil storage Tank Vent Protector shall be the full size of the vent pipe in accordance with NFPA 30 Flammable and Combustible Liquids Code and NFPA 31 Standard for the Installation of Oil-Burning Equipment.
2. It shall be of aluminum construction and provided with standard pipe threads.
3. Provide a tank vent protector as manufactured by Preferred Utilities Mfg. Corp., Danbury, CT.

2.9 FUEL OIL PIPING, VALVES AND ACCESSORIES

A. Anti-siphon Valve

1. Per NFPA 30, furnish and install inside the building, at the high point of the oil suction line, from each fuel oil tank a UL listed and labeled Anti-Syphon Valve(s).
2. Valves that do not have an Underwriters Laboratory certification, listing and label and do not conform to Local, State and Federal Fire Codes shall not be acceptable.
3. Anti-siphon valves supplied without a UL label shall be removed and a U.L. certified valve installed at the contractor expense.
4. Valve(s) shall be sized to meet the flow requirements and shall be equipped with a spring sized according to vacuum head to match the vertical distance between the highest oil storage level of the main tank and the inlet to the fuel oil pumps.
5. Valves with cast iron bodies or Angle check valves designed for back pressure applications are not acceptable.
6. Valve shall be a Preferred Utilities. Model A.

B. Fire Safety Lever Gate Valve

1. Furnish and install valves where shown on the Contract Drawings. Valves shall be quick closing, spring loaded, lever gate-type, held open by a wire with fusible link arranged so that the valve will automatically close if the link melts. Fusible link shall be set at 165°F.

2. The valve shall be equipped with an automatic fuel shut-off limit switch assembly. Switch assembly shall be wired to the Fuel Oil Management System to provide "Fire" and "Loss of Fuel Supply" alarms and interlock fuel oil pump set operation when the valve is closed. When the valve is closed, shut down the fuel oil pumps.
3. The valve shall be a Preferred Utilities Model 110 Oil Lever Gate Valve with an Automatic Fuel Shut-off Limit Switch Assembly, or approved equal

C. Foot Valve

1. Provide and install at the bottom of the tank suction stub a line size single-poppet foot valve suited for service in which drip tight shutoff is required.
2. The body shall be constructed of unleaded bronze with a spring loaded poppet assembly.
3. The foot valve shall be complete with an inlet basket style strainer with a minimum open area ratio of 3 to 1 versus the nominal pipe size.
4. Foot valve shall be same size as the suction line.
5. The foot valve shall be a Preferred Utilities Mfg. Corp. Danbury, CT Model 60.

D. Tank Selection Motorized Ball Valves

1. Furnish and motorized ball valves as shown on drawings for tank selection.
2. Valves shall be full line size, rated for diesel fuel service and have positive/tight shutoff.
 - a. Valves are standard port, ANSI 150 class with Carbon steel body, AISI 316 SS ball, 316 stainless steel stem, Valve to be Apollo series 77- ARX.
3. Provide motorized actuator with open/closed position switches, position indicator and manual override.
 - a. Each ball valve to have Reversing Electric Actuator with end switches.
 - b. Actuator enclosure to be NEMA IV Watertight and NEMA VII & IX hazardous Environmental standards. Enclosure to have a protective hybrid epoxy coating to provide corrosion and ultraviolet light resistance. Cover bolts to be stainless steel.
 - c. Valve assembly to provide precise, repeatable control, automatic sequencing for proper control with fail-safe operation due to loss of power, and for performing in remote indoor or outdoor hazardous areas.
 - d. A high visibility position indicator shall be supplied for ease of valve position viewing from greater distances minimum 12'.
 - e. Actuator to have declutchable manual override.
 - f. Actuator motor to be split- phase, reversing type with thermal overload protection.
 - g. Actuator shall be Conbraco series AE.
4. The tank selector valves shall be by Preferred Utilities Mfg. Corp., Danbury, CT series ACS-Z1121.

E. Vent Terminals

1. Provide full size vent protector constructed of galvanized cast iron with threaded connection and of weatherproof design.

F. Fuel Oil Piping

1. All fuel oil piping prefabricated as DOUBLE-PIPE type containment system. Protect pipe from the exterior environment by a secondary containment pipe. The system supplier shall have at least five (5) years of experience in the manufacturer of secondary containment pipe systems. Factory fabricate all straight sections, fittings and other accessories to job dimensions and design to minimize the number of field connections. Air test all secondary containment joints completed at the factory. The containment shall be drainable and air pressure testable.
2. Provide product pipe of fiberglass reinforced plastic filament wound using continuous glass filaments and epoxy resins to form a structural wall over a resin rich corrosion

- resistant interior liner, Bondstrand 2000 or approved equal. All joints shall be socket type with epoxy adhesive. Supply straight sections in 20 to 30 foot random lengths.
3. All pipe and fittings rated at 125 psi wsp.
 4. Construct the secondary containment pipe of a multi-layer composite fiberglass reinforced thermosetting resin pipe comprised of a two-part corrosion barrier not less than 45 mils thick and a filament wound structural wall. The glass to resin ratio for the inner surface, corrosion barrier and structural wall shall be not greater than 20:80, 30:70 and 70:30, respectively. The outer layer shall contain .2 to .3% by weight of ultraviolet inhibitors for protection during outdoor storage.
 5. The structural wall of the filament wound secondary containment shall have the following minimum properties:

Strength	ASTM Test	Value
Hoop	D-1599	40,000 psi
Axial Compression Tension	D-695 D-2105	18,000 psi 20,000 psi
Flexural	D-790	20,000 psi

Modulus of Elasticity	ASTM Test	Value
Hoop	D-638	3.0×10^6 psi
Axial	D-2105	1.5×10^6 psi
Flexural	D-790	1.5×10^6 psi

6. Provide wall thickness of 150 mils for sizes 14 inches and below, 200 mils for 16 inches through 22 inches, 250 mils for 24 inches through 30 inches.
7. Support spacing per manufacturer based on pipe diameter, pipe material, and operating temperature of the product pipes. In all cases, pipes within the secondary containment shall be supported at not more than 10 foot intervals. Design these supports to allow for continuous air-flow and drainage of the secondary containment in place. When used with a leak location/detection cable, provide guides at supports that facilitate cable pulling and prevent cable damage during pulling operations.
8. Design end seals and other subassemblies and factory prefabricate to prevent the ingress of moisture into the system. All subassemblies shall be designed to allow for complete drainage of the secondary containment.
9. Provide secondary pipe leak detection sensors

2.10 ACCEPTABLE MANUFACTURERS

- A. Preferred Utilities
- B. Viking
- C. Highland Tank

PART 3 - EXECUTION

3.1 GENERAL

- A. Obtain all permits required. Provide adequate notice to inspector(s) for installation and testing of new equipment.
- B. Provide Owner with information and filled-in forms for registration of this facility with New York D.E.C. and EPA.
- C. Provide and install foot valve at bottom of suction stub in tanks, sized for full line size.
- D. Retest all fuel oil tanks after installation.

3.2 OIL PIPING

- A. Provide pressure gauges as shown on Drawings in fuel oil suction and return lines at locations visible from the floor. Gauge on the suction side to be 4½" diameter with 0 to 30" vacuum range at one inch vacuum graduations. Gauge on discharge side to be 4½" diameter with a 0 to 30 lbs. range at one-lb. graduations. Gauges to be as manufactured by Marsh Co. or Ashcroft.
- B. Oil piping to be provided with ground joint unions near each piece of apparatus, to facilitate connecting and disconnecting. Piping must be properly valved, as approved.
- C. Provide double drain valves in series with single hose connection for draining oil at all low points of system.
- D. Oil pipe connections to tanks to be properly graded and shall be provided with a minimum of three (3) elbow swing joints with arms of ample length to permit movement of the tank or pipe in any direction without impairing the efficiency of the pipe connections, and to be so constructed that any settlement of the tank will tend to tighten the threads in said joints. Screwed elbows shall be used at swing joints only; all other underground pipe fittings shall be welded.

3.3 FUEL OIL PIPING

- A. Install the system in accordance with the directions furnished by the manufacturer and as approved by the Architect and Engineer. The secondary containment shall be air tested at 10 PSIG, and the product piping shall be hydrostatically tested to 50 PSIG or 1½ times the operating pressure, whichever is greater. The test pressures shall be held for not less than one hour. The Contractor shall strictly adhere to the installation guidelines supplied by the system manufacturer and shall keep the secondary containment system clean and dry at all times during the installation process.
- B. Pitch pipe to drain back to secondary containment collar on tank.

3.4 ABOVE GROUND TANKS

- A. Install above ground tank on a 4" high concrete pad with steel saddles leveled and grouted in place to assure full bearing. Provide buffer pad of suitable material between tank and saddles.
- B. Install fuel oil day tanks on an angle iron stand within rupture basin. The entire assembly to be field painted after installation is complete with red primer.

3.5 TANK MONITORING AND GAUGES

- A. Install sensors in tank as per manufacturer's recommendations.
- B. Provide wiring from sensors to monitoring panels. Run wires in 1" rigid galvanized underground conduit (see Electrical Specification).
- C. Mount gauges, alarms, bells, etc. in Boiler Plant Control Room. Mount bell near tank vent pipe, 6'-6" above grade. Provide wiring between equipment as required (power wiring provided by Electrical Contractor).

3.6 PUMPS

- A. The pump manufacturer to be responsible for aligning in the field prior to startup of all flexible coupled pumps. Alignment to be with dial indicator with accuracy of ± 0.002 inch. The pump manufacturer must submit a written report certifying that the alignment work has been performed by his personnel and that the pumps are ready for operation.
- B. Pumps to be leveled up on tapered steel wedges in such a manner as to permit a minimum of 3/4 inch of grout between the pump base and the top of the concrete base.

END OF SECTION

SECTION 236210

AIR COOLED AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings, conditions of Contract (including General Conditions, Addendum to the General Conditions, Special Conditions, Division 01 Specification Sections and all other Contract Documents) apply to the Work of the Section.

1.2 DESCRIPTION

- A. Provide air cooled air conditioning units in accordance with the Contract Documents.

1.3 WORK INCLUDED

- A. Packaged Air Cooled A/C Unit.
- B. Split System Air Cooled A/C Unit.
- C. Air Cooled Condensing Units.
- D. Air Cooled Condensers.
- E. Glycol Cooler.
- F. Glycol A/C Units.
- G. Glycol Pump Package.

1.4 SUBMITTALS

- A. Shop Drawings
 - 1. Submit dimensioned drawings with operating weights, piping connections, wiring diagrams, and control interface diagrams.
 - 2. Submit wiring diagrams for all controls, including panel layout and remote devices.
- B. Product Data: Manufacturer's latest listed data for materials, equipment and installation.
- C. Test Reports
 - 1. Certified sound power levels.
 - 2. Certification of all factory tests as required herein.
 - 3. Statement of compliance with all required authorities.
- D. Submit sound power levels and rating data for all units. Noise level from the units are not to exceed NC-38 beyond 10 feet from fan room.
- E. MEA or BS&A number.

- F. Contractor must submit refrigerant information in shop drawing submittals so that this project can be verified for LEED credit compliance.

1.5 QUALITY ASSURANCE

- A. Each unit, including factory-installed options, is to be U.L. listed, performance tested and rated in compliance with ARI 210 and ARI 360, Commercial and Industrial Unitary Air Conditioning Equipment.
- B. Design unit to conform to ANSI-B9.1 and UL 465.
- C. Performance test all units at the factory prior to shipment.
- D. Manufacturer of the unit is responsible for the performance of units, including static pressure and sound attenuation effects of the discharge plenum arrangement.

PART 2 - PRODUCTS

2.1 PACKAGED AIR COOLED UNITS

A. General

- 1. Units to be completely packaged, including filters, evaporator coils, multiple compressors, air-cooled condenser, internal vibration isolation and fan section. Units to require only connection of three phase power, remote sensors, control wiring and duct connections prior to operating units. Units to be mounted on 1" cork and neoprene pads, to be provided by the unit manufacturer.
- 2. Provide units pre-piped, pre-wired, factory assembled and factory tested, with all controls pretested prior to shipping.
- 3. Provide a terminal strip with each electrical component individually and separately wired to strip.
- 4. Provide a separate fuse, internally mounted, for each electrical component. A single fuse for multiple compressors or fan motors will not be accepted.

B. Cabinet, Casing and Frame

- 1. Unit framework to be formed of structural steel members of 12 to 14 gauge mild steel. After assembly paint the framework for maximum protection against rust. Exterior panels to be fabricated of 18 gauge galvanized steel finished with a baked acrylic enamel over an epoxy primer. Provide neoprene gasketing between panels and frame members; panels to be attached to the frame with quick release latches (no sheetmetal screws). Insulate sections including compressor compartment with 1" thick, 3-lb./cu. ft. density fiberglass having an R value of 4.16.
- 2. Arrange units for full front, side and rear service access to all mechanical, electrical and refrigeration controls, adjustment of expansion valves, check out of compressors, adjustment of head pressure controls, check out of electrical control panel, without disrupting or interfering with air flow.
- 3. Provide discharge acoustical plenums lined internally with a minimum of 2" thick, 4 lb/cu.ft. density fiberglass that is in accordance with prototype designs previously tested in a full scale mock-up environment by an acoustical consultant. If the plenum is not built at the factory, it is the manufacturer's responsibility to provide the Mechanical Contractor with the exact construction details and specifications for the plenum to be constructed by the sheetmetal subcontractor.

C. Supply Fan and Motor

1. Provide single width, forward curved Class I II supply fans secured to a machined, ground and polished solid steel shaft. Coat shaft with a rust inhibitor and support by two outboard bearings selected for a minimum 200,000 hours average life. Provide drives with variable pitch sheaves with multiple V-belts sized for 150% of nominal motor horsepower. Mount supply fan motor on a sliding base. Mount fan and motor assembly on a heavy duty steel frame supported by springs designed for 90-99% isolation efficiency.
2. Provide three-phase NEMA design 'B', 40°C continuously rated fan motor with energy-saving design, .85 power factor, NEMA 'T' frame, open drip-proof, operating at 1750 rpm and supplied with grease-lubricated ball bearings.

D. Compressors

1. Provide multiple compressors of the heavy duty suction cooled, 1750 rpm, accessible semi-hermetic hermetic type complete with forced feed lubrication, suction and discharge service valves, suction strainer, oil level sight glass, internal relief valve, crankcase heater, and internal 3-phase solid state thermal motor protection. The compressors are to be mounted on 1" deflection spring vibration isolators.

E. Direct Expansion Coil

1. Provide direct expansion coil with ½" OD seamless copper tubes expanded into aluminum fins, not less than 3 rows deep or more than 12 fins per inch. Provide evaporator coil with a distributor with side port for hot gas bypass and thermostatic expansion valve with adjustable superheat and external equalizer. Test coil at 300 PSIG air pressure under water, completely dehydrate and pressure test with refrigerant.
2. Provide coils with heavy gauge, insulated, galvanized steel drain pans complete with mastic coating for corrosion protection.

F. Heating Coil

1. Electric Coil:
 - a. Construct coil of low density nickel chromium elements, exposed directly to the air stream. Provide a pressure switch cutout to prevent coil operation without air movement. Provide a thermal cutout which shall be backed up by a linear heat limiter to give secondary protection. Coils to be U.L. listed and meet NEC requirements. Circuit breakers, fuse boxes, etc., to be installed and wired.

G. Filters

1. Provide filters having a 40% ASHRAE dust spot efficiency, U.L. Class I pleated media type 2-inch deep.

H. Refrigerant Circuits

1. Each refrigerant circuit is to be an independent circuit completely piped, tested, dehydrated and fully charged with oil and refrigerant R-22. The refrigerant circuits are to include compressor, condenser coil with integral liquid sub-cooler, liquid line service and charging valve, filter drier, and sight glass. Compressor units to include suction and discharge line braided-wire isolators.

- I. Evaporator Defrost Thermostat
 - 1. Provide defrost thermostat package with enclosure, wiring and hardware for field installation.
- J. Thermostat
 - 1. Provide communicating (BAC NET) thermostat for 24 volt operation with automatic changeover for field installation.
- K. External Control Features
 - 1. Provide terminal strip contacts to signal external device operation as follows:
 - a. Remote Start-Stop.
 - b. Signal outdoor air damper to close during morning warm-up and night operation and open for normal cooling operation.
 - c. Smoke detector shutdown.
- L. Disconnect Switch
 - 1. Provide a non-fused disconnect switch, factory mounted on exterior of each unit.
- M. Condenser Coil
 - 1. Construct condenser coil of aluminum plate fins, mechanically bonded to seamless copper tubes. Circuit coil for sub-cooling. Test coils to 425 psi.
- N. Condenser Fans and Motors
 - 1. Furnish belt-driven, centrifugal-type fans. Provide condenser fan motors of the permanently lubricated type, resiliently mounted. Include controls for cycling fans for intermediate season operation and low ambient operation. Balance each fan statically and dynamically.

2.2 SPLIT SYSTEM AIR COOLED UNITS

- A. General
 - 1. Units to be completely packaged, including filters, evaporator coils, multiple compressors, internal vibration isolation and fan section. Units to require only connection of three phase power, refrigerant piping, remote sensors, control wiring and duct connections prior to operating units. Units to be mounted on 1" cork and neoprene pads, to be provided by the unit manufacturer.
 - 2. Provide units pre-piped, pre-wired, factory assembled and factory tested, with all controls pretested prior to shipping.
 - 3. Provide a terminal strip with each electrical component individually and separately wired to strip.
 - 4. Provide a separate fuse, internally mounted, for each electrical component. A single fuse for multiple compressors or fan motors will not be accepted.
- B. Cabinet, Casing and Frame
 - 1. Unit framework to be formed of structural steel members of 12 to 14 gauge mild steel. After assembly paint the framework for maximum protection against rust. Exterior panels to be fabricated of 18 gauge galvanized steel finished with a baked acrylic enamel over an epoxy primer. Provide neoprene gasketing between panels and frame

members; panels to be attached to the frame with quick release latches (no sheetmetal screws). Insulate sections including compressor compartment with 1" thick, 3-lb./cu. ft. density fiberglass having an R value of 4.16.

2. Arrange units for full front, side and rear service access to all mechanical, electrical and refrigeration controls, adjustment of expansion valves, check out of compressors, adjustment of head pressure controls, check out of electrical control panel, without disrupting or interfering with air flow.
3. Provide discharge acoustical plenums lined internally with a minimum of 2" thick, 4 lb/cu.ft. density fiberglass that is in accordance with prototype designs previously tested in a full scale mock-up environment by an acoustical consultant. If the plenum is not built at the factory, it is the manufacturer's responsibility to provide the Mechanical Contractor with the exact construction details and specifications for the plenum to be constructed by the sheetmetal subcontractor.

C. Supply Fan and Motor

1. Provide single width, forward curved Class I II supply fans secured to a machined, ground and polished solid steel shaft. Coat shaft with a rust inhibitor and support by two outboard bearings selected for a minimum 200,000 hours average life. Provide drives with variable pitch sheaves with multiple V-belts sized for 150% of nominal motor horsepower. Mount supply fan motor on a sliding base. Mount fan and motor assembly on a heavy duty steel frame supported by springs designed for 90-99% isolation efficiency.
2. Provide three-phase NEMA design 'B', 40°C continuously rated fan motor with energy-saving design, .85 power factor, NEMA 'T' frame, open drip-proof, operating at 1750 rpm and supplied with grease-lubricated ball bearings.

D. Compressors

1. Provide multiple compressors of the heavy duty suction cooled, 1750 rpm, accessible semi-hermetic hermetic type complete with forced feed lubrication, suction and discharge service valves, suction strainer, oil level sight glass, internal relief valve, crankcase heater, and internal 3-phase solid state thermal motor protection. The compressors are to be mounted on 1" deflection spring vibration isolators.

E. Direct Expansion Coil

1. Provide direct expansion coil with ½" OD seamless copper tubes expanded into aluminum fins, not less than 3 rows deep or more than 12 fins per inch. Provide evaporator coil with a distributor with side port for hot gas bypass and thermostatic expansion valve with adjustable superheat and external equalizer. Test coil at 300 PSIG air pressure under water, completely dehydrate and pressure test with refrigerant.
2. Provide coils with heavy gauge, insulated, galvanized steel drain pans complete with mastic coating for corrosion protection.

F. Heating Coil

1. Electric Coil:
 - a. Construct coil of low density nickel chromium elements, exposed directly to the air stream. Provide a pressure switch cutout to prevent coil operation without air movement. Thermal cutout to be backed up by a linear heat limiter to give secondary protection. Coils to be U.L. listed and meet NEC requirements. Circuit breakers, fuse boxes, etc., to be installed and wired.

G. Filters

1. Provide filters having a 40% ASHRAE dust spot efficiency, U.L. Class I pleated media type 2-inch deep.

H. Refrigerant Circuits

1. Each refrigerant circuit is to be an independent circuit completely piped, tested, dehydrated and fully charged with oil and refrigerant R-22. The refrigerant circuits are to include compressor, condenser coil with integral liquid sub-cooler, liquid line service and charging valve, filter drier, and sight glass. Compressor units to include suction and discharge line braided-wire isolators.

I. Evaporator Defrost Thermostat

1. Provide defrost thermostat package with enclosure, wiring and hardware for field installation.

2.3 AIR COOLED CONDENSING UNITS

A. General

1. Provide units pre-piped and pre-wired, factory assembled and factory tested, with all controls pre-tested prior to shipping.
2. Assemble all condensing unit components on a common base in a weatherproof housing. Provide hermetic compressors designed for use with Refrigerant 22, condenser coil, condenser fans and motors, refrigerant reservoir, charging valve, all controls and holding charge of R-22.
3. Provide a terminal strip with each electrical component individually and separately wired to strip.
4. Provide a separate fuse, internally mounted, for each electrical component. A single fuse for multiple compressors or fan motors will not be accepted.

B. Condenser Coil

1. Construct condenser coil of aluminum plate fins, mechanically bonded to seamless copper tubes. Circuit coil for sub-cooling. Test coils to 425 psi.

C. Condenser Fans and Motors

1. Furnish direct-driven, propeller-type belt-driven, centrifugal fans arranged for vertical horizontal discharge. Provide condenser fan motors of the permanently lubricated type, resiliently mounted. Provide a safety guard for each fan. Include controls for cycling fans for intermediate season operation and low ambient control. Balance each fan statically and dynamically.

D. Compressor(s)

1. Furnish compressors of serviceable hermetic design with external spring isolators and an automatically reversible oil pump.
2. Provide hermetically sealed compressor with overloads and inherent winding thermostat protection for the compressor motor.
3. Provide crankcase heater.

E. Controls

1. Locate factory wired controls in a separate enclosure. Provide high- and low-pressure switches and compressor overload devices. Incorporate a positive acting timer to prevent short cycling of compressor if power is interrupted. Timer to prevent compressor from restarting for approximately 5 minutes after shutdown.

F. Casing

1. Make unit casing fully weatherproof for outdoor installation. Construct casing of galvanized steel, zinc phosphatized and finished with baked enamel.
2. Provide openings for power and refrigerant connections. Make panels removable for servicing. Provide heavy duty coil guards, unit mounting rails and drain holes.

2.4 AIR COOLED CONDENSER

A. General

1. Provide units pre-piped and pre-wired, factory assembled and factory tested, with all controls pre-tested prior to shipping.
2. Design units for use with Refrigerant 22.
3. Assemble all condenser components on a common base in a weatherproof housing. Provide condenser coil, condenser fans and motors, refrigerant reservoir, charging valve, all controls and holding charge of R-22.

B. Condenser Coil

1. Construct condenser coil of aluminum plate fins, mechanically bonded to seamless copper tubes. Circuit coil for sub-cooling. Test coils to 425 psi.

C. Condenser Fans and Motors

1. Furnish direct-driven, propeller-type belt-driven, centrifugal fans arranged for vertical horizontal discharge. Provide condenser fan motors of the permanently lubricated type, resiliently mounted. Provide a safety guard for each fan. Include controls for cycling fans for intermediate season operation and low ambient control. Balance each fan statically and dynamically.

D. Controls

1. Locate factory wired controls in a separate enclosure. Provide high- and low-pressure switches and compressor overload devices. Incorporate a positive acting timer to prevent short cycling of compressor if power is interrupted. Timer to prevent compressor from restarting for approximately 5 minutes after shutdown.

E. Casing

1. Make unit casing fully weatherproof for outdoor installation. Construct casing of galvanized steel, zinc phosphatized and finished with baked enamel.
2. Provide openings for power and refrigerant connections. Make panels removable for servicing. Provide heavy duty coil guards, unit mounting rails and drain holes.

2.5 GLYCOL COOLER

A. General

1. The system shall be a remote outdoor propeller fan, air cooled glycol drycooler (fluid cooler).
2. The drycooler shall provide the condenser heat rejection source for the specified glycol cooled air conditioners.
3. The drycooler shall be sized to provide the performance indicated on Design Drawings.

B. Quality Assurance

1. The system shall be factory assembled, tested and shipped complete.
2. The system shall be designed for outdoor installation and year round service.
3. The drycooler shall be NRTL listed and labeled in compliance with UL 1995.

C. Cabinet Construction

1. Drycooler casings shall be fabricated from heavy gauge galvanized steel for corrosion protection and appearance. Structural components shall be fabricated from galvanized steel for support.

D. Component Access

1. Fans and Fan Motors shall be accessible by removing fan guards.
2. Electrical components shall be accessible via a removable electrical enclosure panel.

E. Electrical System

1. The electrical components shall be located in a weatherproof enclosure mounted on the end of the drycooler.
2. The system shall incorporate overcurrent and overload protection in accordance with UL 1995 requirements.
3. The control circuit shall be a 24 Vac Class 2 low voltage circuit.
4. The system shall be complete with:
 - a. 24 Volt Control Transformer
 - b. Main Power Non-Fused Disconnect Switch
 - c. Main Power Distribution Block and Grounding Lug
 - d. Individual Fan Motor(s) Contactors
5. The drycooler shall be electrically interfaced with the pump package via 24 VAC signal connection.

F. Fan Cycling Controls

1. Drycooler fans shall automatically cycle ON/OFF based on the leaving glycol temperature as sensed by factory provided Aquastat(s) to maintain proper glycol solution temperature.
2. In addition to the drycooler fan cycling controls Free-Cooling Fan Cycling Controls shall be provided.
 - a. Ambient Free-Cooling Mode Enabling Thermostat.
 - b. Free-Cooling Mode Aquastat(s) to sense and maintain proper coolant temperature during Free Cooling mode.

G. Coils

1. Drycooler coils shall be high efficiency with corrugated aluminum fins bonded to staggered copper tubes. Coil end plates shall be hot dipped galvanized.
2. Coils shall be pressure tested and pressurized for shipment.

H. Fan Motors

1. Fan motors shall be energy efficient direct driven at 1140 RPM (see note) and designed for outdoor drycooler applications. Fan motors shall have thermal overload protection and permanently lubricated ball bearings.

I. Fan Blades

1. The drycooler shall incorporate direct-driven propeller fan(s).
2. The fan blades shall be made from aluminum and have zinc plated hubs for strength and corrosion protection.
3. Multiple fan drycoolers shall have internal air baffles to prevent air bypass from one fan section to another and to maximize air through each coil section.

2.6 GLYCOL A/C UNITS

A. General

1. The system shall be a floor mounted air conditioner designed and built to provide precision temperature and humidity control.
2. The system shall be complete and factory run-tested before shipment. The system shall be Intertek Laboratory (an NRTL) listed and labeled in compliance with UL 1995 and CSA C22.2 No. 236.
3. The system shall be manufactured by Stulz Air Technology Systems, Inc., in Frederick, Maryland, USA.

B. Service Access

1. The air conditioner shall require front access for all routinely serviced components.

C. Cabinet Construction

1. Access panels shall be fabricated from heavy gauge steel and shall be securely attached to the base and top plates.
2. Access panels shall be powder coated to match and provide corrosion protection.
3. The panels shall be lined with 1/2" (13 mm), 2 lb/ft² (.90 kg), high-density sound and thermal insulation and sealed with self-extinguishing gasketing conforming to NFPA 90A and 90B.

D. Electrical System

1. The system shall incorporate modular motor controllers utilizing motor start protectors and circuit breakers eliminating the need for fusing, as well as providing:
 - a. Motor branch circuit short circuit protection
 - b. Motor load switching controllers (contactors)
 - c. Motor overload protection
2. The system shall incorporate overcurrent and overload protection in accordance with UL 1995 requirements.
3. Each blower motor, compressor shall be provided with a factory mounted and wired starter/contactors.

4. The control circuit shall be a 24 VAC Class 2 low voltage circuit, including a circuit breaker for protection.
5. Low voltage, high voltage and grounding wires shall be color coded and shall be individually numbered at each end for ease of service tracing.
6. All wiring shall be in accordance with the National Electric Code (NEC).
7. As a factory standard, a unit-mounted main power service switch shall be provided. The service switch shall be a dust-proof, non-fused type with lockable handle.

E. Evaporator Coils

1. Evaporator systems shall be configured for a draw-thru air pattern to provide uniform air distribution over the evaporator coil face.
2. The coils shall be seamless drawn copper tubes, mechanically bonded to tempered aluminum fins with fin pattern designed for maximum heat transfer.
3. Coil end plates shall be hot dipped galvanized.
4. The evaporator coil shall be mounted in an insulated stainless steel condensate drain pan.

F. DX-Refrigeration System

1. All refrigeration piping shall be refrigerant grade tubing.
2. Each refrigerant circuit shall include, as a minimum:
 - a. Refrigerant drier/strainer
 - b. Sight glass with moisture detector
 - c. Thermal expansion valve with rapid bleed port feature and external equalizer
 - d. Evaporator coil, compressor
 - e. High pressure switch with manual reset, and
 - f. Low pressure switch with automatic reset.
3. Split/Remote systems shall have a liquid line solenoid for refrigerant isolation to prevent liquid slugging. All high pressure joints shall be brazed and the entire system shall be pressure tested at the factory with dry nitrogen, evacuated to at least 50 microns and fully charged with refrigerant.

Note: All split/remote DX systems ship with a dry nitrogen holding charge. All self-contained DX systems ship with a full refrigerant (R407c) operating charge.

G. Scroll Compressors

1. Each compressor shall be a high efficiency, high reliability and low sound Scroll Compressor.
2. The compressor shall be complete with charging and service schraeder ports, internal vibration isolation, internal thermal overloads, internal pressure relief valve, internal discharge gas vibration eliminator and external vibration mounting isolation.

H. Blowers/Motors

1. The blower shall be direct-driven with double-width, double-inlet housing and forward-curved blades.
2. The blower shall be dynamically and statically balanced to minimize vibration and operate in in the Class 1 range.
3. The blower shall be corrosion protected.
4. The blower motor shall have internal overload protection.
5. Additionally, the fan speed shall have a manual adjustment via a potentiometer to meet specific air-flow requirements.

I. Evaporator Air Patterns

1. The air conditioner shall be configured for an up-flow air pattern with free evaporator return air through front filtered grille and conditioned supply air through the top of the unit.
2. A top 1" 2 or discharge plenum boxes shall be provided.

J. Air Filtration

1. The air conditioner shall have slice out or 2" deep 60% pleated filters.
2. The filters shall be easily accessed through the front.

K. Heat Rejection

1. Each evaporator refrigerant circuit shall be provided with a factory installed single pass, counterflow configured brazed plate heat exchanger, with integral subcooler, constructed of type 316 stainless steel; designed and tested for a 450 psig. w.w.p.
2. Each refrigerant circuit's head pressure shall be controlled by a factory installed 3-way water/glycol regulating valve rated for 150 psig w.w.p.

(Note: 3-way and high pressure water/glycol regulating valves are optionally available.)

L. Controls

1. The Standard Mini-Space system includes the C5000 microprocessor controller, canister steam humidifier, and dehumidification mode with electric reheat/heat providing precision temperature and humidity control. (See page 3-5).

M. Electric Heat/Reheat

1. A factory-mounted and wired electric resistance heater shall be included to provide automatic sensible reheating mode during the dehumidification cycle and automatic heating mode, as required.
2. Electric heaters shall be provided with thermal/magnetic circuit breakers which shall protect each conductor.
3. Included shall be one automatic resetting and one manual resettable, over-temperature safety device (pilot duty).

N. Reheat

1. A factory piped and wired hot gas reheat valve shall be provided to divert the hot compressor discharge gas from the condenser to the hot gas reheat coil during the dehumidification cycle.
2. This energy saving feature shall require no additional energy to assist in offsetting the sensible cooling capacity while in the dehumidification mode.

O. Head Pressure Control

1. Each refrigerant circuit's head pressure shall be controlled by a factory installed 3-way water/glycol regulating valve rated for 150 psig w.w.p.

P. DX – Capacity Modulation Freeze Protection

1. The Mini-Space floor A/C shall incorporate a snap acting hot gas bypass system to provide modulation of the unit's cooling capacity and evaporator coil freeze protection under low load conditions.

Q. Accessories

1. A 12" high adjustable floor stand shall be provided to allow for ease of installation of the Mini-Space A/C onto a raised floor. The floor stand shall be field installed.

2.7 GLYCOL PUMP PACKAGE

A. General

1. The system shall be a dual (two), redundant, pump package designed to provide the total required glycol condenser coolant flow rate at the total rated system pressure drop.

B. Quality Assurance

1. The system shall be factory assembled, tested and shipped complete.
2. The system shall be designed for outdoor installation and year round service.
3. The glycol pump package manufacturer shall be an ISO-9001 registered and approved company.
4. The pump package shall be MET Laboratory (an NRTL) listed and labeled in compliance with UL 1995.

C. Cabinet Construction

1. The pumps and main electrical enclosure shall be mounted on a welded aluminum frame and protected by a removable galvanized steel weather cover.
2. The pump controls shall be mounted in a NEMA-3R enclosure at the end of the pump package.

D. Component Access

1. Pumps shall be easily accessible via a removable galvanized steel weather cover. Electrical components shall be accessible via a NEMA-3R electrical enclosure with hinged front door.

E. Electrical System

1. The system shall incorporate overcurrent and overload protection in accordance with UL 1995 requirements.
2. The control circuit shall be a 24 Vac Class 2 low voltage circuit.
3. The system shall be complete with:
 - a. 24 Volt Control Transformer
 - b. Main Power Non-Fused Disconnect Switch with Lockable Handle
 - c. Main Power Distribution Block and Grounding Lug
 - d. Individual Pump Motor Contactors with Branch Circuit Protection via Fuses and Overload Protection
 - e. Dual Pump Status (ON/OFF) Dry-Contact Closure Connection
4. As a safety, each indoor air conditioner's and drycooler's control circuit shall require a pump package power initialization signal via field connection to the pump package's 24 VAC interface connections.
5. The pump package electric circuit shall be designed for single point main power supply for pump package operation only. Drycooler main power supply shall require a separate main power supply source.
6. Options

- a. Flow Switch - field installed:
 - 1) A factory provided, field installed coolant sensing flow switch shall be provided for automatic switchover from primary to backup pump operation in the event of a loss of coolant flow.
- b. Manual Lead-Lag Switch:
 - 1) To allow for equal pump run-time and/or to ensure pump operation, a manual lead-lag toggle switch shall be factory included with the Dual Pump Package controls.

F. Pumps – Motors/Impellers

- 1. Pumps shall be a single stage end suction centrifugal type close coupled to a NEMA standard motor.
- 2. Pumps shall be constructed of heavy duty cast iron with precision machined and balanced bronze, non-overloading impellers secured to the motor shaft with a stainless steel locknut.
- 3. Pump motors shall be weather resistant high efficiency TEFC type rated for outdoor installation. Motors shall have overload protection and a minimum NEMA service factor of 1.15.

G. Time Rotation Control

- 1. A programmable, 7-day electronic timer is available for automatic pump sequencing to even the pump operating hours.
- 2. The timer shall have a 7-day battery backup with LCD display for ease of programming. The timer shall be factory wired and surface mounted for operation.

2.8 ACCEPTABLE MANUFACTURERS

- A. Carrier
- B. York
- C. Task Industries
- D. AAON

PART 3 - EXECUTION

- 3.1 Provide refrigerant piping and accessories to connect condensing units condensers to air conditioning units according to manufacturer's instructions.

3.2 STARTUP AND TESTING

- A. Manufacturer's service technician to check alignment of bearings, drives and motors after installation to ensure that no misalignment exists, or make any necessary alignment adjustments prior to startup.
- B. The manufacturer shall furnish a startup check list to the Owner at least two months prior to start up. The list must be explicit as to the various items to be checked prior to start up.

- C. Before units are started up, manufacturer to pump new grease into bearing housings to force out old grease and provide adequate lubrication.
- D. Before acceptance of the equipment by the Owner, conduct all tests as required to demonstrate that the equipment operates mechanically, electrically and acoustically as specified.
- E. Conduct a satisfactory performance test in the presence of the Owner. Any units found to vibrate beyond acceptable levels must be rebalanced in the field at the Contractor's expense.

3.3 SPARE COMPRESSORS

- A. Provide ten percent spare compressors of each size supplied for the building but no less than one of each size.

END OF SECTION

SECTION 238440
SPACE HEATING UNITS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide heating units in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Unit Heaters.
- B. Cabinet Heaters.

1.3 SUBMITTALS

- A. Submit manufacturer's latest information on construction details, capacity data and installation details.

1.4 QUALITY ASSURANCE

- A. All electric heating units to be U.L. or ETL rated and bear certifying label.
- B. All hot water and steam units to be rated and tested for pressure as shown on the Drawings.

PART 2 - PRODUCTS

2.1 UNIT HEATERS - PROPELLER FAN TYPE

- A. Provide propeller type unit heaters with heating elements, motor driven propeller type fans, all installed in a metal casing, finished with lacquer or baked-on enamel.
- B. Motor speeds not to exceed 1,500 rpm. Remove and replace any unit heaters which are found to be objectionably noisy in the opinion of the Architect/Engineer.
- C. Each unit heater to be properly supported from building construction and braced, as necessary, to prevent sway. Unit heaters shall not be supported by the piping to which they are connected.
- D. For wet heating systems, provide copper coil heating elements rated for maximum working pressure. Install an aquastat in the supply connection to each heater, wired to prevent the fan from operating when there is no heat available.
- E. For electric unit heaters, provide heating elements of sheathed nickel-chromium wire.

2.2 CABINET HEATERS - CENTRIFUGAL FAN TYPE

- A. Provide cabinet heaters of type shown on the drawings.
- B. Heating elements for wet systems to be of nonferrous construction throughout, rated at maximum system working pressure.

- C. Heating elements for electric unit heaters to be sheathed nickel-chromium wires.
- D. Construct enclosures of the best grade furniture steel, rigidly braced throughout and fabricated of not less than 16 gauge steel on the back. Valves to be installed within the enclosure. Provide hand access doors for access to the valves. Where the cabinet heater is shown to be recessed or semi-recessed, provide neat, close-fitting metal trim strips to form a permanent bond between the unit heater and the wall.
- E. Provide all enclosures with one prime coat of paint.

2.3 CONTROLS

- A. Unit Heaters and Unit Heaters
 - 1. Thermostats shall be furnished [by Section 15975] [Division 17] [by equipment manufacture]. Thermostats shall be line voltage, and designed to operate on a 3° differential over a temperature range of 45°-75°.

2.4 ACCEPTABLE MANUFACTURERS

- A. Cabinet Heaters and Unit Heaters
 - 1. Trane
 - 2. Modine
 - 3. Airtherm
 - 4. York

PART 3 - EXECUTION

3.1 ACCESSORIES

- A. None.

END OF SECTION

SECTION 238600
ELECTRIC MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide electric motor controllers in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Combination Starters and Disconnect Switches.

1.3 SUBMITTALS

- A. Shop Drawings
 - 1. Submit shop drawings and manufacturer's data for all items in accordance with the conditions of the contract.
 - 2. Include control diagrams, unit wiring diagram for each motor controller, assembly outline drawings, summary sheets, shop interwiring diagrams, field connection diagrams, and nameplates with legends.
- B. Include a statement verifying coordination with the automatic temperature controls and the fire alarm system.

1.4 QUALITY ASSURANCE

- A. Motor Controllers: Comply with Underwriters' Laboratories standard UL-508 and National Electrical Manufacturers Association Standard 1CS-1970.
- B. Disconnect Switches: Comply with National Electrical Manufacturers Standard KS-1-1957 and Federal Standards W-S-865C.

PART 2 - PRODUCTS

2.1 COMBINATION STARTERS AND DISCONNECT SWITCHES

- A. Provide suitable fully coordinated starting and controlling equipment for motors as required. Arrange the starting equipment as indicated in other sections of these specifications.
- B. Consult with each trade affected to determine the exact requirements for each device. Coordinate with automatic temperature control contractor to establish required auxiliaries, including relays, contacts, terminals and the like.
- C. Provide individual starters fully enclosed in neatly finished ventilated boxes of code gauge steel, machine formed and welded. Provide boxes arranged for floor, wall or angle iron frame mounting including a door with a spring catch handle with facility to lock handle in open position.
- D. Provide engraved nameplates for each unit, nomenclature of each to be approved prior to fabrication.

- E. Provide starters for motors less than 1/2 horsepower, including smoke dampers and combination fire/smoke dampers, as 120 volt, 1-phase, 60 cycle, alternating current service with pilot light. Provide manual starters with overload protection and lockout type disconnect switch to control such motors, except where interlocks or automatic controls are required. In such cases, provide magnetic across-the-line starters.
- F. Provide starters for motors 1/2 horsepower to 100 horsepower as magnetic across-the-line, combination type fused disconnect switch. Such starters to be 480 volt, 3-phase, 60 cycle, alternating current service. Provide each controller with a set of properly sized dual element fuses as specified in Division 16.
- G. Provide starters for motors over 100 horsepower to be magnetic, combination reduced voltage auto transformer with fused disconnect switches. Such starters to be 480 volt, 3-phase, 60 cycle, alternating current service.
- H. Provide magnetic starters subject to manual start and in direct view of the motors they control with momentary contact start and stop buttons built into cover. Provide magnetic starters subject to electrical interlock or automatic control with Hand-Off-Automatic switches built into cover. Provide selector switches in starters to be of the maintained-contact type.
- I. Provide starters with a green pilot running light built into cover.
- J. Provide starters for service at voltages higher than 120 volt with transformers for 120 volt secondary service built into each starter casing to serve control circuits.
- K. Provide each starter subject to electrical interlock and/or automatic control with the necessary auxiliary contacts plus one spare set of normally open and normally closed auxiliary contacts. Provide one set of terminals for each control circuit.
- L. Provide magnetic starters with thermal overload in each phase leg and low voltage protection.
- M. Provide coils, cores, resistance, insulation, contacts, trippers, etc., for starters and relays.
- N. Mount individual motor controllers in NEMA Type 1A enclosures for typical indoor locations. Utilize NEMA Type 3R for outdoor locations and NEMA Type 4 for other wet locations or locations subject to water spray or very high humidity.

2.2 MOTOR CONTROL CENTERS

- A. Provided by Division 16.

2.3 ACCEPTABLE MANUFACTURERS

- A. General Electric
- B. Westinghouse
- C. Federal Pacific
- D. ITE
- E. Cutler-Hammer
- F. Allen Bradley

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Motor controllers will be installed under work of Division 16.
- B. Various pieces of packaged equipment will be provided with starters installed by manufacturer at the factory. Coordinate the Division 16 work with these starters.
- C. Review Division 16 and Automatic Temperature Control Division 17 Documents for required accessories, interlocks, etc. Failure to fully coordinate this item with the other Divisions in no way relieves this Contractor from providing a complete, functional, and coordinated system as described.

END OF SECTION

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SECTION 260001

SEPARATION OF WORK BETWEEN THE TRADES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The specifications delineate various items of related work under separate trade headings in accordance with the Contract Documents as listed below.
- B. Indications that the electrical and mechanical trades are to perform an item of work means that they are to perform the work for their own accommodation only, except as specifically noted otherwise.

Key to Abbreviations:

"OTHER"	=	Provided for Owner by the Construction Manager or General Contractor
"PLBG"	=	Plumbing
"FP"	=	Fire Protection
"HVAC"	=	Heating, Ventilating and Air Conditioning
"ELECT"	=	Electrical
"F"	=	Furnished
"I"	=	Installed
"P"	=	Provided (Furnished and Installed)
"C"	=	Final Connection

Scope of Work	Other	Plbg	FP	HVAC	Elect	Notes
Temporary Heat	P					
Temporary Water	P					
Temporary Light & Power	P					
Temporary Fire Standpipe	P					
Temporary Toilets	P					
Excavation & Backfill for MEP Inside Bldg for MEP Outside Bldg	P	P	P	P	P	
Dewatering Site & Excavation	P					
Subsoil Drainage Inside Building	P	C				

Scope of Work	Other	Plbg	FP	HVAC	Elect	Notes
Outside Building	P	C				
Footing Drains	P	C				
Drywells		P				
Manhole & Covers		P	P	P	P	
Concrete Equipment Bases and Pads: Inside Building Outside Building	P	P				
Masonry Pits	P					1
Pit Frames & Covers	I	F				2
Fuel Oil Tank Cradle	P					
Trenches in Floor Slabs	P					
Anchors and Vibration Mounts in Inertia Blocks	I	F	F	F	F	3
Concrete Encasement of Underground Runs		P	P	P	P	
Fastening and Supports		P	P	P	P	
Cutting, Chasing and Patching		P	P	P	P	
Framed Slots and Openings	I	F	F	F	F	
Sleeves through Slabs, Decks and Walls		P	P	P	P	
Waterproof Sealing of Openings		P	P	P	P	
Fireproof Sealing of Excess Openings		P	P	P	P	
Drilling & Cutting of all Holes		P	P	P	P	
Hoisting and Rigging		P	P	P	P	
Floor Drain Flashing		P				
Base Flashing for all Roof Penetrations	P					
Cap Flashing for all Roof Piping Penetrations		P	P	P	P	
Roof Curb Base Flashing	P					
Roof Curb Cap Flashing				P		
Prime Painting MEP Work		P	P	P	P	
Field Touch-Up Painting		P	P	P	P	
Rustproofing Field Cut Iron Work		P	P	P	P	
Color Coding MEP Work		P	P	P	P	
Precast Receptors		P				

Scope of Work	Other	Plbg	FP	HVAC	Elect	Notes
Shower Stall Pan Flashing		P				
Toilet Room Accessories	P					
Soap Dispensers	P					
Domestic Water Make-Up		P				4
Fire Hose & Cabinets			P			
Fire Extinguishers	P					
Fire Extinguisher Cabinets	P					
Finished Access Doors & Frames	I	F	F	F	F	
Ladders & Catwalks	P					
Motors for Mechanical Equipment		P	P	P		
Loose Motor Controls for Mechanical Equipment		F	F	F	I	
Motor Control Centers					P	
Disconnect Switches					P	5
Wiring for Equipment Motors and Starters					P	
Premounted & Prewired Starters and Disconnects		P	P	P	C	
Electric Radiators and Convectors					P	
Electric Duct Heaters				P	C	
Electric Heat Tracing Cable		F	F	F	I	6
Electric Water Heater		P			C	
Plaster Frames for Ceiling Mounted Fixtures, Ceiling Diffusers, etc.	I			F	F	
Power Circuit to Starter Disconnect Switch and Motor					P	
Line Voltage Control Device (Aquastat) etc.		P		P	C	
Control Device Not in Power Circuit to Motor		P		P		
Temperature Control Device & Electric Actuator				P		
Sprinkler & Standpipe Alarm System: Devices Panels			P		C P	
FM200, Deluge and Pre-Action Sprinkler, Smoke and Thermal Detection			P			7

Scope of Work	Other	Plbg	FP	HVAC	Elect	Notes
Space Smoke Detector					P	
Duct Smoke Detector				I	F&C	
Smoke Control/Fire Alarm Panel					P	
Boiler and Refrigeration Room Shut-off & Break Glass				P	C	
Kitchen Hood Fire Suppression System	P				C	8
Lighting Fixtures					P	
Exterior Wall Louvers	P					9
Radiator Enclosures				P		10
Ornamental Grilles	P					
Air Boots for Air/Light Fixtures and Perimeter Slots					P	
Raised Floor	P					
Air Outlets in Raised Floor	I			F		
Masonry Chimney Breeching Frame	P					
Masonry Chimney Cleanout Door	P					
Prefabricated Chimney				P		
Kitchen Range Hood	P					
Dishwashing Hoods	P					
Food Service Equipment	P	C		C	C	
Refrigerators	P				C	
Refrigerator Condensing Units, Air Cooled	P				C	
Refrigerator Condensing Units, Water Cooled	P			C	C	
Lightning Protection					P	
Pneumatic Tube System	P				C	
Exterior Transformer Vault	P					
Incinerator	P	C		C	C	
Elevator	P				C	
Escalator	P				C	
Lifts	P				C	
Laboratory Equipment	P	C		C	C	

Scope of Work	Other	Plbg	FP	HVAC	Elect	Notes
Hospital Equipment	P	C		C	C	
Laundry Equipment	P	C		C	C	
Window Washing Machines	P	C			C	
Linen/Garbage Chutes	P		C			
Vermiculite Fireproofing	P					
Rubbish Removal		P	P	P	P	11
Maintenance Tools		F	F	F	F	

A. SPECIFIC NOTES:

1. Plumbing Trade shall provide sizes and locations.
2. Covers and Frames for sewage ejectors, sump pump and silt pits shall be furnished by the Plumbing Trade.
3. Details furnished by individual Trades.
4. Final connections included in the HVAC work.
5. When not part of a premounted starter.
6. Insulation covering by each Trade after heating cable is connected and tested.
7. Power to Control Panel by the Electrical Trade; tie into the fire alarm system by the Electrical Trade; all other by Fire Protection Trade.
8. Power to the Kitchen Hood Fire Protection System and gas pipe solenoid valve by the Electrical Trade; tie into the fire alarm system by the Electrical Trade.
9. Duct connections and safing of unused portions of louvers shall be by the HVAC Trade.
10. Except where custom enclosures are provided by others.
11. Where one Trade furnishes and another installs, the installing Trade removes the shipping and packing materials where accumulated.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 NOT USED

END OF SECTION

SECTION 260003

ELECTRICAL SCOPE OF WORK

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide the work included in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Provide all labor, materials, equipment, tools, appliances, auxiliaries, services, hoisting, scaffolding, support, supervision, and Project Record Documents, and perform all operations for the furnishing and installing of the complete electrical system, including but not limited to the work described hereinafter. The work shall meet or exceed the latest codes, regulations and requirements of the Building Department.
- B. The electrical work is shown schematically on the Contract Drawings to indicate the general system arrangement and configuration. The work of this Division shall include coordination with the work of other Divisions of the Specifications and the Contract Documents so as to provide a complete and operational system capable of being readily operated and maintained, including approved rearrangement of the systems and equipment and rerouting of distribution services to enable the complete system to fit within the confines of the allotted electrical spaces, all to the satisfaction of the Architect/Engineer or as directed by the Architect/Engineer.
- C. The work includes, but is not limited to the following:
1. Equipment supports and miscellaneous steel for electrical equipment.
 2. Incoming telephone service empty raceway system.
 3. Vibration isolation and restraints for the electrical installation.
 4. Temporary power and lighting system.
 5. Exterior and site lighting, including controls.
 6. Service and distribution feeders.
 7. Complete 277/480 volt and 120/208 volt light and power distribution system, including emergency system.
 8. Fire alarm system, devices, wiring, conduit and programming and connecting to existing Building Fire Alarm System.
 9. Lighting fixtures, lamps, convenience outlet systems, and miscellaneous wiring devices.
 10. Motor power wiring and installation of motor starters.
 11. Miscellaneous electrical equipment and systems.
 12. Telecommunications, security and audio-visual empty conduit systems, including labeled pull wires.
 13. Balancing loads.
 14. Grounding system.
 15. Special mechanical system connections.
 16. Sealing of sleeves and other electrical openings.
 17. Master Label lightning protection system.
 18. Window washing equipment connections.
 19. Pipe heat tracing, connections and controls.
 20. Electric snow melting systems, connections and controls.
 21. Commissioning of electrical systems.
 22. Lighting control systems.
 23. Installation of Owner-furnished equipment.

24. As-built reproducible tracings and electronic files.
25. Field painting.
26. Field acceptance testing, adjusting and balancing, including testing as per Con Edison standards.
27. O & M Manuals.
28. Life-Safety 480/277V Emergency generator, switchgear, 480/277V automatic transfer switches, wiring, controls, and conduit.
29. Electrical Power Monitoring System.
30. 13.2 kV Service Switchgear with Associated Con Edison Electric Services, as per Con Edison standards.
31. Rerouting all existing 13.2 kV to 480/277V or 208/120V substations to be fed from new service switchgear.
32. Provision of 13.2 kV isolation transformers.
33. Provision of 13.2 kV standby generators (3), including associated 13.2 kV automatic transfer switches and 13.2 kV load bank.
34. Fire pump and associated wiring.
35. 125 Volt DC Distribution System.
36. For additional information see drawings.

PART 2 - PRODUCTS

2.1 NOT USED.

PART 3 - EXECUTION

3.1 NOT USED.

END OF SECTION

SECTION 260004
ELECTRICAL UNIT PRICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide unit prices in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Provide costs as indicated herein for changing quantities of work items from those indicated in the Contract Documents. Include labor, materials, equipment and services, overhead, profit, insurance and other incidental expenses to cover the finished work specified.
- B. Identify such costs listed herein on the Contract Bid Form.
- C. The standards set forth in the related sections of these specifications form the standard for the work specified herein.
- D. This form shall be completed and submitted at the time of bid.

1.3 COST GUARANTEE

- A. Any additional work not called for under this Contract will be performed at any time and any quantity as directed by the Architect/Engineer at the unit prices set forth below. Such work will be performed upon request at any time until final acceptance of all work under this Contract. All such additional work will be performed in accordance with the terms and conditions of this Contract. In the event that work is eliminated from this Contract, the Owner will be credited with the cost of said eliminated work at the unit prices set forth below.

PART 2 - PRODUCTS

2.1 UNIT COSTS

- A. Hourly Labor Rate
1. Per hour labor rate including overhead, profit and supervision for each staff member \$_____.
- B. Conductors
1. Furnished and installed costs per 100 linear feet of conductors in specified raceway.
- a. 600 volt copper conductors.

Copper Conductor Size	Type XHW	Type THWN	Type THHN
No. 12	\$_____	\$_____	\$_____
No. 10	\$_____	\$_____	\$_____

Copper Conductor Size	Type XHW	Type THWN	Type THHN
No. 8	\$_____	\$_____	\$_____
No. 6	\$_____	\$_____	\$_____
No. 4	\$_____	\$_____	\$_____
No. 3	\$_____	\$_____	\$_____
No. 2	\$_____	\$_____	\$_____
No. 1	\$_____	\$_____	\$_____
No. 1/0	\$_____	\$_____	\$_____
No. 2/0	\$_____	\$_____	\$_____
No. 3/0	\$_____	\$_____	\$_____
No. 4/0	\$_____	\$_____	\$_____
No. 250 MCM	\$_____	\$_____	\$_____
No. 300 MCM	\$_____	\$_____	\$_____
No. 350 MCM	\$_____	\$_____	\$_____
No. 400 MCM	\$_____	\$_____	\$_____
No. 500 MCM	\$_____	\$_____	\$_____
No. 600 MCM	\$_____	\$_____	\$_____
No. 750 MCM	\$_____	\$_____	\$_____

b. 600 volt aluminum conductors.

Aluminum Conductor Size	Type XHW	Type THWN	Type THHN
No. 1	\$_____	\$_____	\$_____
No. 1/0	\$_____	\$_____	\$_____
No. 2/0	\$_____	\$_____	\$_____
No. 3/0	\$_____	\$_____	\$_____
No. 4/0	\$_____	\$_____	\$_____
No. 250 MCM	\$_____	\$_____	\$_____
No. 300 MCM	\$_____	\$_____	\$_____
No. 400 MCM	\$_____	\$_____	\$_____
No. 500 MCM	\$_____	\$_____	\$_____
No. 600 MCM	\$_____	\$_____	\$_____
No. 750 MCM	\$_____	\$_____	\$_____

c. 5,000 and 15,000 volt copper conductors.

<u>Conductor Size</u>	<u>5,000 volt</u>	<u>15,000 volt</u>
No. 2	\$ _____	\$ _____
No. 1/0	\$ _____	\$ _____
No. 2/0	\$ _____	\$ _____
No. 3/0	\$ _____	\$ _____
No. 4/0	\$ _____	\$ _____
No. 250 MCM	\$ _____	\$ _____
No. 500 MCM	\$ _____	\$ _____
No. 750 MCM	\$ _____	\$ _____

C. Raceways

1. Costs per 100 linear feet of raceways furnished and installed with hangers, coupling, connectors, etc.

<u>Raceway Size</u>	<u>Schedule 40 PVC</u>	<u>Schedule 80 PVC</u>	<u>EMT</u>	<u>RGS</u>	<u>ALUM</u>
3/4"	\$ _____	\$ _____	\$ _____	\$ _____	\$ _____
1"	\$ _____	\$ _____	\$ _____	\$ _____	\$ _____
1-1/4"	\$ _____	\$ _____	\$ _____	\$ _____	\$ _____
1-1/2"	\$ _____	\$ _____	\$ _____	\$ _____	\$ _____
2"	\$ _____	\$ _____	\$ _____	\$ _____	\$ _____
2-1/2"	\$ _____	\$ _____	\$ _____	\$ _____	\$ _____
3"	\$ _____	\$ _____	\$ _____	\$ _____	\$ _____
3-1/2"	\$ _____	\$ _____	\$ _____	\$ _____	\$ _____
4"	\$ _____	\$ _____	\$ _____	\$ _____	\$ _____
5"	\$ _____	\$ _____		\$ _____	\$ _____

2. Furnished and installed costs per 100 linear feet of specified wireways installed.

<u>Size</u>	
2½" x 2½"	\$ _____
4" x 4"	\$ _____
6" x 6"	\$ _____
8" x 8"	\$ _____
12" x 12"	\$ _____

D. Panelboards

1. Branch Circuit Panelboard, 277/480 volt, 3 phase, 4 wire, 22KAIC, 100% neutral bus, ground bus, complete with a full complement of 1, 2 and/or 3 pole 100 amp branch circuit breakers (Furnish and Install)

<u>Circuit Quantity</u>	<u>100A MLO</u>	<u>100A MCB</u>	<u>225A MLO</u>	<u>225A MCB</u>
12	\$_____	\$_____	\$_____	\$_____
18	\$_____	\$_____	\$_____	\$_____
24	\$_____	\$_____	\$_____	\$_____
30	\$_____	\$_____	\$_____	\$_____
36	\$_____	\$_____	\$_____	\$_____
42	\$_____	\$_____	\$_____	\$_____
66	\$_____	\$_____	\$_____	\$_____
84	\$_____	\$_____	\$_____	\$_____

2. Branch Circuit Panelboard, 120/208 volt, 3 phase, 4 wire, 22KAIC, 100% neutral bus, ground bus, complete with a full complement of 1, 2 and/or 3 pole 100 amp branch circuit breakers (Furnish and Install)

<u>Circuit Quantity</u>	<u>100A MLO</u>	<u>100A MCB</u>	<u>225A MLO</u>	<u>225A MCB</u>
12	\$_____	\$_____	\$_____	\$_____
18	\$_____	\$_____	\$_____	\$_____
24	\$_____	\$_____	\$_____	\$_____
30	\$_____	\$_____	\$_____	\$_____
36	\$_____	\$_____	\$_____	\$_____
42	\$_____	\$_____	\$_____	\$_____
66	\$_____	\$_____	\$_____	\$_____
84	\$_____	\$_____	\$_____	\$_____

3. Circuit Breakers

- a. Furnished and installed costs of bolt on circuit breakers installed within a 120/208 volt, 3 phase, 4 wire panel, as specified.

C/B Trip
Ampacity
& Poles

1/P 20A	\$_____
1/P 25A	\$_____
1/P 30A	\$_____
1/P 40A	\$_____

C/B Trip
Ampacity
& Poles

1/P 50A	\$ _____
1/P 60A	\$ _____
1/P 70A	\$ _____
1/P 100A	\$ _____
2/P 20A	\$ _____
2/P 30A	\$ _____
2/P 40A	\$ _____
2/P 50A	\$ _____
2/P 60A	\$ _____
2/P 70A	\$ _____
2/P 100A	\$ _____
3/P 20A	\$ _____
3/P 30A	\$ _____
3/P 40A	\$ _____
3/P 50A	\$ _____
3/P 60A	\$ _____
3/P 70A	\$ _____
3/P 100A	\$ _____
3/P 125A	\$ _____
3/P 150A	\$ _____
3/P 175A	\$ _____
3/P 200A	\$ _____
3/P 225A	\$ _____
3/P 250A	\$ _____
3/P 300A	\$ _____
3/P 400A	\$ _____

- b. Furnished and installed costs of bolt on circuit breakers installed within a 277/480 volt, 3 phase, 4 wire panel as specified.

<u>C/B Trip Ampacity & Poles</u>	
1/P 20A	\$ _____
1/P 25A	\$ _____
1/P 30A	\$ _____
1/P 40A	\$ _____
1/P 50A	\$ _____
1/P 60A	\$ _____
1/P 70A	\$ _____
1/P 100A	\$ _____
2/P 20A	\$ _____
2/P 30A	\$ _____
2/P 40A	\$ _____
2/P 50A	\$ _____
2/P 60A	\$ _____
2/P 70A	\$ _____
2/P 100A	\$ _____
3/P 20A	\$ _____
3/P 30A	\$ _____
3/P 40A	\$ _____
3/P 50A	\$ _____
3/P 60A	\$ _____
3/P 70A	\$ _____
3/P 100A	\$ _____
3/P 125A	\$ _____
3/P 150A	\$ _____
3/P 175A	\$ _____
3/P 200A	\$ _____
3/P 225A	\$ _____
3/P 300A	\$ _____
3/P 400A	\$ _____

E. Rejection Fuses

1. Furnished and installed costs of one (1) set of specified rejection fuses.

Fuse Size	Bussmann Type <u>FRS-R</u>	Bussmann Type <u>FRN-R</u>	Bussmann Type <u>LPS-RK</u>	Bussmann Type <u>LPN-RK</u>	Bussmann Type <u>KTS-R</u>	Bussmann Type <u>KTN-R</u>
15A	\$_____	\$_____	\$_____	\$_____	\$_____	\$_____
20A	\$_____	\$_____	\$_____	\$_____	\$_____	\$_____
30A	\$_____	\$_____	\$_____	\$_____	\$_____	\$_____
40A	\$_____	\$_____	\$_____	\$_____	\$_____	\$_____
50A	\$_____	\$_____	\$_____	\$_____	\$_____	\$_____
60A	\$_____	\$_____	\$_____	\$_____	\$_____	\$_____
70A	\$_____	\$_____	\$_____	\$_____	\$_____	\$_____
80A	\$_____	\$_____	\$_____	\$_____	\$_____	\$_____
90A	\$_____	\$_____	\$_____	\$_____	\$_____	\$_____
100A	\$_____	\$_____	\$_____	\$_____	\$_____	\$_____
110A	\$_____	\$_____	\$_____	\$_____	\$_____	\$_____
125A	\$_____	\$_____	\$_____	\$_____	\$_____	\$_____
150A	\$_____	\$_____	\$_____	\$_____	\$_____	\$_____
175A	\$_____	\$_____	\$_____	\$_____	\$_____	\$_____
200A	\$_____	\$_____	\$_____	\$_____	\$_____	\$_____
225A	\$_____	\$_____	\$_____	\$_____	\$_____	\$_____
250A	\$_____	\$_____	\$_____	\$_____	\$_____	\$_____
300A	\$_____	\$_____	\$_____	\$_____	\$_____	\$_____
350A	\$_____	\$_____	\$_____	\$_____	\$_____	\$_____
400A	\$_____	\$_____	\$_____	\$_____	\$_____	\$_____
600A	\$_____	\$_____	\$_____	\$_____	\$_____	\$_____
601A	\$_____	\$_____	\$_____	\$_____	\$_____	\$_____

F. Disconnecting Means

1. Furnished and installed costs of specified heavy duty, 3 phase, 600 volt disconnect switches.

Size	Unfused <u>NEMA 1</u>	Fused <u>NEMA 1</u>	Unfused <u>NEMA 3R</u>	Fused <u>NEMA 3R</u>
30A	\$_____	\$_____	\$_____	\$_____
60A	\$_____	\$_____	\$_____	\$_____
100A	\$_____	\$_____	\$_____	\$_____

200A	\$ _____	\$ _____	\$ _____	\$ _____
400A	\$ _____	\$ _____	\$ _____	\$ _____
600A	\$ _____	\$ _____	\$ _____	\$ _____
800A	\$ _____	\$ _____	\$ _____	\$ _____
1200A	\$ _____	\$ _____	\$ _____	\$ _____
1600A	\$ _____	\$ _____	\$ _____	\$ _____
2000A	\$ _____	\$ _____	\$ _____	\$ _____

G. Wiring Devices

- Furnished and installed costs of specified wiring devices with outlet box wiring connections and faceplate.

Item

Momentary Contact Switch	\$ _____
1P - Switch	\$ _____
2P - Switch	\$ _____
3 Way Switch	\$ _____
4 Way Switch	\$ _____
20A 120V duplex receptacle	\$ _____
20A 120V duplex GFCI receptacle	\$ _____
20A 120V duplex I.G. receptacle	\$ _____
Occupancy/Vacancy Sensor (Wall)	\$ _____
Occupancy/Vacancy Sensor (Ceiling)	\$ _____
Daylighting Control Sensor (Wall)	\$ _____
Daylighting Control Sensor (Ceiling)	\$ _____
Dimmer Switch (Each Type Used on the Project)	\$ _____

H. Transformation Equipment

- Furnished and installed costs of specified 3 phase, 480 volt delta primary - 120/208 V wye secondary transformers.

<u>kVA Size</u>	<u>Floor Mounted</u>	<u>Ceiling Hung</u>
9	\$ _____	\$ _____
15	\$ _____	\$ _____
30	\$ _____	\$ _____

<u>kVA Size</u>	<u>Floor Mounted</u>	<u>Ceiling Hung</u>
45	\$_____	\$_____
75	\$_____	\$_____
112.5	\$_____	\$_____
150	\$_____	
225	\$_____	
300	\$_____	
500	\$_____	
750	\$_____	

I. Fire Alarm System

1. Furnished and installed cost of specified equipment (include 200 feet of cabling back to DGP)

Flush Mounted Fire Speaker	\$_____
Flush Mounted Fire Speaker with Visual Alarm	\$_____
Surface Mounted Fire Speaker	\$_____
Surface Mounted Fire Speaker with Visual Alarm	\$_____
Smoke Detector	\$_____
Flush Mounted Fire Horn	\$_____
Flush Mounted Fire Horn with Visual Alarm	\$_____
Surface Mounted Fire Horn with Visual Alarm	\$_____
Flush Mounted Visual Alarm	\$_____
Surface Mounted Visual Alarm	\$_____
Fan Shutdown	\$_____
Duct Type Smoke Detector	\$_____
Detector Remote Annunciator Light	\$_____
Duct Detector Remote Lamp & Test Station	\$_____
Firefighters' Phone Set	\$_____
Firefighters' Phone Jack	\$_____
Connect Water Flow Switch	\$_____
Connect Tamper Switch	\$_____

PART 3 - EXECUTION

3.1 Perform the work in accordance with the Contract Documents.

END OF SECTION

SECTION 260005

ACCESS DOORS IN GENERAL CONSTRUCTION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Furnish access doors located in general construction in accordance with the Contract Documents for setting under general construction work. Access doors shall be provided for the operation and maintenance of concealed equipment, pullboxes, ballasts, etc.

1.2 WORK INCLUDED

- A. Access Doors in Drywall.
- B. Access Doors in Ceilings.
- C. Access Doors in Masonry.
- D. Fire Rated Access Doors.
- E. Color Coded Buttons.

1.3 SUBMITTALS

- A. Provide manufacturer's data on access doors to be furnished in each type of general construction by location within the project.

PART 2 - PRODUCTS

- 2.1 Wherever access is required through walls or ceilings to junction boxes, pull boxes, control panels, devices, or other concealed equipment installed under this division, furnish a hinged access door with flush screwdriver operated cam locks and frame as follows:

- A. Drywall construction--Milcor Style DW.
- B. Finished acoustical tile ceiling--Milcor Style AT.
- C. Finished plaster ceiling--Milcor Style AP.
- D. Finished plaster walls --Milcor Style K.
- E. 1 ½ Hour rated shaft --Milcor Fire Rated MIFAB-MPFR.
- F. Provide access doors in rated construction with "B" label fire construction. Furnish a U.L. label on each access door.
- G. Access doors will be installed under another Division. Coordinate all sizes and locations with General Contractor.
- H. No access door shall be installed until location and type have been approved by the Architect.

- 2.2 Furnish color coded buttons or tabs to indicate location of pull boxes, control panels, devices, or other equipment located above removable type ceilings where access doors are not required.
- 2.3 Make access door size a minimum of 18" x 18".

PART 3 - EXECUTION

3.1 GENERAL

- A. Coordinate sizes and location of all access doors with General Contractor.
- B. Direct location and setting of access doors in hung ceilings, furred spaces, walls, etc., to provide access to all concealed work items requiring maintenance and/or adjustment and as directed by the Architect/Engineer. Obtain acceptance of the Architect/Engineer for the locations and sizes of such access doors.
- C. Locate and group equipment requiring access doors so that access door locations are aesthetically acceptable. Coordinate location of equipment requiring access with other trades to minimize number of access doors in one area. Prepare drawings of pull boxes, control panels, devices, etc. locations indicating proposed access door locations for review by the Architect/Engineer prior to installation of pull boxes, control panels, devices, etc. Include equipment of other trades on the Contract Drawing.

END OF SECTION

SECTION 260250
SYSTEMS IDENTIFICATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide fixed identification of all distribution equipment and conductors in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Fixed identification for:
1. Switchboards, Switchgears and Unit Stations.
 2. Motor Control Centers.
 3. Panelboards and Load Centers.
 4. Meter Centers.
 5. Bus Ducts.
 6. Feeder Switches.
 7. Disconnect Switches/Enclosed Circuit Breakers.
 8. Feeder Switches (Fuse Identification).
 9. Remote Smoke Detector Lamps and Test Stations.
 10. Wall Plates.
 11. Motor Controllers.
 12. Fire Alarm Panels.
 13. Automatic Transfer Switches.
 14. Generator Control Panels.
 15. Lighting Control Panels.
 16. Pullboxes, Enclosures and Cable Terminations.
 17. Fire Alarm Jacks and Warden Stations.
 18. Freeze Protection.
 19. Luminaires.
 20. Transformers.
 21. Capping and Staking.
 22. Medium Voltage Raceways.

1.3 SUBMITTALS

- A. Identification procedures shall be noted and scheduled on the applicable shop drawings.

1.4 QUALITY ASSURANCE

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
1. Industry standards shall apply.
 2. NFPA 70.
 3. ANSI A113.1 and NFPA for color coding.
 4. ANSI Z535-4.
 5. OSHA Standards.

PART 2 - PRODUCTS

- 2.1 Unless otherwise noted, nameplates shall be black bakelite plates with white engraved upper case letters enclosed by white border on beveled edge.
- 2.2 Nameplates for equipment supplied by the emergency system shall be red bakelite with white lettering.
- 2.3 All nameplates must be engraved and must be secured with rivets, brass or cadmium plate screws. The use of Dymo type or the like is unacceptable.
- 2.4 Lettering heights unless otherwise noted must be as follows:

Item	Lettering Height
Switchboards, Switchgears & Unit Substations	2"
Motor Control Centers	2"
Panelboards, Load Centers & Lighting Panels	1/2"
Meter Centers & Transformers	1/2"
Bus Ducts	1/2"
Feeder Switches	1/4"
Disconnect Switches/Enclosed Circuit Breakers	1/2"
Feeder Switches (Fuse Identification)	1/4"
Remote Smoke Detector Lamps	1/8"
Wall Plates	1/8"
Motor Controllers & Freeze Protection	1/4"
Fire Alarm Panels	1/2"
Automatic Transfer Switches	1/2"
Generator Control Panels	1"
Pullbox, Enclosures and Cable Terminations	1/8"
Fire Alarm Phone Jacks and Warden Station	1/8"
Medium Voltage Raceways	1"
Transformers	1/2"

- 2.5 Cable tags must be flameproof secured with flameproof non-metallic cord.
- 2.6 Nameplate inscriptions must bear the name and number of the equipment to which they are attached as indicated on the Contract Drawings. The Engineer reserves the right to make modifications in the inscriptions as necessary.
- 2.7 The Engineer reserves the right to request additional nameplates at the time of review of shop drawings and upon site observations. These shall be furnished at no additional cost to the Owner.
- 2.8 Do not manufacture or install nameplates until approved by the Owner.

PART 3 - EXECUTION

3.1 SWITCHBOARDS, SWITCHGEARS, SUBSTATIONS, METER CENTERS AND MOTOR CONTROL CENTERS

- A. Furnish and install a master nameplate for each switchboard, switchgear, substation, meter center and motor control center engraved with the equipment identification indicated on the Contract Drawings. Mount at top of the incoming section.
- B. Provide on each main switch an identifying nameplate. Where multiple mains are employed each switch shall be numbered. Inscription shall be "Main Switch" or "Main Switch No. 1" et al.

3.2 PANELBOARDS, LOAD CENTERS AND TRANSFORMERS

- A. Furnish and install a nameplate for each panelboard and load center engraved with the identification indicated on the Contract Drawings. Mount at top of panel.
- B. After installations are complete, provide and mount under sturdy transparent shield in the directory frame of each panel door, a neat, accurate and carefully typed directory properly identifying the lighting, receptacles, outlets, and equipment each overcurrent device controls.
- C. Include on directory the panel or load center identification, the cable and raceway size of panel feeder, and the feeder origination point.
- D. Provide a nameplate for each transformer engraved with the primary and secondary feeder sizes.

3.3 DISCONNECT SWITCHES AND ENCLOSED CIRCUIT BREAKERS

- A. Furnish and install a nameplate for each disconnect switch and enclosed circuit breaker engraved with the equipment designation.

3.4 MOTOR CONTROLLERS

- A. Furnish and install a nameplate for each motor controller or combination motor controller for both individual motor controllers and those in a motor control center, etc. Engraving must indicate the motor served and the type of service (e.g., AC-1 - 1st floor supply, EF-2 - electric closet exhaust).
- B. Final equipment names shall be coordinated with the Mechanical Contractor and Owner prior to fabrication.

3.5 BUS DUCTS

- A. Furnish and install nameplates for each bus duct engraved with bus duct designation. Install at each bus duct in every electrical closet and on horizontal runs at not less than 50' on center.

3.6 FEEDER SWITCHES

- A. Furnish and install for each feeder switch including, but not limited to those in switchboards, those in switch and fuse panelboards, those take-offs at bus ducts, those in motor control centers, those in meter centers, etc. two (2) nameplates as follows.
 - 1. The first nameplate must be white background with red lettering. Engrave with the words "REPLACE ONLY WITH ____ FUSE". Engrave with proper fuse trade name and ampere rating (i.e. Bussmann LPS-R 100).
 - 2. The second nameplate shall indicate the load served, the size and type of cable and raceway example:

Panels LP-4, LP-5, LP-6
4#500 MCM-THHN-CU-3-1/2"C.

3.7 REMOTE SMOKE DETECTOR LAMPS AND TEST STATIONS

- A. Furnish and install a nameplate on each remote smoke detector lamp and/or test station. Engraving must indicate the address of the device to which the lamp is connected as per the shop drawings marked "NO EXCEPTIONS NOTED."
- B. Provide additional fire alarm device labeling as indicated in the fire alarm specification section.

3.8 WALL PLATES

- A. Furnish and install an engraved wall plate for each switch controlling loads which are not local to the switch. Engraving shall be as directed by the Owner.
- B. Furnish and install engraved wall plate for each receptacle indicating the panel and circuit number.

3.9 PULLBOXES, ENCLOSURES AND CABLE TERMINATIONS

- A. Furnish and install cable tags on each cable which enters a pullbox, enclosure, switchboard, and at terminations. Mark tags with type written inscription noting the load served, type and size of cable and the overcurrent device protecting the cable.

3.10 FIRE ALARM PHONE JACKS AND WARDENS STATIONS

- A. Furnish and install an engraved wall plate on each warden's station and portable fire alarm phone jack. Engraving must indicate the floor and location of the device per the shop drawings marked "NO EXCEPTIONS NOTED."

3.11 MEDIUM VOLTAGE RACEWAYS (OVER 600 VOLTS)

- A. Furnish and install on each medium voltage raceway the following as conditions permit:
 - 1. Exposed:

- a. Self-adhesive labels on each raceway at every floor level and not more than 25' on center. Labels are to be yellow and black and note the operating voltage of the conductors so enclosed.
- 2. Concealed Below Grade or Concrete:
 - a. Concrete insert type markers above each raceway at every floor level and not less than 25' on center. Inserts are to be 4" in diameter of non-ferrous metal fit flush with finished surface. Inscription to state size of raceway and cable operating voltage and date of installation. Concrete fill above ductbank shall be provided with a red dye.

3.12 FREEZE PROTECTION

- A. Install decal type labels on each pipe which is provided with freeze protection.
- B. Labels shall be inscribed "CAUTION -- ELECTRIC HEAT TRACING".
- C. Affix labels to the thermal insulation not more than 20' on center but not less than every length of pipe.

3.13 FIRE ALARM PANELS

- A. Furnish and install on each fire alarm panel an approved nameplate.
- B. Nameplates shall indicate floor and where multiple panels are installed a prime designation for each cabinet (e.g. DGP-1A, DGP-1B) per the shop drawings marked "NO EXCEPTIONS NOTED."
- C. Panels shall be permanently identified in an approved manner.

3.14 LIGHTING CONTROL PANELS

- A. Furnish and install on each lighting control panel a master nameplate similar to that required for panelboards.
- B. Where circuits therein are served via normal and emergency sources, provide warning nameplates as follows: "WARNING THIS PANEL IS ALSO SERVED FROM PANEL CIRCUITS " inscribe panel and circuit numbers. Nameplate to consist of white letters on a red background.
- C. Provide typed directories similar to that required for panelboards.

3.15 CAPPING AND STAKING

- A. Wherever raceways are for future use and are terminated outside of the structure, stake the location with a 2' long 1" x 1" wooden stake having a conspicuous colored flag.
- B. Provide metal markers inserted into 8" D x 12" concrete ballast at all raceway terminations exterior to the structure. Inserts must state the date the raceway was installed, the size of the raceway and the point of the raceway termination.

3.16 LUMINAIRES

- A. Where connected to other than 120 volt circuit, provide each fluorescent or high intensity discharge fixture with the ballast voltage stenciled on the ballast cover in letters not less than ½ inch high.

3.17 AUTOMATIC TRANSFER SWITCHES

- A. Furnish and install a red nameplate for each automatic transfer switch. Engraving shall indicate the switch number, the load served, feeder sizes, and the sources of normal and generator power.

3.18 GENERATOR CONTROL PANEL

- A. Furnish and install a red nameplate for each generator control panel. Engraving shall indicate the generator controlled by the panel.

END OF SECTION

SECTION 260265

TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide complete field acceptance testing of equipment and systems throughout in accordance with the Contract Documents. This testing is in addition to any required commissioning requirements.

1.2 WORK INCLUDED

- A. Testing, adjusting, and balancing for:
 - 1. Wire and Cable (600 Volts and Below).
 - 2. 15 kV Cable.
 - 3. 5 kV Cable.
 - 4. Motor Controllers, including variable frequency drives.
 - 5. Motors.
 - 6. Engine Generator, Paralleling Switchgear, and Automatic Transfer Switches.
 - 7. Primary Switchgear, Unit Substations, Switchgears, and Switchboards.
 - 8. Life Safety Fire Alarm Systems.
 - 9. Cable Snow Melting System.
 - 10. Freeze Protection System.
 - 11. Lightning Protection System.
 - 12. Ballasts.
 - 13. Air Handling Plenums and Luminaires.
 - 14. Emergency Battery System, Packs and Quartz Standby Units.
 - 15. Grounding.
 - 16. Three Phase Receptacles.

1.3 SUBMITTALS

- A. Provide test results as required herein and in each section of this Division.

1.4 QUALITY ASSURANCE

- A. Except as modified by governing codes and by the Contract Documents comply with the latest applicable provisions and the latest recommendations of the following:
 - 1. Industry standards shall apply except as otherwise specified.
 - 2. Testing Agency Qualifications: as specified in each section within this specification containing electrical testing requirements.
 - 3. NETA.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide all labor, premium labor and materials required by shop and field acceptance testing, adjusting, and balancing as specified in the Contract Documents and as required by the authorities having jurisdiction.

2.2 SYSTEMS

A. The following systems shall be tested, inspected and certified.

1. Wire and Cable (600 Volts and Below):

- a. Inspect all splices and terminations and make mechanically and electrically tight during a fifteen (15) day period immediately prior to final acceptance of the work.
- b. Perform standard 600 volt insulation resistance test with "megger" tester and all conductors. Test shall show insulation resistance in excess of minimum values required by the NETA and continuity. Submit certification to the Architect/Engineer.

2. 5 kV Cable:

- a. Each cable shall be fully tested by an approved certified independent testing contractor. Cables shall be tested after all splices and terminations are installed. Cables shall not be connected to any equipment.
- b. 5 kV shielded cables shall be tested at 30 kV for 15 minutes. The 30 kV test voltage shall be applied in 6 equal steps of 5 kV in accordance with the following test procedure.
- c. Test Procedure:
 - 1) Inspect exposed section of cables, insulation, and jacket for physical damage. Assure cable data matches with the Contract Documents.
 - 2) Set up test equipment. Do not connect test lead to cables, but temporarily hang the lead free with an insulator over the clip. Raise the voltage to the same final level at which the cables are going to be tested. The leakage current seen on the DC meter is leakage in the test lead, and should be subtracted from the readings taken later during the cable test.
 - 3) Apply the test voltage to each phase separately, making sure that all other phases, all cable shields, any armoring or neutral conductors, and other nearby metallic objects are grounded to prevent voltage pick-up.
 - 4) Raise the voltage to each increment level, recording the leakage current value after a one minute wait at each level. Upon reaching the final level, record the leakage current values at one minute intervals. These final level values should remain fairly constant or drop off slightly. A continually rising current at any voltage level indicates an imminent failure.
 - 5) Upon completion of a successful test, shut down the test set and allow the voltage to decay to one-fourth the full value. Record the decay time.
 - 6) Solidly ground the conductor and allow the ground to remain in place for a period at least as long as the test time.
 - 7) Repeat the same test sequence for each phase cable.
- d. Provide a graphic plot of current versus voltage for each cable to be submitted with all the actual test readings.
- e. Approved Testing Contractors:
 - 1) Burlington Testing
 - 2) Northeast Testing.

3. 15 kV Cable:

- a. Each cable shall be fully tested by an approved certified independent testing contractor. Cables shall be tested after all splices and terminations are installed. Cables shall not be connected to any equipment.
- b. 15 kV shielded cables shall be tested at 56 kV for 15 minutes. The 56 kV test voltage shall be applied in 4 equal steps of 14 kV in accordance with the following test procedure.
- c. Test Procedure:

- 1) Inspect exposed section of cables, insulation, and jacket for physical damage. Assure cable data matches with the Contract Documents.
 - 2) Set up test equipment. Do not connect test lead to cables, but temporarily hang the lead free with an insulator over the clip. Raise the voltage to the same final level at which the cables are going to be tested. The leakage current seen on the DC meter is leakage in the test lead, and should be subtracted from the readings taken later during the cable test.
 - 3) Apply the test voltage to each phase separately, making sure that all other phases, all cable shields, any armoring or neutral conductors, and other nearby metallic objects are grounded to prevent voltage pick-up.
 - 4) Raise the voltage to each increment level, recording the leakage current value after a one minute wait at each level. Upon reaching the final level, record the leakage current values at one minute intervals. These final level values should remain fairly constant or drop off slightly. A continually rising current at any voltage level indicates an imminent failure.
 - 5) Upon completion of a successful test, shut down the test set and allow the voltage to decay to one-fourth the full value. Record the decay time.
 - 6) Solidly ground the conductor and allow the ground to remain in place for a period at least as long as the test time.
 - 7) Repeat the same test sequence for each phase cable.
- d. Provide a graphic plot of current versus voltage for each cable to be submitted with all the actual test readings.
 - e. Approved Testing Contractors:
 - 1) Burlington Testing
 - 2) Northeast Testing.
4. Motor Controllers:
- a. Submit with certification in tabular form a complete listing of all motors on the project for which motor controllers, including variable frequency drives, have been furnished. Include on this listing, the nameplate full load amperes of each motor and the size overload heaters installed in each motor controller.
5. Motors:
- a. Test all motors under load and verify that motor rotation is correct.
6. Engine Generator, Paralleling Switchgear, and Automatic Transfer Switches:
- a. Factory Testing:
 - 1) Prior to shipment of the engine-generator set from the factory, a certified load test shall be performed and the results submitted to the Architect/Engineer for review before shipment of the unit. The test shall verify the proper operation of all alarms and shut down circuits.
 - 2) The test shall also demonstrate compliance with the set performance criteria as specified herein.
 - 3) Testing shall be performed as follows:
 - a) In a period of four (4) hours with a loading of 25, 50, 75, and 100 percent of rated load. Step loading procedure shall be utilized (i.e. 25 percent first hour, 50% second hour, etc.).
 - b) Maintain 100% load for one (1) hour.
 - c) Verify operation of all shut down and alarm points specified.
 - d) Perform transient response testing to verify performance as specified. Load steps shall be performed as follows.
 - (i) 0% - 25% 0%

- (ii) 0% - 50% 0%
 - (iii) 0% - 75% 0%
 - (iv) 0% - 100% 0%
 - e) All load steps shall be recorded on a chart recorder or light beam oscilloscope.
- 4) Factory testing shall be accomplished using resistive and reactive load banks to match the kilowatt and kVA requirements set forth in the Contract Documents.
- b. Field Testing:
 - 1) After completion of the installation, the Contractor shall arrange with the Architect/Engineer for a full load test of the engine generator and related automatic transfer switches (ATS) and paralleling switchgear. Assure all ATS time delays have been set. The generator shall be required to start-up and accept full load within 10 seconds. The unit shall continue to operate for not less than four (4) hours at 100 percent rated load. The test shall also include demonstrating that all alarms, signals, shut down devices, elevator recall, etc., are functioning properly. The Contractor shall be responsible for securing all temporary load-banks, etc., required for the full load tests. Actual building loads shall be utilized for this testing, augmented with temporary load banks as required.
 - 2) This Contractor shall supply all fuel for the testing. Upon acceptance by the Architect/Engineer, the day tank and main fuel oil tank shall be filled to capacity after testing.
 - 3) Perform testing of all by-pass isolation switches per the manufacturer's requirements.
- 7. Primary Switchgear, Unit Substations, Switchgears, and Switchboards:
 - a. At the completion of the equipment installation, each primary switchgear, unit substation and each switchboard shall be field tested in the presence of the Architect/Engineer. Field tests shall be conducted by the service organization of the manufacturer.
 - b. Inspect physical, electrical, and mechanical condition. Clean all equipment interiors and exterior.
 - c. Verify appropriate anchorage, required code clearances, correct alignment, physical connections, and grounding.
 - d. Confirm all overcurrent protective devices are in place and are of the appropriate rating.
 - e. Field tests shall include the following:
 - 1) Operation of each disconnecting means under full load.
 - 2) Operation of all metering equipment.
 - 3) Operation of all alarm devices.
 - 4) Operation of forced air cooling system, if applicable.
 - 5) Operation of all key interlocks.
 - 6) Verify that windings turn-ratio measurements and polarities are correct.
 - 7) Operation of all surge protective devices.
 - f. The manufacturer shall observe all cable bracing both incoming and outgoing, and certify that same is provided in accordance with the manufacturer's recommendations.
 - g. The ground fault systems shall be set at the level specified by the equipment supplier. Each system shall be tested by checking coordination between ground fault and phase to ground fault of a 1P-20 ampere lighting branch circuit.

- h. Buswork shall be infrared tested and shall be retorqued in accordance with manufacturer's recommendations. Submit certification of same.
 - i. Perform ground resistance tests.
 - j. Perform transformer insulation resistance tests.
8. Life Safety Fire Alarm Systems:
- a. All fire alarm system wiring must be inspected and tested to insure that there are no grounds, opens or shorts. The minimum allowable resistance between any two conductors or between conductors and ground is ten (10) megohms as measured with a 500 volt megger after all conduit, conductors, detector bases, etc., have been installed, but before the detector devices are plugged into the bases or end-of-line devices installed.
 - b. The Contractor must perform all electrical and mechanical tests required by the equipment manufacturers. All test and report costs must be in the Contract price. A checkout report shall be prepared by the technician and submitted in triplicate, one copy of which will be registered with the equipment manufacturer. The report shall include, but shall not be limited to:
 - 1) A complete list of equipment installed and wired.
 - 2) Indication that all equipment is properly installed and functions in conformance with these specifications.
 - 3) Tests results of all individual zones.
 - 4) Serial numbers, locations by zone and model number for each installed detector.
 - 5) Voltage (sensitivity) settings for each ionization detector as measured in place.
 - 6) Response time on all detectors.
 - 7) Contractor shall submit a certified report indicating the following:
 - a) Operating all manual stations and all detectors that can be reset.
 - b) Verifying line supervision of each initiating and indicating circuit.
 - c) Verifying the operation of each initiating circuit.
 - d) Verifying the operation of all indicating devices.
 - e) Verifying the operation of all alarm-initiated functions.
 - f) Verifying full operation of the FACP.
9. Cable Snow Melting System:
- a. Each heater cable shall be tested a minimum of four (4) times for resistance, continuity and insulation at the following times:
 - 1) Before each cable is installed.
 - 2) After each cable is installed and before concrete is poured.
 - 3) After concrete is poured.
 - 4) At the time of acceptance.
 - b. The above data shall be compared to factory test data.
 - c. A written report of the test results for each specific cable shall be provided to the Architect/Engineer upon completion of the tests.
 - d. Any cables failing the tests by lack of continuity, improper resistance, or insulation failure shall be replaced.
 - e. Test shall indicate not less than 20 megohms with a 500 volt D.C. ohmmeter from sheath to conductor.
 - f. Prior to shipment, each heater unit shall be subjected to a high potential test of 1600 volts, 60 cycles, for one minute, from conductor to sheath and the resistance shall measure not less than 20 megohms when using a 500 volt D.C. ohmmeter. Each heater shall be tagged with a metal tag indicating the length of hot section, length of cold section, maximum voltage, and the resistance.

10. Freeze Protection:
 - a. Before and after each heater cable has been completely installed on the piping system, but before pipes are insulated, the following tests shall be made:
 - 1) Check the continuity of the heating cable to be sure the conductors have not been broken during installation.
 - 2) Measure actual applied voltage and load current.
 - b. Repeat the above tests and checks after pipe insulation is applied and installation is complete.
 - c. For each heating cable, the heater number and the test results obtained for each of the tests above shall be recorded both before and after installation of the heating cable and the application of the insulation.
 - d. A qualified manufacturer's representative shall be required to make a final inspection prior to the application of insulation and before start-up.
11. Lightning Protection System:
 - a. Provide certified Master Label for the lightning protection system from U.L. Attach same to the building where directed by the Architect.
12. Ballasts:
 - a. Submit manufacturer's certification that ballasts and transformers for discharge type lamps comply with the latest C.B.M. specifications which have been issued.
13. Air Handling Plenums and Luminaires:
 - a. For recessed luminaires to be mounted in ceilings utilized as air handling plenums, submit manufacturer's certification that they, together with their external connections, are suitable for the purpose.
14. Emergency Battery System, Packs and Quartz Standby Units:
 - a. Each emergency battery pack and system shall be shown to operate satisfactorily. This shall be accomplished by the use of the unit mounted test switch as one test. The second test shall be the interruption of power to the unit.
 - b. Quartz standby lamps in H.I.D. luminaires shall be tested to show proper operation by testing as listed above.
15. Grounding:
 - a. Upon completion of the electrical grounding system, the contractor shall test the grounding system for stray currents, grounds, shorts, etc. These tests shall be performed with approved calibrated instruments.
 - b. Perform point-to-point tests to determine the resistance between the main grounding system and all electrical equipment frames, system neutral, and all derived neutral points.
 - c. The Contractor shall submit in writing to the Architect/Engineer a letter indicating the ohmic resistance of the service grounds and a statement that the grounding system is free of all defects, stray currents, shorts, etc.
16. Three Phase Receptacles:
 - a. Rotometer test all three phase receptacles and verify correct phase rotation.

2.3 CALIBRATION

- A. Calibrate and adjust all components in accordance with manufacturer's procedures and recommendations or as required, for the following categories of equipment:

1. Primary switchgear.

2. 600V switchboards and switchgears.
 3. Unit substations.
 4. Transformer taps.
 5. Lighting fixtures (lamp positions, reflector positions, etc., as required).
 6. Motor Control Centers and motor starters.
 7. Generator Controls and synchronization.
 8. Lighting controls, including all sensors.
 9. UPS and PDU equipment.
- B. Provide overloads in all motor starters, in accordance with motor nameplate data and as recommended by the manufacturer.

PART 3 - EXECUTION

- 3.1 Notify the Architect/Engineer seven (7) days prior to the testing dates. If the Architect/Engineer so elect not to witness a specific test a statement of certification must be forwarded to the Architect/Engineer for his approval.
- 3.2 Conduct tests at a time agreeable to the Architect/Engineer. Provide premium labor as necessary.
- 3.3 Products which are found defective or do not pass such tests shall be removed and replaced at the Contractor's expense. All tests shall be repeated until equipment meets all testing criteria.
- 3.4 Arrange for and conduct all test and inspections required by the authorities having jurisdiction. All fees for testing and inspection shall be paid by the Contractor.
- 3.5 All test results shall be submitted to the Engineer.
- 3.6 Refer to individual specification sections for additional equipment testing requirements.

END OF SECTION

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SECTION 260270

TEMPORARY LIGHTING AND POWER

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide temporary lighting and power in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Temporary Lighting and Power.

1.3 SUBMITTALS

- A. None required.

1.4 QUALITY ASSURANCE

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
 - 1. Utility company standards.
 - 2. Occupational Safety and Health Act.

PART 2 - PRODUCTS

2.1 NOT USED.

PART 3 - EXECUTION

- 3.1 Contractor shall make all necessary arrangements with the Owner for the new installation of temporary lighting and power services tailored for this project and the setting of temporary meters in accordance with the Utility Company's requirements. He shall pay for the installation and maintenance of all temporary light and power wiring, including, but not limited to conduits, wire, switches, fuse boxes, receptacles, distribution panel boards, fused disconnect switches, ground fault interruption equipment, fixtures, lamps, fuses and any other incidental material and/or equipment required to provide sufficient illumination and power, as required by the State Labor Board, OSHA, or all other authorities having jurisdiction for all areas of the site where work will be performed by this Contractor, his subcontractors, or any other contractors.
- 3.2 Furnish and install one complete set of work lamps, including those required for trailers and/or temporary offices. Contractor shall also furnish and install one complete set of fuses for temporary light and power services, as required. The replacement of burned out and broken lamps shall be carried out by those using the trailers and/or offices.
- 3.3 Rubber covered trailers, each 40' long, having plugs, sockets and locked type guards, shall be supplied by this contractor for use by other contractors, as required.
- 3.4 Temporary power circuits and outlets, etc. shall be provided in accordance with the power requirements of the various horsepower ratings of the equipment to be installed under all contracts and for temporary motors, elevator, etc. Temporary power required for motor operated tools and

appliances to be used by various contractors in construction work, and not to be a part of the permanent equipment shall be provided.

- 3.5 Irrespective of the union working hours for the electricians, the Electrical Contractor shall maintain and pay the entire regular and overtime labor costs of keeping the temporary light and power system energized from a period of 15 minutes before the established starting time of the building trade which starts work earliest to a period of 15 minutes after the established stopping time of the trade which stops work latest. This shall apply to every working day of the week during the life of the contract, unless otherwise directed, or until such time that the maintenance of the temporary light and power system is no longer required by reason of the activation of and use of the permanent light and power systems.
- 3.6 When the electricians are entitled to a holiday or holidays under union rules and the other building trade workmen are required to work and do not have the same holiday or holidays, the Electrical Contractor shall maintain and pay the entire overtime labor costs of keeping the temporary light and power system energized for the full day or those full days, as the case may be, including the extra 15 minutes before the start and after the close of the working day, as stated in the preceding paragraph.
- 3.7 Should this Contractor or any contractor require temporary light or power, or both, before or after the hours set forth in the preceding paragraphs, this Contractor or other contractors shall pay the extra cost of keeping the systems energized and in serviceable condition.
- 3.8 Remove the temporary light and power systems, when directed. This Contractor shall replace and make good all damage to the permanent systems, as required, replacing all damaged parts. Under no circumstances shall temporary wiring be left in finished hung ceiling spaces.
- 3.9 When the permanent lighting and power systems are installed and operational, this Contractor shall make the change-over. The cost of making the change-over of the electric services from the temporary lines to service from permanent lines shall be borne by this Contractor.
- 3.10 At no time shall the temporary electrical equipment installation be used for permanent lighting and power services.

END OF SECTION

SECTION 260280

EQUIPMENT CONNECTIONS AND COORDINATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide final connections to equipment and coordinate same in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Equipment to receive final connections shall include but not be limited to the following:
 - 1. Motors and Equipment.
 - 2. Appliances.
 - 3. Owner Furnished Equipment.

1.3 SUBMITTALS

- A. None required.

1.4 QUALITY ASSURANCE

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
 - 1. NFPA-96.

PART 2 - PRODUCTS

2.1 ONLY THOSE PRODUCTS LISTED IN THIS DIVISION SHALL BE EMPLOYED.

PART 3 - EXECUTION

3.1 EXAMINATION OF DOCUMENTS

- A. Prior to the submitting of bids, this Contractor shall familiarize himself with all conditions affecting the proposed installation of equipment requiring electrical connections and shall make provisions as to the cost thereof. Failure to comply with the intent of this paragraph shall in no way relieve the Contractor of performing all necessary work required for final electrical connections and equipment and the coordination thereof.
- B. Connections shall be made in accordance with the manufacturers' recommendations and reviewed shop drawings.

3.2 MOTORS AND EQUIPMENT

- A. Connections for and coordination of motors and equipment requiring electrical connections shall be included but is not be limited to the following:

1. Install motor controllers and disconnect switches for each motor and each piece of equipment.
2. Verify that the motor rotation is correct and reconnect if necessary.
3. Provide separate ground conductor in flexible metal conduit so as to provide an electrically continuous ground path. Ground all equipment.
4. Provide motor branch circuit conductors and connections to each individual motor controller and from each controller to the motor through an approved disconnect switch. Make final connection in a minimum of 24 inch length of liquid-tight, flexible, metal conduit.
5. Provide all necessary wiring and connections for interlocking, remote and automatic controls. Installation of equipment and wiring shall be in compliance with the manufacturer's recommendations.
6. Where equipment is fed from a branch circuit routed in or under the slab, terminate branch circuit at a junction box on 2 foot rigid conduit stub-up and make final connection to equipment in liquid-tight, flexible, metal conduit. Provide suitable knee brace on conduit stub-up.
7. Where equipment is fed from overhead, support conduit feeder descending from ceiling on flanged floor fitting with conduit type fitting connecting to a motor with 24-inch minimum of liquid-tight flexible metal conduit.
8. Where nameplate on equipment indicates fuse protection, the disconnecting means shall be equipped with time delay fuses.

3.3 APPLIANCES

- A. Connections for and coordination of appliances shall include but is not limited to the following:
1. The basic requirements for motors and equipment specified above shall apply where applicable.
 2. Where cord and plugs are provided with the appliances, this Contractor shall coordinate the receptacle installation to match. Information on the Contract Documents as to a receptacle type is for bidding purposes only.
 3. Direct connected equipment shall be serviced by disconnecting means.

3.4 OWNER FURNISHED EQUIPMENT

- A. The requirements for equipment furnished by the Owner for installation by this Contractor shall include but is not limited to the following:
1. The coordination of the proper delivery scheduling of such equipment.
 2. The receiving and unloading of such equipment at the property line.
 3. The inspection of such equipment for damage, defacement, corrosion, missing components, etc. at the job site. All deficiencies shall be recorded. Deficiencies occurring after inspection shall be corrected by this Contractor at his cost.
 4. The safe handling at secure storage of such equipment from unloading to the time of permanent installation.
 5. The completion of field make up of internal wiring as required.
 6. The lamping of equipment, with new lamps.
 7. The installation of accessories on such equipment.

8. The installation of such equipment including the transportation of the equipment to the installation area, and the installation of all supports, fasteners, canopies, extensions, etc. required to insure safe support and adaptation to the finished structural, electrical and architectural conditions.
9. The final connections and grounding to the building electrical system including all necessary labor and materials including but not limited to junction box extensions, lug change outs, wiring, conduit, etc.
10. The testing of such equipment in its final location.

END OF SECTION

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SECTION 260290

CEILING, FLOOR AND WALL ELECTRICAL
PENETRATION FIRE SEALS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide pre-mixed putty sealant at wall, ceiling and/or floor electrical penetration fire seals in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Wall, ceiling and/or floor electrical penetration fire seals.

1.3 SUBMITTALS

- A. Product Data
 - 1. Submit manufacturer's product data for all fire seals, including barrier rating.

1.4 QUALITY ASSURANCE

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
 - 1. ASTM E-814, "Fire Test of Penetration Fire Stops."
 - 2. ANSI/UL 1479, "Fire Tests of Through Penetration Firestops."
 - 3. ASTM E-119, "Fire Tests of Building Constructions and Materials."
 - 4. ANSI/UL263, "Fire Tests of Building Construction and Materials."
 - 5. ASTM E-84, "Surface Burning Characteristics of Building Materials."
 - 6. ANSI/UL723, "Surface Burning Characteristics of Building Materials."
- B. All products shall contain no VOC nor emit odors.
- C. All products shall be U.L. listed for their intended uses.

1.5 PERFORMANCE REQUIREMENTS

- A. Provide products that upon curing, do not re-emulsify, dissolve, leach, break down or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during and after construction.
- B. Openings within walls and floors designed to accommodate cabling systems subjected to frequent cable changes shall be provided with re-enterable products specifically designed for retrofit.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver through-penetration firestop system products to the project site in original, unopened containers or packages with intact and legible manufacturer's labels identifying product and manufacturer, date of manufacture; lot number; shelf life, if applicable; qualified testing and

inspection agency's classification marking; and mixing instructions for multicomponent materials.

- B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants or other causes.

1.7 PROJECT CONDITIONS

- A. Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limitations recommended by the manufacturer.
- B. Do not install through-penetration firestop systems when substrates are wet due to rain, frost, condensation, or other causes.
- C. Do not use materials that contain flammable solvents.
- D. Do not install water-based or products that are conductive when wet in contact with energized electrical conductors. Exercise care when energizing penetrants.

1.8 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes or cut openings to accommodate through-penetration firestop systems.
- C. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

PART 2 - PRODUCTS

2.1 FIRE SEAL PUTTY SYSTEM

- A. System shall provide immediate fire seal, require no curing time and emit no hazardous or toxic fumes.
- B. Require no special tools and shall be capable of being installed from one side.
- C. No derating whatsoever required of wiring systems passing through seal.
- D. Field modified for additions or deletions of raceways or cables.
- E. Reusable materials to accommodate penetration changes.

2.2 MISCELLANEOUS FIRE SEAL PRODUCTS

- A. Firestop devices: Factory-assembled steel collars lined with intumescent material sized to fit specific outside diameter of penetrating item.
- B. Cast-In-Place Firestop Device: Single component molded firestop device installed on forms prior to concrete placement with totally encapsulated, tamper-proof integral firestop system and smoke sealing gasket.

- C. Composite Sheet: Intumescent material sandwiched between a galvanized steel sheet and steel wire mesh protected with aluminum foil.
- D. Fire Rated Grommet: Molded two-piece grommet made from plenum grade polymer with a foam inner core for sealing individual cable penetrations.
- E. Firestop Plugs: Re-enterable, foam rubber plug impregnated with intumescent material for use in spare sleeves and sleeves with cable.
- F. Firestop Putty: Intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds.
- G. Firestop Putty Pads: Intumescent, non-hardening putty pads to be installed on metallic and nonmetallic electrical switch and receptacle boxes when horizontal separation between boxes is less than 24".
- H. Wrap Strips: Single component intumescent elastomeric strips faced on both sides with a plastic film.
- I. Latex Sealants: Single component latex formulations that upon cure do not emulsify during exposure to moisture.
- J. Silicone Sealants: Moisture curing, single component, silicone elastomeric sealant for horizontal surfaces (pourable or nonsag) or vertical surfaces (nonsag).
- K. Firestop Pillows: Re-enterable, non-curing mineral fiber core encapsulated with an intumescent coating contained in a flame retardant bag.
- L. Mortar: Portland cement based dry-mix product formulated for mixing with water at Project site to form a non-shrinking, water-resistant, homogenous mortar.
- M. Silicone Foam: Multicomponent, silicone-based liquid elastomers, that when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

2.3 ACCEPTABLE MANUFACTURERS

- A. Nelson Firestop
- B. Hilti
- C. 3M
- D. Dow Solutions
- E. STI Inc.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Examination of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
- B. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellants, and any other substances that may inhibit optimum adhesion.
- C. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
- D. Do not proceed until unsatisfactory conditions have been corrected.

3.2 GENERAL

- A. Install fire seal in accordance with the manufacturer's requirements..
- B. Place minimum of 0.5 inches of putty around each penetrating item. When not possible build up cone around penetrating items, using second layer of putty. Slope cone at 30 degrees from wall or floor.
- C. Wall openings shall not have unsupported space of putty greater than 4 inches and floor openings an unsupported opening of 1.5 inches.
- D. Provide ceramic wool temperature rated 2300°F in conjunction with putty in accordance with manufacturer's instructions.
- E. Provide ceramic fiberboard temperature rated 2000°F in conjunction with putty in accordance with manufacturer's recommendation.
- F. Firmly anchor penetrating items prior to putty installation. Provide all necessary anchor bolts, fittings, etc. as necessary.

3.3 FIELD QUALITY CONTROL

- A. Inspections: Owner shall engage a qualified independent inspection agency to inspect through-penetration firestop systems.
- B. Keep areas of work accessible until inspection by authorities having jurisdiction.
- C. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.

3.4 ADJUSTING AND CLEANING

- A. Remove equipment, materials and debris, leaving area in undamaged, clean condition.
- B. Clean all surfaces adjacent to sealed openings to be free of excess through-penetration firestop system materials and soiling as work progresses.

3.5 INSTALLATION

- A. Provide fire seals at all cable, conduit and bus duct penetrations through fire-rated walls, floors and ceilings, and where noted on the Contract Drawings. Coordinate with architectural and structural drawings for location of fire-rated walls.
- B. Install in accordance with the manufacturer's directions to provide barrier rating equal to or greater than the barrier rating of wall.

3.6 WARRANTY

- A. Products shall be free of defects for one (1) year from the date of installation.

END OF SECTION

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SECTION 260500

BUS DUCT

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide a low impedance, metal enclosed bus duct system in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Bus Duct (feeder and plug-in types).
- B. Plug-In Units.
- C. Tap and End Boxes.
- D. Bus assembly hangers and supports.
- E. Hook stick.

1.3 SUBMITTALS

- A. Shop Drawings
 - 1. Complete fabrication and installation dimensional layout of all busway runs, with all components shown on the Bill of Materials. Contractor shall obtain all necessary field measurements to assure that the equipment will fit in the allocated space in full compliance with the NEC.
 - 2. External and internal dimensions, including all fittings.
 - 3. Arrangement of components comprising each fitting, hanger and straight section.
 - 4. Recommended methods of installation of the busway, fittings, and plug-in devices.
 - 5. All take off devices must be sized and illustrated including fuse sizes and types.
 - 6. All concrete curbs and mounting methods must be sized and illustrated.
 - 7. All fire stopping devices and mounting methods must be sized and illustrated.
 - 8. Seismic restraint calculations and certificates.
- B. Product Data
 - 1. Manufacturer's specification covering construction details; type of materials and finish for each item; and performance characteristics of copper bus bars.
 - 2. Electrical Characteristics: D.C. resistance and A.C. resistance, reactance and impedance at 60 hertz; voltage drop charts for various power factors.
 - 3. Recommended torque and resistance values for splice points where sections are joined together.
 - 4. Identify type of fuse clips, associated rejection feature, and fuse application warning labels for plug-in device fusible switches.
 - 5. Full load heat rejection in BTU per hour per 10' length of bus duct and take off devices.
- C. Test Reports
 - 1. Submit certified field test report as required in Part 3.

1.4 QUALITY ASSURANCE

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
 - 1. NEMA BU 1
 - 2. Federal Specification W-B-811b
 - 3. UL 857
 - 4. Service entrance label where part of service entrance.
 - 5. ANSI/IEEE C37.23
- B. Approval by Underwriters' Laboratories for busway and fittings; U.L. labeling of each busway section.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General
 - 1. Indoor busway; low impedance feeder or plug-in type as shown on the Contract Drawings.
 - 2. Voltage and ampere ratings as shown on the Contract Drawings.
 - 3. Neutral bus where required or as shown on the Contract Drawings.
 - 4. Voltage Drop:
 - a. Maximum 2.8 volts line-to-line per 100 feet for plug-in busway with distributed load at 80% power factor.
 - b. Maximum 3.8 volts line-to-line per 100 feet for feeder busway with concentrated loading at 80% power factor.
 - 5. Short-Circuit Ratings (Six Cycle Withstand):
 - a. Unless otherwise indicated on the Contract Drawings, the following ratings shall be provided.
 - 1) 600 Amperes Rating and Below: 50,000 amperes, 3 phase, RMS symmetrical.
 - 2) 800 - 2,000 Amperes Rating: 100,000 amperes, 3 phase, RMS symmetrical.
 - 3) 2001-3000 Amperes Rating: 150,000 amperes, 3 phase RMS symmetrical.
- B. Busway Construction
 - 1. General:
 - a. One or more fully insulated bus bars per phase and neutral (where applicable) totally enclosed within non-ventilated steel housing.
 - b. Standard ten-foot straight lengths, except where special lengths required.
 - c. Insulated supports to rigidly support bus bars in air.
 - d. Suitable for hanging on 5'-0" support centers for horizontal runs.
 - e. Capability for joining plug-in and feeder type busways.
 - f. Capability for removing a single section without disturbing adjacent pieces.
 - g. Internal ground bus securely bolted to each enclosure length at joint areas.
 - h. Capable of mounting in any position without derating.
 - i. Completely polarized.
 - 2. Bus Bars:

- a. High conductivity copper bars designed to carry load current within maximum temperature rating specified by NEMA standards.
 - b. Bus joints silver plated, tightly clamped with through bolts to insure maximum conductivity.
 - c. Silver plating of bus bars at plug-in openings.
 - d. Offset at one end to provide rigid mechanical and electrical lap joint.
 - e. Straight end with elongated holes for ease of alignment.
 - f. Bus washers of cup, spring compression type. High compression signal bolt at joints for "corrugated" side busway housings.
 - g. Provide a 50% minimum ground bus, internal or integrated housing ground path. Bond ground bus to busway housing.
 - h. Provide a 50% minimum internal ground bus; integrated housing ground path system is not permitted. Bond ground bus to busway housing.
3. Insulation:
- a. NEMA Class B (130°C) bus insulation material, minimum.
 - b. Molded insulation system or "sandwich" type construction consisting of layers of insulating and separating material between bars and where in continuous contact with corrugated side busway housings.
 - c. High dielectric non-tracking material with high impact and low moisture absorption characteristics for insulators in plug-in openings and between bus bars and flat side busway housings.
 - d. Busway maximum temperature rise at continuous rated load not to exceed 55°C above maximum ambient temperature of 40°C.
4. Housing:
- a. Formed of 16 gauge steel, bonderized after fabrication with primer coat and finish coat of manufacturer's standard gray paint applied on interior and exterior surfaces for the busways.
 - b. Handhole openings with covers at each joint on both sides of each duct section.
 - c. Joint fastenings designed for positive electrical continuity between housing sections for low impedance path for return of fault current.
 - d. Cadmium or zinc-plated hardware.
5. Plug-In Openings (Plug-In Busway Only):
- a. Ten (10) openings staggered on opposite sides of duct to each ten foot section such that all openings can be used simultaneously.
 - b. Covers for openings securely locked in place, but with means for insertion of plug-in devices.
 - c. All openings of identical design to permit complete interchange of plugs without use of adapters and without a change in phase rotation.
 - d. Sized to accommodate fusible switch plugs from 30 ampere through 400 ampere sizes.
- C. Plug-In Units (Plug-In Busway Only)
1. General:
- a. Constructed of code gauge steel with adequate concentric knockouts.
 - b. Silvered copper stabs with high pressure, full area contact with bus bars even after repeated insertions.
 - c. No projections extending into busway housing other than plug-in stabs.
 - d. Ground stab to engage internal ground bus in advance of engagement of phase buses and to part after disengagement of phase buses.
 - e. Ground lug for connection to branch circuit.

- f. Bolt-on clamps or hook-on hangers for installation on busway housing prior to engaging stabs on bus bars.
 - g. Designed so that plug-in devices cannot be inserted or withdrawn while in "ON" (closed) position even if plug-in device cover door has been opened by means of cover interlock bypass.
 - h. Internal barriers to prevent accidental contact of fish tape and conductors with live parts on line side of plug-in unit during wire pulling operations.
 - i. Polarized, to be interchangeable without modification on all ratings of similar busway.
 - j. Finish on all plug-in units shall be manufacturer's standard.
 - 2. Fusible Switch Bus Plugs: NEMA heavy-duty type with number of poles, voltage and ampacity ratings as shown on the Contract Drawings with following features:
 - a. Quick-make/quick-break, horsepower rated.
 - b. Visible switching contacts when switch is in "OFF" (open) position and unit door is open; all exposed current carrying parts "dead".
 - c. Dual-Element reinforced heavy-duty fuse clips with rejection feature. Clip spacing for 600 volts or 250 volts as required.
 - d. Switch ampacity determined by use of dual-element fuses.
 - e. Interrupting rating of ten (10) times rated current at maximum rated voltage.
 - f. Capability for continued operation without maintenance after fuse clears bolted fault of 42,000 amperes symmetrical available with dual-element fuses, with switch either in the closed position or closed into fault.
 - g. Defeatable door interlocks that prevent door from opening when operating handle is in "ON" position.
 - h. Provision for padlocking handle in "OFF" position.
 - i. Neutral assemblies where required.
 - j. Completely enclosed switching mechanism to contain arcing on switch break.
 - k. External operating handle for use with pull chains or hook stick from floor.
 - 3. Molded-Case Circuit Breakers (MCCB): UL 489/NEMA AB1 hookstick-operated handle, lockable with two padlocks, and interlocked with cover in closed position.
- D. Tap Boxes
- 1. Formed of 16 gauge steel.
 - 2. Provided with concentric knockouts for conduits.
 - 3. Bolt-type lugs for phase, neutral and ground wire, sizes as indicated on the Contract Drawings.
 - 4. Types of Tap Boxes:
 - a. Center Cable Tap Box: Attached to the busway standard joint.
 - b. End Cable Tap Box: For attachment to the end of the busway length or elbow.
 - 5. Tap boxes which plug into device openings are not acceptable.
- E. Expansion Fittings
- 1. Furnished as separate components with maximum length of five (5) feet.
 - 2. Provide where required by layout, where crossing building expansion joint, and where attached to different structures.
 - 3. Provide at all continuous busway runs which exceed 200 feet.
 - 4. Busway shall be positioned to accommodate all expansion sections.
- F. End Closers: 16 gauge steel closers for ends of the bus duct runs.
- G. Flanged fittings where passing through walls and floors to close openings on both sides and prevent spread of fire and smoke.

- H. Flanged weatherproof fittings where passing from exterior to interior with flanges on both sides and fitting made weatherproof.
- I. Miscellaneous System Components: Elbows, offsets, switchboard stubs, tee and cross connectors, reducers, and other components of same material and quality as standard busway lengths.
- J. Lugs
 - 1. Wire Sizes No. 6 AWG and Smaller: Screw tight, pressure type for copper conductors.
 - 2. Wire Sizes No. 4 AWG and Larger: Bolt type tin-plated, made of high strength aluminum alloy, U.L. approved and so stamped for use with copper or aluminum conductors.
- K. Supporting Devices
 - 1. Manufacturer's Standard Hook Hangers: Suitable for single rod suspension of the busway, designed to securely clamp busway so that busway cannot separate from hanger under normal loading conditions or under accidental conditions where personnel might grasp busway if falling.
 - 2. Rods: 1/2 inch threaded.
 - 3. Adapters: As required for threaded rod connection.
 - 4. Sway Bracing: As required for a complete rigid installation. Fasten above vibration isolators.
 - 5. Provide for bus bar flatwise mounting of plug-in busway; edgewise or flatwise mounting for feeder busway as indicated on the Contract Drawings.
 - 6. Vibration Isolators: Provide spring type vibration isolators at each support point.
 - 7. Provide adjustable spring hangers/supports for vertical runs at each floor penetration.
- L. Fire Barriers
 - 1. Busway section penetrations shall be fire sealed.
 - 2. Wall or floor flanges to maintain the fire ratings of walls and floors traversed.

2.2 BUS DUCT - CURRENT LIMITING

- A. Complete current limiting busway system including all required electrical and mechanical components and with following features:
 - 1. Similar to bus duct specified in Article 2.1 of this Section.
 - 2. Impedance selected so that for length of bus duct shown, short circuit will be reduced from that indicated as available at the source end to that indicated as allowable at load end.

2.3 ACCEPTABLE MANUFACTURERS

- A. Siemens
- B. Eaton/Cutler Hammer
- C. Square D
- D. General Electric

The bus duct must be of same manufacturer as switchboard.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. Provide necessary fittings, expansion joints, hanging devices, and accessories as required for the installation. Provide fire barrier where busway or raceways pass through fire-rated wall, floor, or ceiling. Provide removable steel flanges with minimum gauge equal to that of busway enclosure on both sides of the fire barrier to seal spaces between busway and openings in building construction. Connecting flanges and connection accessories, including spring type supports, shall be standard adjustable units furnished by the manufacturer of the busway.
2. Assemble busways from standardized sections so that the complete system shall be rigid in construction and neat and symmetrical in appearance. Provide necessary offsets, elbows, fittings, tap boxes, flanges, etc., as required to properly fit the actual job conditions and maintain maximum headroom.

B. Routing

1. Install busway with vertical runs plumb and horizontal runs level and parallel or perpendicular to building structural members wherever possible.
2. Coordinate routing to avoid interferences with other trades.
3. Joints shall be located to be accessible for maintenance.

C. Supporting Devices

1. Support busway with bus bars flatwise unless otherwise indicated or directed.
2. Install hangers at distances not greater than 5'-0" on centers for horizontal runs.
3. Install hanger for each elbow, tee, cable tap box, and cross connector.
4. Do not fasten hangers to pipes or ductwork, or so as to prevent removal of pipes or ductwork.
5. Provide sway bracing at 10'-0" intervals on alternate sides of busway unless otherwise indicated or directed.
6. Support vertical busway runs at each floor at a spacing not to exceed 16 feet. Utilize spring hangers.
7. Installed busway shall not sway or distort when reasonable pressure is applied.

D. Connections

1. Comply with manufacturer's recommendations.
2. Clean and align bus joints; tighten bolts with torque wrenches to proper torque rating in accordance with the manufacturer's recommendations.
3. Inspect bus joints before attaching enclosing plates.
4. Provide ground connection from plug to plug-in unit enclosures; bolt branch circuit ground to ground lug in plug-in unit enclosure.

E. Expansion Fittings: Install at locations recommended by manufacturer; at specific locations shown on the Contract Drawings; within these specifications; and as required by building construction.

F. Curbs

1. Provide 4" high and 4" wide curb surrounding all floor openings. Inside opening must be 2 inches greater than actual bus duct opening required. Fire seal the entire opening.

3.2 FIELD QUALITY CONTROL

- A. Provide certified "megger" insulation resistance testing of the entire bus assembly; phase-to-phase; and phase-to-ground.
- B. Provide certified test report of torque value of every bolted busbar connection.
- C. After installation and energization, provide infrared testing of every bus duct joint. Testing to be accomplished with bus duct carrying a minimum of 30% rated load. If building load is not sufficient, provide temporary load banks, as required.
- D. Provide scaffolding, tools, and safety equipment required for tests.
- E. Make corrections and re-test where insulation resistance, torque and temperature values exceed maximum recommended by the manufacturer.

END OF SECTION

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SECTION 260513

15 KV CABLE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide 15 kV cable for medium voltage feeder circuits in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. 15 kV Cable.
- B. Splices and Terminations.
- C. Separable Load Break Connectors.
- D. Fault Indicators.

1.3 SUBMITTALS

- A. Product Data
 - 1. Submit manufacturer's catalog cuts and specifications for the cable, splice kits, terminations, fault indicators, and load-break devices. Indicate the cable manufacturer's recommendation for splice kits, terminations and load-break devices used.
 - 2. Submit evidence of qualifications of the cable splicers.
 - 3. Submit certified factory test reports.

1.4 QUALITY ASSURANCE

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
 - 1. NEC Article 328
 - 2. U.L. 1072, MV-105
 - 3. IPCEA Pub. No. 5-68-516
 - 4. NFPA 70.
 - 5. IEEE
 - 6. AEIC No 5, CS-6.
 - 7. NEMA Pub. No. WC 8
 - 8. ASTM B-496, B-400
 - 9. Con Ed EO 17, and any other Con Ed applicable standards.
- B. Personnel performing terminations and splices shall be qualified, having a minimum of 10 years' experience with 15 kV cable.

1.5 GENERAL REQUIREMENTS

- A. All 15 kV cables shall be run in a rigid galvanized conduit for interior, FRE for Con Ed and RGS PVC coated for Buried Javits Distribution. EMT is not permitted.

- B. The riser with 15 kV cables from Con Edison manholes up to primary service switchgear shall be encased in concrete. Kellems grips shall be utilized for cable support, as required by Con Edison.

PART 2 - PRODUCTS

2.1 15 KV CABLE

- A. Single conductor 15 kV cable of conductor sizes shown on the Contract Documents. Unless noted otherwise, all conductors shall be copper. U.L. Type MV-105 for installation in accordance with the NEC. Uncoated soft copper stranded concentric conductor in accordance with ASTM B-496 Class B. The cable shall be rated for 105°C for normal operation, 140°C for emergency overload condition and 250°C for short circuit conditions.
- B. Insulation system shall consist of extended conductor shield followed by a solid extruded ethylene propylene rubber (EPR) compound followed by another layer of semi-conducting tape. All three layers shall be applied by a triple tandem extrusion process to avoid interfacial contamination. All three (3) layers shall be chemically and thermally compatible.
- C. The extruded insulation screen shall be covered with a bare copper tape. The copper tape shall be 5 mils thick and be helically applied with a 12-1/2% overlap.
- D. The overall jacket shall be a PVC or polyethylene jacket resistant to the effects of alkali, acid, oil, or sunlight.
- E. No splice shall be permitted in the 15 kV cable, unless shown on the Contract Documents.
- F. Insulation suitable for a grounded system, with a 133% insulation level.
- G. Fire wrap all conductors and splices in manholes, ducts, cable chambers, and vaults. The wrap shall be UL listed for 2 hours.
- H. Provide automatic fault indicators arranged to clamp to the cable sheath and provide an LED display after a fault has occurred in the cable. Install one (1) per phase.

2.2 15 KV CABLE TERMINATION

- A. Furnish and install cable terminations for all 15 kV cables. Termination kits supplied shall be capable of properly terminating a 15 kV class, single conductor polymeric-insulated, of the AWG cable size indicated on the Contract Documents. Kits shall meet Class I requirements and be design-proof tested per IEEE 48 and be capable of passing a test sequence per draft and revisions of IEEE 404. Kits as specified shall accommodate any common form of cable shielding/construction without the need for special adaptors or accessories, and shall accommodate a wide range of cable size and shall also be capable of being properly installed on out-of-round or out-of-tolerance cable as per relevant ICEA Standards. Kits shall accommodate commercially available connectors.
- B. Terminations for single-conductor cables shall consist of heat-shrinkable stress control and outer non-tracking insulation tubings along with a high relative permittivity stress relief mastic for insulation shield cutback treatment with a heat activated sealant for environmental sealing. Three-conductor kits shall contain necessary materials to seal the cable jacket, phase conductors, and any ground wires, as well as rejacket phase and ground conductors.

- C. The manufacturer shall, upon request, be able to demonstrate fifteen (15) years of actual field experience and suitable accelerated and real-time testing of weathering resistance. Test reports shall be submitted, which will verify device stability with time, temperature and stress variations. Submit six (6) copies of report.
- D. Each single-conductor kit shall contain:
 - 1. Stress relief mastic.
 - 2. Stress control tube.
 - 3. Environmental sealant.
 - 4. Non-tracing outer insulation tube.
 - 5. Installation instructions for each cable type.
 - 6. Connectors.
- E. All 15 kV terminations shall be performed in the presence of the manufacturer's technical personnel. This requirement is mandatory.
- F. All 15 kV cable and cable splices shall be fireproofed.

2.3 15 KV CABLE SPLICES

- A. Power cable splices for shielded solid dielectric EPR cables shall be factory engineered kits containing all necessary components to reinstate primary cable insulation, metallic shielding, grounding system and overall jacket to the equivalent of the cable itself.
- B. Splices shall be of a uniform cross-section heat-shrinkable polymeric construction utilizing a high dielectric strength insulating layer. The insulating layer shall be bonded to a conducting layer for shielding. The cable jacket shall be replaced with a heavy wall, heat-shrinkable sleeve to provide a waterproof mastic seal.
- C. The splice shall accommodate a range of cable sizes and be completely independent of cable manufacturer's tolerances.
- D. When assembled on cables, the splice shall be capable of passing the electrical test requirements of IEEE 48, IEEE 404, and water immersion tests of ANSI C119.2.
- E. Splice manufacturer shall provide a test report demonstrating compliance with the above test requirements.
- F. Splices shall be pre-manufactured by Thomas & Betts "Elastimold 600 Series dead-break splice kits or approved equal. Provide proper size splices per the cable size.
- G. All cable splicing shall be performed in the presence of manufacturer's technical representative.

2.4 ACCEPTABLE MANUFACTURERS

- A. Cable
 - 1. Okonite
- B. Splice and Termination Kits
 - 1. As recommended by cable manufacturer.

PART 3 - EXECUTION

3.1 CABLE INSTALLATION

- A. Pulling Tensions: Do not exceed manufacturer's written recommended cable pulling tensions during cable installation. Calculations shall be submitted and approved prior to pulling any cable.
- B. Use only pulling compounds during cable installation as per the written recommendation by the cable manufacturer. Submit proposed pulling method with specific reference to the type of grease/compound being used, breakaway clutch and pulling eye being used. Basket pulling will not be allowed.
- C. Ground cables sheaths near all terminals according to the manufacturer's written recommendations.
- D. Provide engraved brass label tags for all feeders in all manholes, cable chambers, and vaults.
- E. All 15 kV cables shall be installed in rigid, galvanized steel conduits. All conduits shall be equipped with warning labels installed every 10 feet.
- F. Fire wrap all cables with a 2HR rated UL listed wrap.
- G. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to the arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:
 - 1. Clean cable sheath.
 - 2. Wrap metallic cable components with 10-mil wrapping tape.
 - 3. Smooth surface contours with electrical insulation putty.
 - 4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
 - 5. Band arc-proofing tape with 1-inch wide bands of half-lapped, adhesive, glass-cloth tape 2 inches on center.

3.2 TERMINATIONS AND SPLICES

- A. Make all terminations and splices in accordance with the manufacturer's written recommendations.

3.3 SEPARABLE LOAD-BREAK CONNECTORS

- A. Install load-break elbows, switch modules, integrated bushings and miscellaneous accessories as required for connections to dead front transformers and equipment.

3.4 FAULT INDICATORS

- A. Shall be Thomas & Betts – Fisher Pierce UCM Series, or approved equal, underground clamp type fault indicator with LED display. Time reset four (4) hours (standard), manual reset, low 400A nominal trip rating 200A or high 800A nominal trip rating for 600A. Internal shielding preventing adjacent phase effects. 0.4" to 2.2" cable range diameter.

3.5 TESTING

- A. The following visual and mechanical inspections shall be performed by an independent testing lab acceptable to the equipment manufacturer and the Owner.
1. Visual and Mechanical Inspection
 - a. Compare cable data with the Contract Documents and specifications.
 - b. Inspect exposed sections of the cables for physical damage.
 - c. Verify tightness of accessible bolted connections by calibrated torque wrench in accordance with the manufacturer's published data. Perform thermographic survey. Submit test results.
 - d. Inspect compression - applied connectors for correct cable match and indentation.
 - e. Inspect for shield grounding, cable support, and termination.
 - f. Verify that visible cable bends meet or exceed ICEA and/or manufacturer's minimum allowable bending radius.
 - g. Inspect for adequate fireproofing in common cable areas.
 - h. If cables are terminated through window-type current transformers, make an inspection to verify that neutral and ground conductors are correctly placed and that shields are correctly terminated for operation of protective devices.
 - i. Visually inspect jacket and insulation condition.
 - j. Inspect for correct identification and arrangements.
- B. Electrical Tests
1. Perform a shield-continuity test on each power cable by ohmmeter method.
 2. Perform an insulation-resistance test utilizing a megohmmeter with a voltage output of at least 2500 volts. Individually test each conductor with all other conductors and shields grounded. Test duration shall be one (1) minute.
 3. Perform a DC high-potential test on all cables. Adhere to all precautions and limits as specified in the applicable NEMA/ICEA standard for the specific cable. Perform tests in accordance with ANSI/IEEE Standard 400. Test procedure shall be as follows, and the results for each cable test shall be recorded as specified herein. Test voltages shall not exceed 80 percent of cable manufacturer's factory test value.
 - a. Insure that the input voltage to the test set is regulated.
 - b. Current-sensing circuits in test equipment shall measure only the leakage current associated with the cable under test and shall not include internal leakage of the test equipment.
 - c. Record wet- and dry-bulb temperature or relative humidity and temperature.
 - d. Test each section of cable individually.
 - e. Individually test each conductor with all other conductors grounded. Ground all shields.
 - f. Terminations shall be adequately corona-suppressed by guard ring, field reduction sphere, or other suitable methods as necessary.
 - g. Insure that the maximum test voltage does not exceed the limits for terminators specified in IEEE Standard 48 or manufacturer's written specifications.
 - h. Apply a DC high-potential test in at least six (6) equal increments until maximum test voltage is reached. No increment shall exceed the voltage rating of the cable. Record DC leakage current at each step after a constant stabilization time consistent.
 - i. Raise the conductor to the specified maximum test voltage and hold for 15 minutes on a shielded cable. Record readings of leakage current at 30 seconds and one (1) minute and at one (1) minute intervals thereafter.
 - j. Reduce the conductor test potential to zero and measure residual voltage at discrete intervals.

- k. Apply grounds for a time period adequate to drain all insulation stored charge.
 - l. When new cables are spliced into existing cables, the DC high-potential test shall be performed on the new cable prior to splicing. After test results are approved for new cable and the splice is completed, an insulation-resistance test and a shield-continuity test shall be performed on the length of new and existing cable including the splice. After a satisfactory insulation-resistance test, a DC high-potential test shall be performed on the cable utilizing a test voltage acceptable to Owner and not exceeding 60 percent of factory test value.
4. Test Values
- a. Shielding must exhibit continuity. Investigate resistance values in excess of ten (10) ohms per 1000 feet of cable.
 - b. Graphic plots may be made of leakage current versus step voltage at each increment and leakage current versus time at final test voltages.
 - 1) The step voltage slope shall be reasonably linear.
 - 2) Capacitive and absorption current shall decrease continually until steady state leakage is approached.

END OF SECTION

SECTION 260519

600 VOLT WIRE AND CABLE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide 600 volt wire and cable in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Wire and Cable.
- B. Connectors and Terminations.
- C. Electrical Tape.

1.3 SUBMITTALS

- A. Product Data: for each type of conductor, connectors and termination assemblies.
- B. Field Test Reports.

1.4 QUALITY ASSURANCE

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
 - 1. Underwriters' Laboratories labeling of all insulations and jackets.
 - 2. NEC
 - 3. NRTL
 - 4. Connections
 - a. 486A & 486B.
 - 5. Mineral Insulated (MI) Cable
 - a. U.L. 2196.

PART 2 - PRODUCTS

2.1 WIRE AND CABLE

- A. General
 - 1. Provide wire and cable with a minimum insulating rating of 600 volts, except for wire used in 50 volts or below applications. For control or signal systems, use 300 volt minimum or 600 volt where permitted to be incorporated with other wiring systems.
- B. Conductors
 - 1. Provide factory fabricated electrical grade, annealed copper conductors and fabricated in accordance with ASTM B3 standards.

C. Stranding and Number of Conductors

1. No. 12 and 10 AWG conductors shall be solid.
2. Conductors larger than No. 10 AWG shall be stranded in accordance with ASTM Class B stranding designations.
3. Control wires shall be stranded in accordance with ASTM Class B stranding designations.

D. Insulated Single Conductors

1. Type THW or THWN - Thermoplastic insulation suitable for use in wet locations up to 75°C above grade use.
2. Type THHN - Flame Retardant: Heat-resistant thermoplastic insulation, nylon jacket rated for 90°C temperature rating above grade use.
3. Type XHHW 2 for all below grade use.

E. Multi-Conductor Control and Supervisory Control Cables

1. Size No. 16 AWG, minimum.
2. Suitable for direct burial, open air, duct or conduit installation.
3. Temperature Rating: 75°C Wet or Dry.
4. Uninsulated ground wire.
5. Cross-linked polyethylene conductor insulation; thickness satisfying requirements of ICEA.
6. Flame retardant overall polyvinyl jacket satisfying the requirements of ICEA.
7. Individual conductors bound together with overall binder tape prior to jacket application.
8. Individual conductors rating of 300 volts (instead of 600 volts) for cables designated Supervisory Control Cable.
9. Factory color coded.

F. Acceptable Manufacturers

1. Products by any manufacturer meeting the performance requirements specified herein may be utilized, but are not limited to, the following manufacturers:
 - a. American Insulated Wire Corp.
 - b. General Cable Corporation
 - c. Southwire Company
 - d. Belden
 - e. Pyrotenax/Tyco

2.2 CONNECTORS

A. Wire No. 10 AWG and Smaller

1. Hand-Applied:
 - a. Coiled tapered, spring wound devices with a conducting corrosion-resistant coating over the spring steel and a plastic cover and skirt providing full insulation for splice and wired ends. Screw connector on by hand.
2. Tool-Applied:
 - a. Steel cap, with conduction and corrosion resistant metallic plating, open at both ends, fitted around the twisted ends of the wire and compressed or crimped by means of a special die designed for the purpose. Specifically fitted plastic or rubber insulating cover wrap over each connector.
 - b. Hydraulic tool of same manufacturer as lug which shall emboss on the connector the proper die number for inspection.

B. Acceptable Manufacturers

1. Hubbell
2. OZ/Gedney
3. Thomas & Betts.

2.3 INSULATING TAPE

A. Provide vinyl plastic tape that meets the requirements of UL 510 and has the following characteristics:

1. 8.5 mil minimum thickness.
2. ASTM D-3005 Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape – Type 1.
3. Rated 600 volts and 105°C, suitable for indoor and outdoor applications.
4. Retains flexibility, adhesion, and applicable at temperature ranges from 0 through 100°F without loss of physical or electrical properties.
5. Resistant to abrasion, moisture, alkalis, acid, corrosion, and sunlight.
6. Manufacturer: 3M “Scotch Super 88”.

2.4 WIRE PULLING LUBRICANT

- A. Provide wire pulling lubricant that is compatible with the conductor insulation, has a maximum coefficient of friction of 0.055, and is stable up to a temperature of 180°F. For cold weather installations, provide wire pulling lubricant suitable for conduit temperature.
- B. Compatibility with conductor insulation shall be determined in accordance with IEEE Std 1210 Standard Tests for Determining Compatibility of Cable-Pulling Lubricants with Wire and Cable.

2.5 MINERAL INSULATED CABLE

- A. Factory assembly of one (1) or more conductors insulated with highly compacted magnesium oxide insulation, enclosed in a seamless, liquid, and gas tight continuous copper sheath.
- B. Conductors shall be solid, high electrical conductivity copper (suitable for equipment grounding purposes) with a cross sectional area corresponding to standard sizes.
- C. Insulation shall allow for proper spacing of conductors. Thickness on insulation shall be at least 55 mils for cable from No. 14 AWG through 250 MCM.
- D. Mineral insulated cable shall be classified by Underwriters Laboratories as having a two (2) hour fire resistive rating.
- E. MI Cables shall be rated for 90° C and 600 volts.
- F. Fittings shall be identified for such use.
- G. Provide required gland conduit fitting; three (3) terminal kits; 2-3 hole brass plates, and required tools for each termination point.
- H. Acceptable Manufacturer: Pyrotenax/Tyco or approved equal. Cable sizes indicated are based on Pyrotenax/Tyco.

PART 3 - EXECUTION

3.1 WIRE AND CABLE

- A. Provide a complete system of conductors in a raceway system. Mount wiring through a specified raceway, regardless of voltage application.
- B. Contract Drawings do not indicate size of branch circuit wiring; use No. 12 AWG as a minimum. For 20 ampere branch circuits whose length from the panel to the furthest outlet exceeds 100 feet for 120-volt circuits or 150 feet for 277-volt circuits, use No. 10 AWG or larger for the entire branch circuit installation.
- C. Provide dedicated neutral conductor and equipment ground conductor for each branch circuit serving television broadcast equipment, audio visual equipment and sound system equipment. If isolated grounds are shown as required, they shall also be dedicated.
- D. Provide dedicated neutral conductor for each dimmer branch circuit and for each ground fault interrupter branch circuits.
- E. Provide a shared neutral conductor, one (1) standard wire size greater than the branch circuit phase conductor, for all branch circuits to receptacle loads.
- F. Conductor Types
 - 1. Type THW or THWN - Use for lighting, receptacle and motor circuits and for panel and equipment feeders.
 - 2. Type THHN - Use for lighting branch circuit wiring installed and passing through the ballast channels of fluorescent fixtures.
 - 3. Type XHHW-2 – 600 Volt, Copper Conductor Cross-Linked Polyethylene (XLP) Insulators High-Heat and Moisture-Resistant – Use for underground application, also equipment ground conductor with medium voltage cables.
- G. Do not install wire in incomplete conduit runs nor until after concrete work and plastering is completed and moisture is swabbed from the conduits. Eliminate splices wherever possible. Where necessary, splice in readily accessible pull, junction, or outlet box.
- H. Provide cable supports for all vertical risers where required by the NEC not to exceed the following for copper conductors. Modify if aluminum conductors are used to meet the NEC requirements:

Copper Minimum Conductor Size	Vertical Supports
No. 18 AWG to No. 8 AWG	100 ft.
No. 6 AWG to No. 0 AWG	100 ft.
No. 00 AWG to No. 0000 AWG	80 ft.
211,601 CM to 350,000 CM	60 ft.
350,001 CM to 500,000 CM	50 ft.
500,001 CM to 750,000 CM	40 ft.

- I. Flashover or insulation value of joints to be equal to that of the conductor. Use Underwriters' Laboratories listed connectors rated at 600 volts for general use and 1,000 volts for use between ballasts and lamps of gaseous discharge lighting fixtures.
- J. Use terminating fittings, connectors, etc., of a type suitable for the specified cable furnished. Make bends in cable at termination prior to installing compression device. Make fittings tight.

K. Color Coding

- 1. Provide consistent color coding of all AC feeders, sub-feeders, motor circuits and the likes as follows:

	208Y/120 Volts Code	480Y/277 Volts Code
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	Grey
Ground	Green	Green
Isolated Ground	Green/Yellow Striped	N/A

- 2. Factory color code wire No. 2 AWG and smaller. Where color coding cannot be readily provided because of limited quantities involved, provide either of the following:
 - a. Plastic adhesive tape applied spirally and half-lapped over exposed portions of conductors within manholes, boxes, and similar enclosures. Tape shall be $\frac{3}{4}$ " minimum.
 - b. Colored tubing cut and inserted over ends of wire prior to installing terminals.
 - c. Provide black conductor insulation where colored tape is used to for color coding.
 - 3. Wire No. 1 AWG and larger may be color coded by color taping of the entire length of the exposed ends.
 - 4. Color code wiring for control systems installed in conjunction with mechanical and/or miscellaneous equipment in accordance with the wiring diagrams furnished with the equipment.
 - 5. DC power system conductors shall be color coded; Positive – Red; Negative – Black.
- L. The Contractor shall verify if XHHW-2 need to be used for VFD drive feeders. This is to be provided and supported by letter from each VFD manufacturer drive to be used on this project.

3.2 INSTALLATION

A. General

- 1. Provide tools, equipment and materials to pull all wire and cable into place and to make required splices and termination.

B. Wire and Cable in Conduit, Duct or Wireway

- 1. Utilize roller bearing swivel to prevent twisting of cables entering the conduit or duct.
- 2. Take precautions to avoid entrance of dirt and water into the conduit and ducts.
- 3. Clean conduits and ducts to remove any pulling compound prior to pulling of cables.
- 4. Do not damage conductor insulation, braid jacket or sheath during installation. Any damaged conductors shall be replaced immediately.

5. Do not bend conductors to less than the manufacturer's recommended radius.
6. Lubricate cable if required for pulling.
7. Make splices only in pull boxes, junction boxes and outlet boxes.
8. Utilize cable reels on jacks for pulling through pull boxes, ducts and conduits so bends will not be excessive and conductors will not touch sharp edges; use feeding tube where required.
9. For large diameter cables, utilize properly sized pulling grips (endless woven basket two to four feet long of ductile steel).
10. Do not exceed maximum recommended pulling tension of wire and cable.
11. Fire seal around cables penetrating fire rated barriers.
12. Provide proper supports of the cables installed in cable support boxes, in accordance with the NEC.

C. Splices, Terminations and Connections

1. General: Except where lugs are furnished with the equipment, provide terminals and connectors suitable for the quantity, conductor size and direction of entry (top or bottom).
2. Insulated Flanged Terminals: Provide for connection of conductors No. 12 AWG and smaller to device terminals; do not exceed three (3) terminals at any single connections.
3. Circumferential Compression Type Connectors or Cytolok spring compression terminator (Provide for Splices and Connections No. 6 AWG and larger):
 - a. Use for incoming and outgoing cable connections at enclosures and for ground connections.
 - b. Use manufacturer's approved tool and correct size hex head which embosses die number on the connector or lug.
 - c. Make crimped indentations parallel with insulation putty.
 - d. Fill voids and irregularities with insulation putty.
 - e. Cover neatly with four (4) layers of vinyl plastic tape except where insulated covers are permitted; half-lap tape in two (2) directions.
 - f. Use spring-held bakelite covers over splices or taps only with the approval by the Engineer.
4. All lugs and splicing hardware shall be of the same rating (including temperature) as the conductors.

D. Wire Marker Identification Labels

1. Utilize labels for those circuits where individual conductor identity is indicated on the Contract Drawings.
2. Apply to wires and cables at terminals and in all pull, junction and splice boxes.
3. Do not cut and splice multi-conductor control cable for purpose of labeling.
4. Clean surfaces before applying labels.

3.3 MINERAL INSULATED CABLE INSTALLATION

A. Examination

1. Verify that the factory installed temporary end seals are intact.
2. Verify that no moisture has entered cable installation.

B. Storage

1. Cables shall be shipped from the manufacturer with ends sealed against moisture.
2. Protect the exposed cable ends with shrinkable, molded polyolefin end caps or other suitable means such as standard conduit sealing compound and PVC tape.
3. Cable shall be stored in a clean dry location.

- C. Handling
 - 1. Cable shall be uncoiled by rolling or rotating supply reel.
 - 2. Take precautions necessary to prevent damage to cable from contact with sharp objects, such as when pulled over foreign material on sheaves.
- D. Installation
 - 1. The wiring cable shall be installed according to the manufacturer's recommendations, the instructions in the Installation Specification or Manual and the requirements of the UL Fire resistance Directory listing.
- E. Field Quality Control
 - 1. Inspect cable for physical damage and proper connection.
 - 2. Measure tightness of any bolted connections and compare torque measurements with manufacturer's recommended values.
 - 3. Verify continuity of each conductor.
 - 4. Prior to energizing cables, measure insulation resistance of each cable. Tabulate and submit for approval.
 - 5. Provide certification from cable manufacturer that installation is in accordance with their requirements.

3.4 FIELD TESTING

- A. Test system wiring for continuity, grounds and short circuits prior to connection of any equipment.
- B. Test final equipment connections for continuity of grounds and short circuits.
- C. Insulation Resistance of Feeders and Subfeeders
 - 1. Test with megger for insulation resistance. Insulation resistance to comply with ICEA values.
 - 2. Correct faults and sections with faulty insulation.
- D. Remove and replace defective conductors and retest.

END OF SECTION

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SECTION 260526
GROUNDING SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide a low impedance grounding system in accordance with the Contract Documents and all applicable codes.

1.2 WORK INCLUDED

- A. Ground Connectors and Clamps; Grounding, Bushings and Locknuts.
- B. Welding Type Ground Connectors.
- C. Compression Type Grid Connectors.
- D. Ground Rods, Plates, and Clamps.
- E. Bonding Jumpers for Hinged Joints in Cable Trays.
- F. Electrical Insulating Tape.
- G. Compound for Compression Connectors.
- H. Grounding Test Well
- I. Provide step and touch potential calculations per IEEE 80.

1.3 SUBMITTALS

- A. Shop Drawings
 - 1. Provide a complete set of shop drawings showing service and all grounding methods as called for on the Contract Documents and required by the NEC and all applicable codes.
 - 2. Submit wiring diagrams for electrical grounding and bonding work which indicates layout of ground rods, location of system grounding electrode connections, and routing of conductors. Diagrams shall indicate sizes of all equipment to be used, including all connection details.
 - 3. Product data of all equipment to be used.
 - 4. Testing procedures which will be used for all field test reports.
 - 5. Qualification data for the testing agency and the agency's field supervisor.
- B. Test Reports
 - 1. Submit test reports certifying resistance values for buried or driven grounds and water pipe grounds.

1.4 QUALITY ASSURANCE

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
 - 1. Underwriters Laboratory Standard No. U.L. 467 and 486A.
 - 2. ANSI/IEEE C2 – National Electrical Safety Code.
 - 3. IEEE Standard No. 142-1982, 1100-1992, and 80-2000 and IEEE 837-2002.
 - 4. ANSI/TIA/EIA 607 – Commercial Building Ground and Bonding Requirements for Telecommunications.
 - 5. NFPA 780 and UL 96.
 - 6. NETA.
 - 7. NFPA 70 – National Electric Code (NEC).
 - 8. ASTM B3, B8, and B33.
 - 9. NEMA GR1.
 - 10. IEEE 81.
- B. Testing Agency Qualifications: An independent agency that is a member company of a nationally recognized testing laboratory (NRTL) as defined by OSHA.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Ground Conductors: Bare or green color coded, insulated, annealed stranded tinned copper conductor as indicated on the Contract Documents; insulated conductor to conform with the requirements of the conductor specification section herein.
- B. Provide green THW insulated for 600V copper equipment grounding conductor between the ground bus of the source distribution panel or switchboard and each load being served. Provide separate grounding conductor for each branch circuit, unless otherwise indicated on Contract Documents.
- C. Mechanical Connectors: Tin-plated aluminum alloy, U.L. approved and stamped for use with aluminum or copper conductors. Connectors shall be two (2) bolt type, heavy duty type and be highly conductive.
- D. Ground Rods
 - 1. Copper-clad steel core and electrolytic-grade copper outer sheath fabricated by molten welding process.
 - 2. Diameter: 3/4 inch.
 - 3. Length: 10 feet.
- E. Plate Electrode: Highly conductive copper plates, minimum 1/4" thick, 24 inch square.
- F. Ground Lugs and Connectors for Cable Tray: Tin-plated aluminum alloy, suitable for use with aluminum or copper conductors.
- G. Bonding Jumper Braid: Copper braided tape, constructed of 30-gauge bare copper wires and properly sized for indicated applications.
- H. Grounding Bus: Bare, annealed copper bars of rectangular cross section (1/4" x 4"), with insulators and a minimum length of 24". Utilize type 304 stainless steel bolts, washers and nuts.

I. Ground Test Wells

1. Flush grade precast concrete box.
2. Diameter: 8 inches; depth: 12 inches.
3. Cover: lifting holes with inscription: "GROUND ROD."
4. Steel plate for traffic areas.

2.2 IDENTIFICATION AND LABELING

- A. Grounding conductors shall be marked with tie wrap style cable markers.

2.3 ACCEPTABLE MANUFACTURERS

- A. Erico Products, Inc.
- B. Appleton Electric Company, a Division of Emerson
- C. Kearney, a Division of Cooper Industries.
- D. O-Z/Gedney Electric Company, a Division of Emerson
- E. Raco, Inc., a Division of Hubbell, Inc.
- F. Thomas & Betts Electrical

PART 3 - EXECUTION

3.1 GENERAL

- A. Purpose of the Grounding System.
1. Adequate path for ground fault currents.
 2. Safety to personnel from accidental electric shock hazards.
 3. Prevention of hazardous discharge of static electricity.
- B. Whether or not indicated on the Contract Documents, provide continuous ground path for all electrical circuits from point of utilization back to source through ground wires, bonded metallic conduit runs, grounded cable trays, and related items.
- C. Electrical Equipment: Provide complete exterior and interior grounding system, including grounding provisions for all switchboards, switchgear, transformers, motor control centers, cable trays, lightning arrestors, motors, emergency generators and other equipment as indicated on the Contract Documents and required by applicable codes.
- D. Miscellaneous Equipment: Provide complete grounding for chimneys, smokestacks, flag poles, metal lighting standards, substation fences, metal antennas, supports for elevated metal floors, steel framework of the building, elevators, and other equipment as indicated on the Contract Documents and required by applicable codes.
- E. Equipment grounds shall be installed in the same raceway with the associated phase conductors.
- F. Grounding systems shall be provided in accordance with the requirements of the local authorities, NEC Article 250, and subject to the review of the Architect/Engineer.

- G. All ground conductors and bonding jumpers shall be stranded copper installed in conduit. All ground conductors shall be without joints and splices over its entire length.
- H. The system neutral shall be grounded at the service entrance only, and kept isolated from the grounding systems throughout the building. Ground shall be permanently installed and tested prior to energizing any equipment or service.
- I. Each system of continuous metallic piping and ductwork shall be grounded in accordance with the requirements of the NEC Article 250.
- J. Mechanical equipment shall be bonded to the building equipment grounding system. This shall include but is not limited to fans, pumps, chillers, etc.
- K. Non-metallic conduits and portions of metallic piping and duct systems which are isolated by flexible connections, insulated couplings, etc., shall be bonded to the equipment ground with a flexible bonding jumper or separate grounding conductor.
- L. Metal raceways, cable trays, cable armor, cable sheath, enclosures, frames, fittings and other metal noncurrent-carrying parts that are to serve as grounding conductors shall be effectively bonded where necessary to assure electrical continuity and the capacity to conduct safely any fault current likely to be imposed on them. Any nonconductive paint, enamel, or similar coating shall be removed at threads, contact points, and contact surfaces or be connected by means of fittings so designed as to make such removal unnecessary.

3.2 SERVICE GROUNDING SYSTEM

- A. Provide a bare copper bus bar mounted within the electrical service room. Bus shall be 4" H x 1/4" W x 2' L minimum, equipped with type 304 stainless steel mounting brackets and fasteners. Provide the required insulators.
- B. Extend two (2) service grounding connectors in separate raceways from the ground bus to the ground bus in each switchboard.

3.3 SWITCHBOARD, UNIT SUBSTATIONS AND PRIMARY SWITCHGEAR

- A. Bond each section of the switchboard, unit substations, and primary switchgear housing and service conduits entering same to the ground bus.

3.4 SEPARATELY DERIVED SYSTEMS

- A. Equipment grounding conductors shall be provided for separately derived systems and shall be grounded to building steel, cold water pipes, etc., or an alternate grounding means. Equipment grounding shall consist of but is not to be limited to the following:
 - 1. Lighting transformers.
 - 2. Power transformers.
 - 3. Electric generator sets.
 - 4. UPS systems.
 - 5. Power Distribution Units (PDU).

3.5 RECEPTACLES

- A. Receptacles shall be grounded to the outlet box by means of a bonding jumper between the outlet box and the receptacle grounding terminal.

3.6 ISOLATED GROUND RECEPTACLES

- A. Isolated ground receptacles shall not be connected to the respective outlet boxes.
- B. Provide an insulated ground conductor for each isolated ground receptacle circuit. The isolated ground conductor shall serve only those receptacles which are isolated. Route the isolated ground conductor together with phase and neutral conductors in a common raceway. Provide a dedicated ground conductor for each receptacle circuit.
- C. Terminate isolated ground conductor at the ground from the separately derived system serving the isolated ground receptacles. Where not supplied by a transformer, run the isolated ground conductor to the service ground bus.

3.7 TELECOMMUNICATIONS GROUNDING SYSTEMS

- A. Telecommunications grounding systems include the following items:
 - 1. Telecommunications Bonding Backbone (TBB) – A copper conductor that extends from the telecommunications main grounding busbar (TMGB) to each telecommunications grounding busbar (TGB) in a star configuration to avoid ground loops.
 - 2. Telecommunications Main Grounding Busbar (TMGB) – The TMGB serves as a dedicated extension of the building grounding electrode system for telecommunications infrastructure. The TMGB is located in the main telecommunications room (MDF) and shall be connected to the electrical service ground busbar. The TMGB shall be a minimum of 1/4" x 4" x 36" long and made of tin plated copper.
 - 3. Telecommunications Grounding Busbar (TGB) – A busbar shall be placed in an accessible location in each telecommunications room (TR) that is connected back to the TMGB. All equipment served from the TR shall be connected to the local TGB. The TGB shall be a minimum of 1/4" x 4" x 24" long and made of tin plated copper.
 - 4. All ground busbars shall be mounted on 2" insulators off the wall. Utilize stainless steel type 304 mounting brackets and accessories.
- B. Bond all telecommunication equipment chassis, ladder racks, cable trays, conduits, equipment frames, cabinets and other telecommunications room and equipment room metallic components to a local TGB with No. 6 AWG, 600 volt, insulated copper conductor (minimum).
- C. Bonding of grounding conductors shall be with the following methods as specified herein.
- D. Grounding conductors shall be marked per ANSI/TIA/EIA 606. Mark each cable end using tie wrap style cable markers.

3.8 OUTDOOR EQUIPMENT

- A. Outdoor enclosures shall be connected with No. 2 AWG bare copper (minimum) cable installed not less than 24 inches below grade, connecting to the required ground rods. Fence and equipment connections shall be bare copper No. 2 AWG. Fence shall be grounded at each gate post and corner post. Each gate section shall be bonded to the fence post through a 1/8-inch by one-inch flexible braided copper strap and approved clamps.

3.9 CONCENTRIC KNOCKOUTS

- A. Provide grounding type bushings for conduits terminated through multiple concentric knockouts not fully knocked out inside of the panelboards. Ground bushing with No. 12 AWG copper to the panelboard ground bus.

3.10 LIGHTNING ARRESTERS

- A. Lightning (surge) arrester grounding conductors shall be separate from other grounding conductors, but shall have a bond from the equipment ground, at the transformer. Ground conductors shall not be smaller than No. 1/0 AWG for secondary class, distribution class, and intermediate class. Station-class shall be No. 4/0 AWG. Ground conductors shall be connected to a ground rod. Ground resistance shall not be greater than 25 ohms for distribution-class arresters, 10 ohms for intermediate-class arresters, and 5 ohms for station-class arresters.

3.11 TRANSFORMER VAULTS

- A. Provide ground rods at the primary and secondary transformer vault compartments and next to the barrier walls. Two (2) ground rods shall be provided for each bay in which a transformer will be installed and located at each end and adjacent to each barrier wall.

3.12 ELEVATED TRANSFORMER VAULTS

- A. Provide a No. 4/0 AWG bare copper ground ring around the vault on the inside wall and directly accessible to each transformer that is installed. The ground ring shall be tied-off at two (2) opposite ends with No. 4/0 AWG bare copper conductor and connected to the building service ground bus.

3.13 BUS DUCTS

- A. Where bus ducts are routed to the switchboard, the ground bus in the bus ducts shall be extended to the ground bus on the switchboard.
- B. Where bus ducts are served via cable tap boxes, extend ground conductors from the ground bus in the bus duct to the ground bus of the switchboard.
- C. All bus duct take off switch and fuse devices shall have a ground pin within them for positive connection to the ground bus.

3.14 HOT TUBS, WHIRLPOOLS, SWIMMING POOLS, ETC.

- A. Provide grounding and bonding in accordance with the NEC Article 680.
- B. Provide an insulated No. 8 AWG conductor in a raceway common with the phase and neutral conductors from the panelboards which service this equipment through to the respective switchboard. Bond this connector at each distribution point between the respective panelboards which serve the area and the switchboard.

3.15 RAISED ACCESS FLOORS

- A. Provide bonding of at least 25% of all raised access floor pedestals.
- B. Provide green insulated No. 4 AWG ground conductor from opposite ends of the raised floor to the panelboard serving that area.

3.16 TOGGLE SWITCHES

- A. Provide grounding clip on each toggle switch. Mount over device mounting strap such that contact is made between mounting strap, faceplate and outlet box.

- B. Provide devices with ground screw where required by local authorities and bond this with No. 10 AWG conductor to the associated outlet box.

3.17 GROUNDING METHODS

- A. Ground rods shall be copper-clad steel not less than 3/4 inch in diameter, ten (10) feet long, driven full length into the earth. The maximum resistance shall not exceed five (5) ohms. If this resistance cannot be obtained with a single rod, additional rods shall be installed not less than ten (10) feet on center. If sectional type rods are used, two (2) additional sections may be coupled and driven with the first rod. Ground plates can be used as alternates for rods in hard soil/rock conditions; however, resistance criteria must remain.
- B. The metal frame of the building, where effectively grounded. Install a ground rod at the base of each corner column and at intermediate exterior columns at distances not more than sixty (60) feet apart.
- C. A metal underground water piping system used for grounding shall be in direct contact with the earth for ten feet or more and shall be electrically continuous. Provide bonding jumpers at the water meter and at the insulating joints.
- D. Steel reinforcing bars used for grounding shall be encased by at least two (2) inches of concrete, located within and near the bottom of a concrete foundation or footing that is in direct contact with the earth. Reinforcing bars shall be minimum 1/2 inch diameter and consisting of twenty feet of one (1) or more steel reinforcing bars.
- E. All bonding jumpers for the above grounding systems shall be sized in accordance with the NEC Article 250.

3.18 INSTALLATION

- A. Grounding Grid
 - 1. Install grounding grids with ground rods and cables as indicated on the Contract Documents and these specifications.
 - 2. Avoid splices in ground conductors.
 - 3. Connectors:
 - a. Install mechanical connectors in above ground accessible locations only.
 - b. Install welding type ground connections or irreversible compression connection type grid grounding connectors underground; above grade, building steel, electrode connections, in manholes, or at inaccessible locations only. All connections must comply with industry standards.
 - c. Thoroughly clean contact surfaces before making connections.
 - d. Apply manufacturer's oxide inhibitor compound for compression connectors to conductors prior to crimping.
 - e. Made connections using compression type grid grounding connectors with approved manufacturer's hydraulic tool and correct size hex head die which, for inspection, embosses proper die number on connector.
 - 4. Make connection from ground grid to equipment ground buses as required by the NEC and as shown on the Contract Documents.
 - 5. Provide for future disconnection for testing at all locations where building ground loop or grid connects to exterior or interior steel.
 - 6. Wrap conductors with self-fusing electrical tape and cover with vinyl electrical tape where insulation of grounding system connections is required.

B. Cold Water Pipe Grounding

1. Make connection with clamp type fitting; do not damage the incoming water pipe.
2. Bond ground conductor and its conduit to the street side of the water pipe.
3. Install No. 4/0 AWG bonding jumper with ground clamps around (input and output) the water meter.

C. Ground Conductors

1. Route along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
2. Underground Grounding Conductors: Use bare copper conductor. Bury at least 24 inches below grade.
3. Size as shown on the Contract Documents or as required by NEC Table 250-95.
4. Where ground conductors are required, install insulated copper ground conductors in steel conduit.
5. Where ground conductors are protected by metallic conduit, bond the conductor to the conduit at both ends.
6. Connect ground conductors to appropriate ground buses (as in switchboards and distribution panelboards, etc.).
7. Tighten screws and bolts for grounding and bonding connectors and terminals according to the manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.

D. Grounding Rods: Provide a minimum of three (3) rods and locate a minimum of one (1)-rod length from each other and at least the same distance from any other grounding electrode.

1. Drive until tops are 12 inches below finished floor or final grade, except as otherwise indicated.
2. Interconnect with grounding-electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make these connections without damaging copper coating or exposing steel.
3. Install in a ground well for future access and testing.

E. Grounding Plates: Provide a minimum of three (3) plates and locate a minimum of six (6) feet from each other and at least the same distance from any other grounding electrode.

1. Install a minimum 30 inches below finished floor or final grade.
2. Interconnect with grounding-electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make these connections without damaging copper coating or exposing steel.

F. Conduit Attachment to Electrical Equipment

1. Ground conduits to metal framework of the electrical equipment with double locknuts or grounding bushings and bonding jumpers unless otherwise noted.
2. Install bonding jumpers at all electrical equipment to provide continuous ground return path through the metallic conduit system.
3. Install NEC approved bonding jumpers across expansion fittings between conduit sections for ground path continuity.
4. Where motors or other utilization equipment are connected to the electrical system with flexible conduit, the conduit shall be equipped with a ground conductor.

G. Cable Trays and Wiring Troughs

1. Bond together wiring troughs containing power circuits and tie to ground bus at the switchboards, panelboards; install minimum No. 4/0 AWG copper conductors for bonding between cable systems and switchboards ground buses.
 2. Install a minimum No. 2 AWG insulated copper conductors for bonding between cable support system and conduit dropouts, service equipment or cabinets.
 3. Apply antioxidant compound to contact surfaces for all bonding connections to cable trays.
 4. Install bonding jumpers across hinged joints.
- H. Receptacles and Switches
1. Install bonding jumpers between the outlet box and receptacle grounding terminal except where contact device or yoke is provided for grounding purposes.
- I. Wireways
1. Install grounding jumpers for bonding between wireways and other panelboards, conduits, switchboards, and at any other point where a solid connection would otherwise not be provided in supporting the system to insure a continuous ground path.
- J. Underfloor Duct
1. Install No. 8 AWG bare copper bonding jumper between the underfloor duct sections on either side of an expansion joint using pressure type lugs with embedding type bonding screws.
- K. Panelboards
1. Install bonding jumpers inside all panelboards to bond the feeder conduit to panelboards, except ground panelboards containing branch circuits each having less than 150 amperes current carrying capacity, with two (2) standard locknuts and bushings, one (1) inside and one (1) outside, run up wrench tight.
- L. Dry-Type Transformers
1. Provide grounding in accordance with NEC Article 250.
 2. Install bonding jumper across flexible conduit from the transformer housing to the rigid conduit.
- M. Sheet Metal Boxes
1. Install bonding jumpers inside all sheet metal boxes containing one (1) or more feeders with current carrying capacity of 150 amperes or greater, to bond one (1) conduit with another.
 2. Ground boxes containing branch circuits only or feeders each less than 150 amperes current carrying capacity, with two (2) standard locknuts and bushings, one (1) inside and one (1) outside, run up wrench tight. Two (2) standard locknuts and bushings, one (1) inside and one (1) outside, run up wrench tight.
 3. Install bonding in sheet metal boxes in systems over 600 volts, regardless of current carrying capacity.
- N. Floor Boxes
1. Install grounding jumpers where adequate ground connections are not provided through locking screws between high potential power service fittings, cover plates, and conduit system.
- O. Underground Distribution System Grounding

1. Duct Banks: Install a continuous grounding conductor with at least 50 percent ampacity of the largest phase conductor in the duct bank.
2. Manholes and Handholes:
 - a. Install a driven ground rod within 2 inches of the wall and set rod depth so 4 inches will extend above the finished floor.
 - b. If necessary, install ground rod before manhole is placed and provide a No.1/0 AWG bare, tinned-copper conductor from the ground rod into the manhole through a waterproof sleeve in the manhole wall.
 - c. Protect ground rods passing through concrete floors with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below the concrete. Seal floor openings with waterproof, non-shrink grout.
3. Connections to Manhole Components:
 - a. Connect all exposed-metal parts, such as inserts, manhole frames, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to the ground rod or grounding conductor.
 - b. Make connections with No. 4 AWG minimum, stranded, hand-drawn copper conductor.
 - c. Install conductors level or plumb around corners and fasten to the manhole walls.
 - d. Connect to the cable armor and cable shields as recommended by the manufacturer of the splicing and termination kits.
4. Pad-Mounted Transformers and Switches:
 - a. Install two (2) ground rods and counterpoise conductor circling the pad.
 - b. Ground pad-mounted equipment and noncurrent-carrying metal items associated with the transformer or switch by connecting them to the underground cable and grounding electrodes.
 - c. Use tinned-copper conductor not less than No. 2 AWG for counterpoise and for taps to the equipment ground pad. Bury counterpoise not less than 18 inches below grade and 6 inches from the foundation.

3.19 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing and inspecting agency to perform the field tests and inspections and prepared test reports.
- B. Acceptable Testing Equipment: Vibroground by Associated Research, Inc.; or Megger Earth Tester by James G. Biddle Co.
- C. Method: Three (3) electrode fall of potential as prescribed by instrument manufacturer.
- D. Drive additional ten-foot ground rods spaced ten (10) feet apart, if necessary, until total resistance of system is measured at five (5) ohms or less. Retest to demonstrate compliance.
- E. The test report shall include, but is not limited to:
 1. Date of test.
 2. Time of day.
 3. Weather condition.
 4. Date of last rainfall $\geq \frac{1}{2}$ " in a 24 hour period.
 5. Soil type.
 6. A plot of all readings indicating a level spot in the curve at a system resistance.

3.20 FIELD TESTING

- A. Visual inspection of all systems, raceway and equipment grounds shall be made to determine the adequacy and integrity of the grounding. All ground testing results shall be properly recorded, witnessed, and reported to the Contractor.
- B. After installing the grounding system, but before permanent electrical circuits have been energized, test for compliance with requirements.
- C. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - 1. Measure ground resistance not less than two (2) full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - 2. Perform tests by fall-of-potential method according to IEEE 81.
 - a. Measure ground resistance without the soil being moistened by any means other than natural precipitation or natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Ground tests shall be performed using a low resistance, null balance type, ground testing ohmmeter, with test lead resistance compensated for. Measure the resistance of the ground under test and remote earth or a reference ground as specified. The test instrument shall be the type which compensates for potential and current rod resistances.
 - c. Test completed grounding system at the service disconnect enclosure grounding terminal and at ground test wells. Perform tests, by the fall-of-potential method according to IEEE 81.
 - d. Testing record shall include drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

3.21 PERSONNEL TRAINING

- A. Building Maintenance Personnel Training: Train the Owner's building maintenance personnel in procedures for testing and determining resistance-to-ground values of the grounding system. Also instruct maintenance personnel in preparation and application of chemical solution for earth surrounding grounding rods for reducing ohmic resistance to the required levels.

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SECTION 260533

RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide raceways, fittings, boxes, enclosures, and cabinets for electrical wiring in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Rigid Steel Conduit.
- B. Rigid Aluminum Conduit.
- C. Electrical Metallic Tubing (EMT).
- D. Armor Clad (AC) Cable.
- E. Flexible Metal Conduit.
- F. Liquid-Tight Flexible Metal Conduit.
- G. Rigid Non-Metallic Conduit.
- H. Conduit Fittings.
- I. Wireways and Auxiliary Gutters.
- J. Outlet, Junction, Cable Support Boxes and Pull Boxes.
- K. Identification Labels.
- L. PVC-Coated Rigid Steel Conduit and Fittings.

1.3 SUBMITTALS

- A. Shop Drawings
 - 1. Full erection drawings where wireways and/or auxiliary gutters are employed. Drawings shall include plan views, elevations, size of wireways, type and quantity of conductors proposed to be installed therein, etc.
 - 2. Indicate duct banks on multi-trade coordinated shop drawings.
 - 3. Indicate all cable support boxes on all submittals.
- B. Product Data
 - 1. Submit dimensioned detailed drawings for boxes exceeding 24 inches in any one (1) dimension.
 - 2. Submit manufacturer's catalog data for all raceways, fittings, enclosures, cabinets, floor boxes and accessories.

1.4 QUALITY ASSURANCE

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
1. Rigid Steel and PVC Coated Rigid Galvanized Steel Conduit:
 - a. U.L. Standard 6.
 - b. ANSI C80-1 Conduit.
 - c. ANSI C80.4 Fittings.
 - d. NEMA RN-1 2005.
 - e. Federal Specification WW-C-581E.
 2. Rigid Aluminum Conduit:
 - a. ANSI C80-5.
 3. Electrical Metallic Tubing:
 - a. U.L. Standard 797.
 - b. ANSI C80.3.
 - c. Federal Specification WW-C-563.
 4. Armor Clad Cable:
 - a. U.L. Standard 4.
 - b. Federal Specification J-C-30B.
 - c. NEC Article 333.
 5. Flexible Metal Conduit:
 - a. U.L. Standard 1.
 6. Liquid-Tight Flexible Metal Conduit:
 - a. U.L. Standard 360.
 - b. UL514B Conduit, Tubing and Cable Fittings.
 - c. UL 1660 Liquid Tight Flexible Nonmetallic Conduit.
 7. Rigid Non-Metallic Conduit:
 - a. U.L. Standard 651.
 - b. ANSI Standard F512.
 - c. NEMA Standard TC-2.
 - d. Federal Specifications GSA-FSS and W-C-1094-A.
 - e. Corps of Engineers Specification CE-303:01.
 8. Wireways and Auxiliary Gutters:
 - a. U.L. Standard UL-870.

PART 2 - PRODUCTS

2.1 RACEWAYS

- A. Rigid Steel Conduit
1. Rigid steel conduit shall be heavy wall, galvanized type.
- B. PVC Coated Galvanized Rigid Steel Conduit

1. PVC coated galvanized rigid steel conduit shall fully comply with all sections of UL6, NEMA RN-1 2005 and ANSI C80.1 without exception. PVC coated galvanized conduit shall have hot dipped galvanized threads. The external PVC coating shall be a nominal 40 mils of external PVC coating and 2 mils of internal urethane coating. The PVC coating shall be applied by the same manufacturer of the hot dipped galvanized rigid steel conduit.
 2. The galvanized coating of the hot dipped galvanized conduit shall not be disturbed in any fashion prior to the application of the PVC coating in accordance to UL6 and NEMA RN-1 2005 3.1.1.
 3. The PVC coated galvanized rigid steel conduit shall comply with all UL listings, providing the hot dipped galvanized coating as the primary means of protection for the conduit and the PVC coating shall be listed as a secondary means of corrosion protection as required by UL6 and NEMA RN-1 2005.
 4. All PVC coated galvanized conduit bodies and fittings shall also be manufactured with 40 mils of PVC coating and 2 mils of internal urethane. All conduit bodies shall be NEMA 4X Rated with encapsulated stainless steel screws.
 5. Acceptable Manufacturers
 - a. Calbond
 - b. Thomas & Betts – OCAL
 - c. Rob Roy Industries – Plasti Bond
- C. Rigid Aluminum Conduit
1. Rigid aluminum conduit shall be heavy wall type.
 2. Acceptable Manufacturers
 - a. Allied Tube & Conduit
 - b. Wheatland Tube
 - c. Or approved equal
- D. Electrical Metallic Tubing
1. Continuous, seamless tubing galvanized or sheradized on exterior, coated on interior with smooth hard finish of lacquer, varnish or enamel.
 2. Acceptable Manufacturers
 - a. Republic Conduit
 - b. Wheatland Tube
 - c. Western Tube
- E. Armor Clad Cable
1. Conductors rated at 90°C as specified elsewhere herein, uninsulated ground wire, moisture and fungi resistant fillers, and an interlocking steel armor shield.
 2. Acceptable Manufacturers
 - a. AFC Cable
 - b. Southwire
 - c. Or approved equal
- F. Flexible Metal Conduit
1. Single strip, continuous, flexible interlocked double-wrapped steel, galvanized inside and outside forming smooth internal wiring channel.
- G. Liquid-Tight Flexible Metal Conduit

1. Liquid Tight flexible metal conduit shall have external PVC jacket and shall be UV stable and shall be machine tool grey in color. Internal construction shall be light-weight aluminum core.
 2. Acceptable Manufacturers
 - a. OZ Gedney / A Division of Emerson
 - b. Hubbell Raco
 - c. Thomas & Betts
- H. Rigid Non-Metallic Conduit
1. Composed of polyvinyl chloride suitable for 90°C.
 2. Raceway, fittings and cement must be produced by same manufacturer who must have had minimum of ten (10) years' experience in manufacturing the products.
 3. Materials must have tensile strength of 7,000-7,200 psi at 73.4°F, flexural strength of 12,000 psi and compressive strength of 9,000 psi.
 4. Acceptable Manufacturers
 - a. Allied Tube
 - b. Carlon
 - c. Wheatland Tube
- I. PVC-Coated Rigid Steel Conduit
1. Summary
 - a. Section includes: Furnishing, installation and assembly of PVC-coated electrical rigid metal conduit (ERMC) for all underground raceways enclosed in concrete.
 2. General
 - a. Furnish PVC-coated ERMC of size as indicated. The smallest trade size shall be $\frac{3}{4}$ in. The PVC-coated ERMC system shall include necessary PVC-coated fittings, boxes and covers to form a complete encapsulated system.
 3. Manufacturers
 - a. Acceptable Manufacturers
 - 1) Thomas & Betts
'Ocal PVC-Coated Rigid Conduit'
 - 2) or Approved Equal
 4. PVC-Coated Rigid Steel Conduit
 - a. The PVC-coated rigid steel conduit shall be hot-dip galvanized inside and out with hot-dip galvanized threads.
 5. PVC-Coated Strut, Hangers and Clamps
 - a. Right-angle beam clamps and U-bolts shall be specially formed and sized to fit snugly the outside diameter of the PVC-coated conduit. Support products, such as ferrous strut, pipe straps, clamp back spacers, conduit clamp hangers, and all-thread rods shall have a minimum 15-mil PVC coating by the manufacturer of the ERMC conduit and system components.
 6. Preparation
 - a. Preparation shall be done in accordance with manufacturer's printed instructions.

7. Installation
 - a. Install in accordance with manufacturer's printed instructions and manufacturer's installation training.
8. Manufacturer's Field Services
 - a. Free on-site installation training course by company representative. This representative must conduct the on-site training course in order to qualify for the installation certificate. The time required for this training is estimated to be two (2) hours.
 - b. After the on-site training installation, the representative shall then register the installer in his database and provide certification for installation.

2.2 CONDUIT FITTINGS

- A. Rigid Steel Conduit
 1. Threaded type fittings.
- B. Rigid Aluminum Conduit
 1. Threaded type fittings.
- C. Conduit Expansion Joints and Deflection Fittings, Rigid Galvanized Steel Conduit. Weather tight, internal ground, expansion joint for galvanized rigid steel conduit.
 1. Acceptable Manufacturers
 - a. Crouse Hinds / A Division of Cooper Industries – Type XJG & XD
 - b. OZ Gedney / A Division of Emerson – Type AX & DX
 - c. Thomas & Betts – Type XJG & XD
- D. Electrical Metallic Tubing
 1. 2½-inch in size and larger may be set screw type. 2-inch in size and smaller, steel compression gland.
 2. In slab or concrete work, concrete-tight fittings.
- E. Armor Clad Cable
 1. Malleable iron or die-cast zinc with insulating bushing.
- F. Flexible Metal Conduit
 1. Compression-type metal fittings.
- G. Liquid-Tight Flexible Metal Conduit
 1. Body, gland and lock nut shall be steel of malleable iron. Ground cone shall be steel, sealing ring and insulator shall be blue molded thermoplastic rated at 150°C (221°F) maximum.
- H. Rigid Non-Metallic Conduit
 1. Solvent cemented type.
- I. Acceptable Manufacturers
 1. All fittings shall comply with UL, NEMA and ANSI Standards as shall be provided by same manufacturer as approved conduit type manufacturers.

2.3 WIREWAYS AND AUXILIARY GUTTERS

- A. Wireways and gutters shall be of sizes and shapes indicated on the Contract Documents and as required to meet the field conditions. Equipment shall be sheet metal, with enamel finish, NEMA 250 rated.
- B. Provide all necessary elbows, tees, connectors, adaptors, etc.
- C. Provide hinged cover secured with captive screws.
- D. Wire retainers shall be provided not less than twelve (12) inches on center.
- E. Acceptable Manufacturers
 - 1. Square D
 - 2. Wiremold/Legrand
 - 3. Hubbell

2.4 OUTLET, JUNCTION AND PULL BOXES

- A. Cast Type Conduit Boxes, Outlet Bodies, and Fittings
 - 1. For rigid steel conduit, ferrous alloy box with inside threaded hubs.
 - 2. For rigid aluminum conduit, aluminum box with inside threaded hubs.
 - 3. For electrical metallic tubing, ferrous alloy box with compression or inside threaded hubs with adapter.
 - 4. Covers: Cast or sheet metal unless otherwise required.
 - 5. Tapered threads for hubs.
- B. Galvanized Pressed Steel Outlet Boxes
 - 1. General: Pressed steel, galvanized or cadmium-plated, minimum of 4" octagonal or square with galvanized cover or extension ring as required.
 - 2. Concrete Box: 4" octagon with removable backplate and 3/8" fixture stud, if required. Depth of box shall allow for a minimum of 1" of concrete to be poured above the backplate.
 - 3. Switch and Receptacle Box, Indoors: Nominal 4" square, 1½" or 2-1/8" deep as required, with raised cover unless otherwise indicated on the Contract Documents.
 - 4. Lighting Fixture Box:
 - a. 4" octagon with 3/8" fixture stud.
 - b. For suspended ceiling work, 4" octagon with removable backplate where required, and two (2) parallel bars for securing to cross-furring channels and extend flexible metal conduit to each fixture.
- C. Sheet Steel Boxes Indoors
 - 1. No. 12 USS gauge sheet steel for boxes with a maximum side less than 40 inches, and a maximum area not exceeding 1,000 square inches; riveted or welded 3/4 inch flanges at exterior corners.
 - 2. No. 10 USS gauge sheet steel for boxes with a maximum side 40 to 60 inches, and a maximum area 1,000 to 1,500 square inches; riveted or welded 3/4 inch flanges at exterior corners.
 - 3. No. 10 USS gauge sheet steel riveted or welded to 1½" by 1½" by ¼" welded angle iron framework for boxes with a maximum side exceeding 60 inches and more than 1,500 square inches in area.

4. Covers:
 - a. Same gauge steel as the box.
 - b. Subdivided single covers so no section of the cover exceeds 50 pounds.
 - c. Machine bolts, machine screws threaded into tapped holes or sheet metal screws as required; maximum spacing of 12 inches.
5. Paint: Rust inhibiting primer; ANSI No. 61 light gray finish coat.
- D. Pull and Splice Boxes, Outdoors
 1. Aluminum reinforced, with removable covers secured by stainless steel machine screws.
- E. Junction Box, Sidewalk Type
 1. Cast iron, hot-dipped galvanized with threaded conduit entrance hubs, flanged, reinforced checkered cover, gasketed with pry bar slots and countersunk stainless steel screws.
- F. Acceptable Manufacturers:
 1. Cooper Industries
 2. Appleton Electric Company / A Division of Emerson
 3. Erickson Electrical Equipment Co.
 4. Hoffman
 5. Hubbell / RACO
 6. OZ Gedney / A Division of Emerson
 7. Thomas & Betts / Steel City
- G. Floor Boxes
 1. General:
 - a. Class I, UL 514B Rated watertight, normal depth cast iron construction Type I, fully adjustable, for use in concrete.
 - b. Single Gang: Round type.
 - c. Multiple Gang or Combination: Rectangular type: partitions for separating power from communication sections.
 2. Floor Box Covers:
 - a. Rugged construction, impervious to cleaning detergents.
 - b. Compatible with floor covering.
 - c. Finish as selected by the Architect. Satin Aluminum metallic finish minimum or approved equal by the Architect.
 - d. Providing continuous ground path to the box.
 - e. Cover plates shall accept duplex power receptacles and communication devices to match the Contract Documents.
 - f. All cover plates shall be equipped with flip up lids.
 3. Acceptable Manufacturers:
 - a. Single or Double Gang for duplex receptacle and/or communication devices: Round with four (4) 1 inch hubs and single flush or double cover.
 - 1) Hubbell
 - 2) Thomas & Betts – Steel City
 - 3) Wiremold/Legrand
 - b. Single Gang for Communication devices: Round with four (4) 1¼" hubs and single flush cover.
 - 1) Hubbell

- 2) Thomas & Betts – Steel City.
- 3) Wiremold/Legrand
- c. Multi-gang with Interior Partitions and 3/4 Inch Hubs:
 - 1) Hubbell
 - 2) Thomas & Betts – Steel City
 - 3) Wiremold/Legrand
- d. Single Gang Rectangular Covers for Multi-Gang Boxes:
 - 1) Hubbell
 - 2) Thomas & Betts - Steel City
 - 3) Wiremold/Legrand
- e. Dual service round floor box with 3/4" and 1 1/2" conduit hubs:
 - 1) Hubbell
 - 2) Thomas & Betts – Steel City
 - 3) Wiremold/Legrand

2.5 IDENTIFICATION LABELS

- A. Plasticized Cloth
 - 1. Non-conductive.
 - 2. Waterproof.
 - 3. Capable of withstanding continuous temperatures of 235°F and intermittent temperatures to 300°F.
 - 4. Overcoating for protection against oil, solvents, chemicals, moisture, abrasion and dirt.
- B. Heavy, thermo-resistant industrial grade adhesive for adhesion of label to any surface without curling, peeling, or falling off.
- C. Legends: Sharp, bold-face, two (2) inch black letters on "Alert" orange background.
- D. Label Designations, Nominal System Voltages
 - 208 volts
 - 240 volts
 - 460 volts
 - 480 volts
 - 2,400 volts
 - 4,160 volts
 - 12,400 volts
 - 13,200 volts
 - 13,800 volts
- E. Acceptable Manufacturers
 - 1. W.H. Brady Company
 - 2. Thomas & Betts Corporation
 - 3. DYMO

PART 3 - EXECUTION

3.1 APPLICATION OF RACEWAYS

- A. The following applications must be adhered to. Raceways not conforming to this listing must be removed and replaced with specified material at no additional expense.

Raceway Types	Applications
Rigid Steel Conduit	Where exposed to mechanical injury, where specifically required; indoors where exposed to moisture; where required by codes and for all circuits in excess of 600 volts. Outdoor locations, sump and ejector pits, elevator pits, loading docks, garage, window washing equipment, and service feeders. Fire pump feeders concrete encased with 2" of concrete when Mineral Insulated (MI) Cable is not used.
PVC Coated Rigid Galvanized Steel Conduit	Where exposed to extreme outdoor and indoor corrosion and or weather conditions: Bridges, Water Treatment, Food and Beverage processing. Stub out of Concrete applications. In applications where two (2) UL Listed Layers of Corrosion protection is required and Hot Dipped Galvanized Conduit as Primary Protection is listed PVC Coating is listed as Primary Corrosion is also UL Listed.
Rigid Aluminum Conduit	For 400 Hz feeders and branch circuits. Outdoor locations.
E.M.T.	Use in every instance except where another material is not specified.
Aarmor Clad Cable	Lighting and receptacle branch circuits concealed in dry hollow spaces of a building. May not be used in corridors, places of assembly, or where prohibited by Code.
Flexible Metal Conduit	Use in dry areas for connections to lighting fixtures in hung ceilings, connections to equipment installed in removable panels of hung ceilings; at bus duct takeoffs; at all transformer or equipment raceway connections where sound and vibration isolation is required.
Liquid-Tight Flexible Metal Conduit	Use in areas subject to moisture where flexible metal conduit is unacceptable, at connections to all motors, and all raised floor areas.
Rigid Non-Metallic Conduit	Schedule 40 - Where raceways are in a slab below grade levels; for raceway duct banks. Schedule 80 - For underground raceways outside of the building which are not encased in concrete.
Wireways and Auxiliary	Where indicated on the Contract Documents and as

Raceway Types	Applications
Gutters	otherwise specifically required.

3.2 RACEWAY SYSTEMS IN GENERAL

- A. Provide separate raceways for all wiring systems, including security, data, paging, low voltage et al. All 480Y/277 volt wiring must be kept independent of 208Y/120 volt wiring. Emergency system wiring must be kept independent of the normal system wiring. Provide grounding conductor within all circuits. Minimum size 3/4-inch for home runs and 1-inch minimum for power distribution. Wiring of each type and system must be installed in separate raceways.
- B. Install capped bushings on the raceways as soon as they are installed and remove only when cables are pulled. Securely tie embedded raceway in place prior to embedment. Raceways installed below or in floor slabs must extend a minimum of four (4) inches above the finished slab to the first connector. Lay out work in advance to avoid excessive concentrations of multiple raceway runs.
- C. Locate raceways so that the strength of structural members are unaffected and they do not conflict with services of other trades. Install 1-inch or larger raceways in or through structural members (beams, slabs, etc.) only when and in a manner accepted by the Structural Engineer. Draw up couplings and fittings full and tight. Protect exposed threads from corrosion with one (1) coat of zinc chromate after installation.
- D. Provide raceway installation (with appropriate seal-offs, explosion-proof fittings, etc.) in special occupancy area, as required. Provide conduit seal-offs where portions of the interior raceway system pass through walls, ceiling or floors which separate adjacent rooms having substantially different maintained temperatures, as in refrigeration or cold storage rooms.
- E. Provide labeled pull wire in all spare or empty raceways. Allow five (5) feet of slack at each end and in each pull box. Tag both ends of the cable denoting opposite and termination location with black india ink on flameproof linen tag.
- F. Above Grade: Defined as area above the finished grade for the building exterior and above the top surface of any slabs (or other concrete work) on grade for the building interior.
 - 1. Install concealed except at surface cabinets and for motor and equipment connections in electrical and mechanical rooms. Install a minimum of six (6) inches from flues, steam pipes, or other heated lines. Provide flashing and counter-flashing for waterproofing of raceways, outlets, fittings, etc., which penetrate the roof. Route exposed raceways parallel or perpendicular to the building lines with right-angle turns and symmetrical bends. Run concealed raceways in direct line and, where possible, with long sweep bends and offsets. Maximum length of six (6) feet for flexible metal conduit. Each section of flexible metal conduit shall contain bonding ground connector bonded at each end and sized as required. Provide connectors with insulating bushings. Provide sleeves in the forms for new concrete walls, floor slabs and partitions for passage of the raceways. Waterproof sleeved raceways where required.
 - 2. Provide raceway expansion joints for exposed and concealed raceways with necessary bonding ground conductor at building expansion joints and between buildings or structures and where required to compensate for raceway or building thermal expansion and contraction. Provide expansion fittings every 200 feet of conduit.
 - 3. Provide one (1) empty 3/4 inch raceway for each three (3) spare unused poles or spaces of each flush-mounted panelboard. Terminate empty 3/4 inch conduits in a junction box, which after completion is accessible to facilitate future branch circuit extension. Provide pull lines in each raceway.

G. Below Grade: Defined as area below the finished grade for the building exterior and below or within the bottom floor slab for the building interior. Below grade raceways shall comply with the following:

1. Extend below-grade raceways two (2) inches minimum above the floor or equipment foundation. Install exterior underground conduits 24 inches minimum below the finished grade. Do not penetrate waterproof membranes unless proper seal is provided.
2. Protect metallic raceway in earth or apply with two (2) coats of asphalt base paint. Touch up abrasions and wrench marks after conduit is in place.
3. In lieu of the above, protect raceways with a minimum of 20 mil tape appropriate for the purpose, overlapped a minimum of one-half tape width.

H. Duct Banks

1. Provide duct banks and concrete encasements for both interior and exterior work as indicated on the Contract Documents, for all circuits in excess of 600 volts, for all utility company feeders, and as otherwise indicated.
2. Reinforce duct banks with steel rebars where such duct banks are positioned beneath roads and parking areas.
3. Concrete minimum $f_c = 3,000$ pounds per square inch.
4. At building walls and at manhole walls, provide raceway of rigid steel, one size larger than the specified raceway, for five (5) feet. Pitch conduit away from the building at every point where the duct bank enters the building or equipment.
5. Support all raceways installed in the duct banks every five (5) feet to assure correct alignment.
6. Terminate raceways with flared bells to enable ease of pulling cable and to eliminate stress on the cable. Free bells and raceway terminations of burrs and rough edges. Mandrel all raceways before the installation of any conductors.
7. Provide concrete markers at grade where duct banks are stubbed out for future use.
8. Install utility duct banks not less than 36 inches below grade to the top elevation.
9. Employ red dye inhibiting agents in the concrete mix for power duct banks.
10. Provide yellow vinyl tracer ribbon twelve (12") inches above each duct bank buried in the backfill.

I. Fire Pump Raceways

1. Encase all raceways for the fire pumps in a minimum 2" of concrete. Concrete shall have a red dye.

J. Install no raceway in the concrete slab except with the permission of the Structural Engineer and written consent of the Owner. Maximum conduit sizes embedded in structural concrete slabs:

Raceway Size	Min. Thickness of Concrete Slab
3/4 in.	4½ in.
1 in.	5 in.

1. Do not install raceways 1¼ inch size and larger in structural concrete slabs.
2. In no case will the installation of raceways be permitted to interfere with proper placement of principal reinforcement.
3. Place raceways in the structural slabs between the upper and lower layers of reinforcing steel. Careful bending of the conduits is required.
4. Space the raceways embedded in concrete slabs not less than eight (8) inches on centers and as widely spaced as possible where they converge at panels or junction boxes.

5. Install raceways running parallel to slabs supports, such as beams, columns and structural walls, not less than 12 inches from such supporting elements.
 6. Secure saddle supports for conduit, outlet boxes, junction boxes, inserts, etc. with suitable adhesives during concrete pour of the slab to prevent displacement.
- K. Rigid Non-Metallic Raceway
1. All joints shall be made by solvent cementing method using material recommended by the raceway manufacturer. Clean components prior to assembly. Supply fittings, cement and conduit shall be by the same manufacturer.
 2. Square raceway cutoffs made by handsaw or other appropriate means which does not deform the conduit. Ream raceway prior to solvent cementing to couplings, adaptors, or fittings.
 3. Ground electrical devices served by rigid non-metallic raceways by means of a ground conductor pulled in the raceway.
 4. Use male box adapters for all box or raceway fittings to terminate rigid non-metallic raceways.
 5. Where separable terminations are required, make using rigid non-metallic threaded adapters with locknuts or bushings. If such terminations must be watertight, install "O" rings.
 6. Make bends by methods that do not deform or damage the conduit. Radii of field bends shall not be less than those established by the N.E.C.
 7. Provide raceway expansion fittings where necessary. Adjust position of expansion fitting proportional to the temperature at the installation.
 8. Install raceway supports to allow the rigid non-metallic conduit to slide through supports as temperature changes.
 9. Use galvanized rigid steel conduit elbows at all bends.
- L. PVC Coated Rigid Galvanized Conduit
1. Manufacturer shall provide Certified Field Installers Training. All installers of PVC Coated Rigid Galvanized Steel Conduit shall be certified by the manufacturer and shall provide proof of certification upon request.
 2. All repairs and patching to PVC Coated Rigid Galvanized Steel Conduit, shall be in accordance with manufacturers recommendations. Contractors shall use manufacturer's patch and repair kits in order to guarantee certified products are used and compliance with all factory warranty guidelines are met.
- M. Raceways in hung ceilings shall be installed on and secured to the slab or primary structural members of the ceiling, not to lathing channels or T-bars, Z-bars or other elements which are direct supports of the ceiling panels. Secure conduit firmly to the steel with clips and fittings designed for that purpose. Install as high as possible but not less than 1'-0" above the hung ceilings.
- N. Install exposed raceways parallel or at right angles with building lines. Secure raceway clamps or supports to masonry materials by toggle bolts, expansion bolts, or steel inserts. Install raceways to steel construction with appropriate clamps which do not depend on friction or set-screw pressure alone.
- O. Clear raceways of all obstructions and dirt prior to pulling in cables. Use ball mandrel (diameter approximately 85% of the conduit inside diameter) followed by close fitting wire brush and wad of felt or similar material. This assembly may be pulled in together with, but ahead of any cable being installed. Clean all empty raceways similarly. Clear any raceway which rejects ball mandrel, then re-attempt mandrel application.

- P. Support vertically installed raceways less than 2" trade size at intervals no greater than eight (8) feet. Support such raceways 2" trade size or larger and made up with threaded couplings, at intervals no greater than story height, or fifteen (15) feet, whichever is smaller.
- Q. Support horizontally installed raceways less than 1" trade size at intervals no greater than six (6) feet. Support such raceways 1" trade size or larger, at intervals no greater than ten (10) feet.

3.3 WIREWAYS AND AUXILIARY GUTTERS

- A. Place wireways installed in hung ceilings such that the covers will hinge upward from the side.

3.4 OUTLET, JUNCTION, AND PULL BOXES

- A. Provide outlet, junction, and pull boxes as indicated on the Contract Documents and as required for the complete installation of the various electrical systems, and to facilitate proper pulling of the cables. Size the junction boxes and pull boxes per the NEC. Size the boxes on any empty conduit systems as if containing conductors of No.4 AWG.
- B. The exact location of outlets and equipment is governed by the structural conditions and obstructions, or other equipment items. When necessary, relocate outlets so that when fixtures or equipment are installed, they will be symmetrically located according to the room layout and will not interfere with other work or equipment. Verify final location of outlets, panels equipment, etc., with the Architect prior to installation.
- C. Back-to-back outlets in the same wall, or "thru-wall" type boxes are not permitted. Provide 12-inch minimum spacing for outlets shown on opposite sides of a common wall to minimize sound transmission.
- D. Fit outlet boxes in finished ceilings or walls with appropriate covers, set flush with the finished surface. Where more than one (1) switch or device is located at one (1) point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes are not permitted. Provide tile box or 4 inch square box with tile ring in masonry walls not plastered or furred. Where drywall material is utilized, provide plaster ring. Provide outlet boxes of type and size suitable for the specific application. Where outlet boxes contain two (2) or more 277 volt devices, or where devices occur of different applied voltages, or where normal and emergency devices occur in the same box, provide suitable barrier(s).
- E. All outlet and device box depths shall have sufficient depth to prevent damage to the conductors when devices or utilization equipment are installed as intended in the box.
- F. Types of Boxes and Fittings for Various Locations

Location	Type
Outlet	Galvanized pressed steel
Outlet exposed to moisture or outdoors	Cast type conduit fitting
Splice	Galvanized pressed steel
Splice exposed to moisture or outdoors	Cast type conduit fitting or sheet metal (4½" x 5" x 3" minimum)
Pull or Junction	Cast type conduit fitting or sheet metal (4½" x 5" x 3" minimum)

Location	Type
Pull or Junction - Outdoors	Aluminum (4½" x 5" x 3" minimum)
Terminal	Sheet steel (6" x 6" x 3" minimum)
Terminal - Outdoors	Aluminum (6" x 6" x 3" minimum)

G. Pull Box Spacing

1. Provide pull boxes so no individual conduit run contains more than the equivalent of four (4) quarter bends (360° total).
2. Conduit Sizes 1¼" and Larger:
 - a. Provide boxes to prevent cable from being excessively twisted, stretched or flexed during installation.
 - b. Provide boxes so that maximum pulling tensions do not exceed the cable manufacturer's recommendations.
 - c. Provide support racks for boxes with multiple sets of conductors so that the conductors do not rest on any metal work inside the box.
3. Conduit Sizes 1 Inch and Smaller, provide boxes at every (Maximum Distances):

150 feet	straight runs
100 feet	runs with one (1) 90° bend or equivalent
75 feet	runs with two (2) 90° bends or equivalent
50 feet	runs with three (3) or (4) four 90° bends or equivalent.

H. Sheet Steel Boxes

1. Boxes shall be sized to permit pulling, racking and splicing of the cables (if not indicated on the Contract Documents). They shall be sized to avoid exceeding the manufacturer's minimum bending radius recommendations for the conductors.
2. Provide access for the removal and replacement of the conductors, splices and equipment.
3. Minimum Dimensions of Boxes in Runs of 1½" or Larger Conduit:
 - a. Straight Pulls: Size length eight (8) times nominal diameter of the largest conduit.
 - b. Angle or U-Pulls: Size such that the distance between the conduit entry and the opposite wall of box is six (6) times the nominal diameter of the largest conduit.
4. For boxes containing over 600V conductors, provide insulated cable supports and removable steel barriers to isolate each feeder. Stencil cable voltage class in red letters on the front cover of the box.
5. Covers: Fasten to the flange or framework of the box with machine bolts, machine screws threaded into tapped holes or sheet metal screws as required.
6. Plug any open knockouts not utilized.

I. Pull and Splice Boxes, Outdoors

1. Where size of the box is not indicated, size to permit pulling, racking and splicing of cables being installed.
2. Braze ground connector suitable for copper cables to the inside of the box.

J. Floor Boxes

1. Prior to the Concrete Pour:
 - a. Orient as shown on the Contract Documents and obtain approval from the Architect.

- b. Firmly support all boxes.
 - c. Adjust leveling screws to insure that the box covers will be flush with the finished floor.
 - d. Plug unused openings with proper fittings and seal joints with a compound for exclusion of concrete and moisture.
- 2. After the Concrete Pour:
 - a. As soon as traffic is permitted on the slab, remove any accumulation of water and foreign matter to avoid corrosion and rust.
 - b. Insure covers are flush with the finished floor.
 - c. Install cover plates and accessories after floor finishing materials have been installed; refer to the Contract Documents for requirements for the types of covers.
- K. Identification labels for all pull, splice and junction boxes in main feeder and subfeeder runs, shall indicate nominal system voltage:
 - 1. Apply labels after painting of any boxes, conduits, and surrounding areas are completed.
 - 2. Clean surfaces before applying labels; clean aluminum surfaces with solvent wipe.
 - 3. Apply labels on the cover and a minimum of one (1) fixed side; one (1) label visible from the floor where the boxes are installed exposed.

3.5 FIRE PUMP AND SERVICE ENTRANCE RACEWAYS

- A. Use rigid steel heavy-wall conduits.
- B. Encase in concrete with a minimum of 2" of cover.
- C. Utilize red dye in the fire pump duct bank.

3.6 SLEEVES

- A. Where sleeves are required for the installation of electrical work passing through walls or floors, furnish and install under this Section of Specification unless indicated otherwise on the Contract Documents. Use galvanized or black enameled rigid steel conduit or Schedule 40 black steel pipe. Do not use aluminum conduit. Where specific sizes are not indicated on the Contract Documents, size sleeves shall provide ½ inch clearance around the outside surface of the item for which installed. Cut flush with the wall surfaces and extend two (2) inches above the finished floor level or as indicated on the Contract Documents. In mechanical rooms, extend sleeve four (4) inches above the finished floor level.
- B. For interior walls and for floors, pack space between the conduit, ground cable or similar items and sleeves to the full depth of the wall or slab thickness with fire stopping material to maintain the required rating.

3.7 CABLE SUPPORT BOXES

- A. Cable support boxes shall be installed and of dimensions as required by the NEC. These boxes shall be built of steel or aluminum with removable cover secured by brass machine screws and shall be stiffened with heavy angle irons. Cable supports shall be OZ type "S". Boxes must in all ways be satisfactory to the Architect and subject to his approval. Provide ground lug in the box, secured by welding or brazing. Submit shop drawings for approval.

END OF SECTION

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SECTION 260534
MANHOLES AND HANDHOLES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide pre-cast manholes, handholes, and accessories in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. This Section Includes the following:
 - 1. Manholes
 - 2. Handholes.
 - 3. Accessories.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Manholes and handholes.
 - 2. Accessories.
 - 3. Warning tape.
 - 4. Warning planks.
- B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include dimensioned plans, elevations, sections, details, attachments to other work, and accessories, including frame and cover design, grounding detail, cable rack inserts, sumps and pulling irons.

1.4 QUALITY ASSURANCE

- A. Comply with the latest applicable provisions and latest recommendations of the governing codes and the Contract Documents.
- B. Power Utility Company Standards.
- C. U.L. Listing of all products.

1.5 COORDINATION

- A. Coordinate layout and installation of manholes and handholes with the final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of manholes and handholes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features.

PART 2 - PRODUCTS

2.1 GENERAL

A. Manholes

1. Provide precast concrete manholes consisting of 3000 psi compressive strength at 28 days. Prefabricated maintenance structures shall be designed to resist a vertical pressure of approximately 3,000 pounds per square foot and a uniform lateral earth pressure of 1,500 pounds per square foot. Where applicable, the structure should be designed to resist hydrostatic pressure acting against the side walls and the bottom.
2. Provide manhole sizes as required by the application and to accept the quantity and location of the entry and exit points.
3. Manhole collar and shaft sections shall have minimum of 30 inches diameter clear opening.
4. Windows for duct entry shall be sized as required to meet incoming and outgoing ductbanks.
5. Maintain access to the sump to place portable pump.
6. Provide two (2) cable pulling irons opposite each conduit entry window, one (1) above and one (1) below.
7. Provide galvanized steel cable, support rack, cast iron frame and cover, ground rod with copper bonding tree, galvanized steel ladder, and galvanized steel conduit end ball.
8. Manhole Accessories
 - a. Manhole Frames and Covers: Provide manhole frames and covers gray cast iron, machine finished with flat bearing surfaces. All manhole frames and covers shall be heavy duty type with highway load bearing capacity with sealed cover. Reinforcing steel to withstand ASHTO-HS20 loading. All hardware shall be stainless.
 - b. Sump Covers: Provide sump covers gray cast iron.
 - c. Pulling Irons: Provide pulling irons of 7/8 inch diameter steel bar forming a triangle of 9 inches per side when set. Galvanize for irregular shaped articles.
 - d. Cable Rack Inserts: Provide steel channel insert with minimum load rating of 800 pounds, length to match cable rack channel.
 - e. Cable Rack Channel: Provide 4 by 1-1/2-inch by 3/16 inch steel channel wall bracket, 48-inch length, with cable rack arm mounting slots on 8-inch centers. Cable-racking shall be fiber type.
 - f. Cable Racks: Provide cable racks; fiber type, 2-1/2 by 14 inches with high-glazed wet-process porcelain insulators. Cables to be secured with plastic tie-wraps, stainless throat fasteners.
 - g. Manhole Steps: Provide manhole steps which are cast iron, suitable for manhole shape and constructions.
 - h. Hardware: All hardware and accessories for the manhole shall be stainless steel.
9. Heavy Duty Non-Metallic Cable Rack.
 - a. Manhole Hardware. Cables shall be well supported on walls by heavy duty non-metallic cable racks. The cable racks consist of a stanchion that shall be attached to the manhole wall in accordance with the manufacturer's recommendations and adjustable arms that lock into the stanchion. Unless otherwise specified:
 - 1) At least two (2) stanchions shall be installed on each manhole wall.
 - a) Cable rack arm lengths shall be appropriate for the manhole size and amount of cable being installed.

- b) At least two (2) spare arms shall be installed at each stanchion position.
- b. Cable Rack: Stanchions and arms shall be made from 50% glass-reinforced nylon or a non-metallic material having equal mechanical strength, thermal resistance, chemical resistance, dielectric strength and physical properties. The stanchion shall be 36 inches long, shall incorporate multiple arm mounting holes that are 4 inches apart and recessed bolt mounting holes. Holes or slots shall be provided in the arms for cable wire ties. The cable racks shall be marked with the manufacturer's name, plant location and date manufactured. Cable racks shall be Underground Devices, Inc. CR36, 3HDS, RA04, RA06, RA08, RA11, RA14, and RA20.
- c. Cable Rack Mounting Hardware. Either one of the following corrosion resistant hardware sets may be used to secure the stanchion to the manhole wall.
 - 1) Drop-in anchors (UDI Catalog No. FSRM – 12) shall have a rated pullout working capacity of 1200 lbs. and shall be made from either 303 or 316 stainless steel. A 316 stainless steel ½ - 13 hex head cap screw (UDI Catalog No. FHC316-16-044) and a 316 stainless steel .562 ID X 1.250 OD X .078 THK. Flat washer (UDI Catalog No. FFW316-18-40) shall be used with each drop-in anchor.
 - 2) Cast-in-place anchors (UDI Catalog No. FNMA-16) shall have a ½ - 13 thread, a working load capacity of 1260 lbs. and shall be made from Acetal Copolymer. A special 316 stainless steel ½ - 13 hex head cap screw (UDI Catalog No. FHC316-16-088) and a 316 stainless steel washer (UDI Catalog No. FFW316-18-40) shall be used with each cast-in-place anchor.
- B. Comply with ASTM C 858. Manholes shall be provided with interlocking mating sections, complete with accessories, hardware, and features.
 - 1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - 2. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
- C. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.
- D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
- E. Acceptable Manufacturers:
 - 1. Carder Concrete Products.
 - 2. Christy Concrete Products.
 - 3. Elmhurst-Chicago Stone Co.

2.2 HANDHOLES

- A. Description: Factory-fabricated, reinforced pre-cast concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of the enclosure and shall have a load rating consistent with that of a handhole.
 - 1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing stainless-steel bolts.

2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing stainless-steel bolts.
 3. Cover Legend: Molded lettering, ["ELECTRIC."] ["TELEPHONE."]
 4. Configuration: Units shall be designed for flush burial and have a closed bottom.
 5. Extensions and Slabs: Designed to mate with the bottom of enclosure. Same material as the enclosure.
 6. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - a. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - b. Window openings shall be framed with at least two (2) additional No. 4 steel reinforcing bars in concrete around each opening.
 7. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 8. Handholes shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
- B. Acceptable Manufacturers:
1. Quazite
 2. Christy Concrete Products
 3. Oldcastle Precast Group.
 4. Utility Concrete Products, LLC.

2.3 HANDHOLES OTHER THAN PRECAST CONCRETE

- A. Description: Comply with SCTE 77.
1. Configuration: Units shall be designed for flush burial and have closed bottom.
 2. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with the enclosure.
 3. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 4. Cover Legend: Molded lettering, ["ELECTRIC."] ["TELEPHONE."].
 5. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings.
 6. Duct Entrance Provisions: Duct-terminating fittings shall mate with the entering ducts for secure, fixed installation in the enclosure wall.
 7. Handholes shall have factory-installed inserts for cable racks and pulling-in irons.
- B. Polymer Concrete Handholes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two. Handholes shall comply with the requirements of SCTE 7 [Tier 5] [Tier 8] [Tier 15] [Tier 22] loading.
1. Acceptable Manufacturers:
 - a. Quazite
 - b. Armorcast Products Company.
 - c. Oldcastle Enclosure Solutions
 - d. Hubbell Power Systems
- C. Fiberglass Handholes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
1. Acceptable Manufacturers:
 - a. Quazite

- b. Armorcast Products Company.
 - c. Oldcastle Enclosure Solutions.
 - d. Hubbell Power Systems.
- D. Fiberglass Handholes: Molded of fiberglass-reinforced polyester resin, with covers of hot-dip galvanized-steel diamond plate.
 - 1. Acceptable Manufacturers:
 - a. Quazite
 - b. Oldcastle Enclosure Systems
 - c. Armorcast Products Company
 - d. Hubbell Power Systems.

2.4 CAST-IN-PLACE MANHOLES

- A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for conduit entrance and sleeve for ground rod.
- B. Materials: Comply with ASTM C 858.
 - 1. Concrete shall have a minimum compressive strength of 3000 psi (20 MPa).

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037 and SCTE 77.

PART 3 - EXECUTION

3.1 GENERAL

- A. Excavation, shoring, bracing, back-filling and grading provided by other section.
- B. Manholes shall be constructed as shown on the Contract Drawings. Manholes shall not be constructed until final conduit grading has been determined, including any field changes required by underground interferences. Shop drawings shall be submitted for all manhole details that differ in any way from those shown on the Contract Drawings.
- C. Cables to be secured with tie-wraps. Cable racks shall be fiber.
- D. Provide a copper clad steel ground rod, 3/8 inch by 10 feet long, in each manhole. All noncurrent-carrying metal parts in manholes and handholes including metallic sheaths of cables, shall be connected to the ground rod by a bare copper ground conductor. Install the ground rod with top protruding 4 inches above manhole floor.
- E. Provide a cast iron sump frame and cover for each manhole. Provide 12-by 12-by 6-inch deep sump. Excavate below sump 6 inches and fill sump bottom with clean gravel. Slope floor of manhole 1/8-inch per foot to the edge of the sump.
- F. Waterproof exterior surfaces, joints, and interruptions of manholes after concrete has cured 28 days minimum.
- G. Attach cable racks to inserts after manhole.

- H. Manholes and handholes are shown on the Contract Documents in approximate locations. The exact location shall be field determined after careful consideration of other utilities, grading, and paving.
- I. In paved areas, set top of frame and cover flush with finished surface. In unpaved areas, set top of frame and cover approximately ½ inch above finished grade.
- J. The installation of manholes shall be in an excavated area free of obstructions for a minimum 6 inches around outside perimeter, with a 6 inch compact gravel base of uniform thickness and level. The preparation of the base shall insure no settlement. Backfill shall consist of good compactable material, such as pea gravel, sand or clean earth fill. Backfilling should be done progressively from bottom to top surface. Minimum earth cover from roof of manhole to finished grade shall be 8 inches.
- K. Concrete encased duct banks entering wall may be cast in the concrete or enter through opening of suitable dimensions and arrangement. Where openings are provided, caulk the space between duct bank and walls tight with lead wool or other suitable material. Reinforce iron of the ductbank to be connected to the wall.
- L. Flush end bells shall be mounted on side walls where duct enters.
- M. Duct entrances shall be carefully planned via the field for best application of cable pulling and racked. All cables shall be secured with tie-wraps to porcelain saddles.
- N. Waterproofing shall be done in accordance with manufacturer's instructions.
- O. Collar shall be cast concrete rings, stacked to required height. Set height in field per final grade elevations.

3.2 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes for 600 V and Less, Including Telephone, Communications, and Data Wiring:
 - 1. Units in Roadways and Traffic Paths: Precast concrete.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 22 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8 structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf "Light-Duty" vertical loading.

3.3 EARTHWORK

- A. Excavation and Backfill: Do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades unless otherwise indicated on the Contract Documents. Replace removed sod immediately after backfilling is completed.

3.4 INSTALLATION OF CONCRETE MANHOLES AND HANDHOLES

- A. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891 unless otherwise indicated.
 2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
 3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, and compacted to same density as adjacent undisturbed earth.
- B. Elevations:
1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
 2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
 3. Install handholes with bottom below the frost line.
 4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
- C. Drainage: Install drains in bottom of manholes where indicated.
- D. Manhole Access: Circular opening in manhole roof; sized to match cover size.
1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
 2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening.
- E. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors.
- F. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- G. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- H. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.5 INSTALLATION OF HANDHOLES OTHER THAN PRECAST CONCRETE

- A. Install handholes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use pull box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
- B. Unless otherwise indicated, support units on a level 6-inch- thick bed of crushed stone or gravel, graded and compacted to same density as adjacent undisturbed earth.
- C. Elevation: Set so cover surface will be flush with finished grade.
- D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors.
- E. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

- F. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
 - 1. Concrete: 3000 psi (20 kPa), 28-day strength.
 - 2. Dimensions: 10 inches wide by 12 inches or as indicated.

3.6 GROUNDING

- A. Ground underground ducts and utility structures.

3.7 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in this division."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.8 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION

SECTION 260535

UNDERGROUND DUCTS AND RACEWAYS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide underground ducts and raceways in accordance with the Contract Documents

1.2 WORK INCLUDED

- A. Underground conduit, ducts, and duct accessories for [direct-buried] [and] [concrete-encased] duct banks, [and in single duct runs].
- B. Raceways.
- C. Concrete reinforced rods, etc.
- D. Excavation and backfill for the underground duct-bank systems.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Duct-bank materials, including separators and miscellaneous components.
 - 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 3. Warning tape.
 - 4. Warning planks.
- B. Shop Drawings for dimensioned Underground Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
 - 1. Duct entry provisions, including locations and duct sizes.
 - 2. Reinforcement details.
 - 3. Grounding details.
- C. Duct-Bank Coordination Drawings: Show dimensioned duct profiles and coordination with other utilities and underground structures.
 - 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
- D. Submit results of field tests.
- E. Record Documents: show dimensional locations of all underground ducts, handholes, and manholes.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Comply with ANSI CS.

- C. Comply with NFPA 70.
- D. U.L. listing of all products.

1.5 COORDINATION

- A. Coordinate layout and installation of ducts with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by the coordination with other utilities, underground obstructions, and surface features.

PART 2 - PRODUCTS

2.1 UNDERGROUND DUCT SYSTEM

- A. Contractor shall furnish and install raceways and fittings for an underground duct system, as indicated on the Contract Drawings and specified herein.
- B. All bends at underground duct system shall be per the manufacturer's bending requirements.
- C. Bending for the medium voltage service lines shall also comply with the Utility Company requirements.
- D. The minimum bend radius for Telco carrier conduit, under any circumstances shall be greater than 12 times the conduit diameter. Comply with Utility Company requirements.
- E. Raceways shall transform from EPC (electrical plastic conduit) PVC to rigid galvanized steel conduit within 10 feet of any foundation walls. Run EPC PVC duct bank to the manholes. Contractor shall furnish and install proper couplings to accommodate aforementioned transition.
- F. Where offsets are required to clear obstructions and other underground services, a maximum of 5° angle will be allowed at duct joints.
- G. Ducts shall be installed so as to drain to the manholes. Ducts entering into the point of entry (P.O.E.) room shall be installed with upward slope of minimum of 0.125 inch/foot.
- H. All raceways as previously described shall utilize a mandrel of sufficient size to thoroughly clear raceways of all obstructions prior to the installation of any wiring.
- I. All concrete construction, excavation and backfill for the underground ductbank system shall be described under other sections of the project specifications. Red dye shall be added to the concrete mixture.
- J. All conduits penetrating into the buildings shall be totally sealed in order to prevent any migration of water through the ductbank into the building.
- K. Prior to backfilling of the underground duct system, provide a yellow (with black, lettering) warning tape, 1'-0" from finished grade, stating, "CAUTION ELECTRIC LINE BURIED BELOW" above all electrical ductbank, and "CAUTION TELECOMMUNICATIONS CABLE BELOW" above all Telecom ductbank.

2.2 CONDUITS

- A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- B. PVC NEMA TC 2, [Type EPC-40-PVC] [and] [Type EPC-80-PVC], UL 651, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.3 NON-METALLIC DUCTS AND DUCT ACCESSORIES

A. General

- 1. Schedule EPC-40-PVC or EPC-80-PVC conduit shall be used for all concrete encased duct banks.
 - a. PVC conduits shall not be used within the building area.
- 2. All penetrations through floor slabs or foundation walls shall be rigid steel conduits. No EPC conduit shall be used in or through any floor slab.
- 3. PVC conduits shall not be allowed under paved areas, which are subjected to vehicular traffic. Concrete encased rigid steel conduit shall be used.
- 4. Acceptable Manufacturers:
 - a. Carlon Product Corporation
 - b. Excelon
 - c. Southern Pipe, Inc.

B. Duct Accessories:

- 1. Duct Separators (Spacers)
 - a. Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
 - b. Duct bank shall be encased in concrete with at least three inches of concrete at the top and bottom and two inches on each side. A horizontal and vertical separation between the ducts of 3 inches shall be maintained by installing Underground Devices High Impact Polystyrene Spacers. Spacers shall be interlocked horizontally only. Along the length of the duct run spacers shall be staggered at least 6 inches vertically and shall be placed at an interval of 4 spacers per 20 feet.
 - c. Telco carrier ducts shall be separated from electrical ducts by a minimum of 36" and shall cross electrical ductbanks at 90-degree angle only, when unavoidable.
 - d. In general, duct spacers should be of the type recommended by the conduit manufacturers and approved by the Utility Company. Maximum spacing for 4" - 6" conduits shall not exceed 10 feet.
- 2. Concrete Warning Planks: Nominal 12 by 24 by 3 inches.
 - a. Color: Red dye to concrete during batching.
 - b. Mark each plank with "Electric" in 2-inch high, 3/8-inch deep letters.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Cables over 600 V: NEMA [Type EPC-80] [Type EPC-40] -PVC, in concrete-encased duct bank unless otherwise indicated.

- B. Ducts for Electrical Feeders 600 V and Less: NEMA [Type EPC-80] [Type EPC-40]-PVC, in concrete-encased duct bank unless otherwise indicated.
- C. Ducts for Electrical Feeders 600 V and Less: NEMA [Type EPC-80] [Type EPC-40]-PVC, in direct-buried duct bank unless otherwise indicated.
- D. Ducts for Electrical Branch Circuits: NEMA [Type EPC-80] [Type EPC-40]-PVC, in direct-buried duct bank unless otherwise indicated.
- E. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: NEMA Type EPC-40-PVC, in concrete-encased duct bank unless otherwise indicated.

3.2 EARTHWORK

- A. Excavation and Backfill: Do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades unless otherwise indicated.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work.

3.3 DUCT INSTALLATION

A. General

- 1. Concrete for conduit envelopes shall be as required or as specified under other Divisions of the project specifications. Red dye shall be added to concrete mixture. Concrete shall extend at least 3 inches beyond exterior surface of each conduit in bank.
- 2. Concrete envelopes may be poured directly against sides of trenches provided the trench wall is clean, even and free of loose material. Remove loose dirt and extraneous material. Concrete shall be spaced during pouring to eliminate voids under and between conduits and to prevent honeycombing of exterior surfaces. Power-driven tampers or agitators shall not be used. Secure bolts sufficiently to prevent movement during concrete placement.
- 3. Concrete envelopes between manholes, or between the manhole and building, shall be poured in a single operation. Where more than one (1) pour is necessary, provide $\frac{3}{4}$ inch reinforcing rod dowels extending 18 inches into concrete on each side of joint. Concrete envelopes installed over extensive area of disturbed earth shall have a separate concrete base.
- 4. Concrete envelopes that cross other conduits or pipelines or are run under roads and driveways shall be reinforced. Provide reinforcement where envelopes connect to manhole and building walls. Concrete envelopes that terminate for future extension shall have dowels as specified for joints between pours. Reinforcement shall be as required; consult with the structural engineer.
- 5. Trenches shall not be backfilled until concrete envelopes have had sufficient time to set. After concrete envelopes have set, nonmetallic conduits shall be cleared with mandrel of the same size as the conduit.
- 6. Cap ends of spare conduits 5 feet beyond pavement and protect them from mechanical damage. Mark the location of conduit ends with concrete monuments, 6 inches in diameter by 18 inches long, set flush in the ground with "S/C" indented in the top.
- 7. Arrange multiple conduits as shown on the Contract Drawings. Make minor changes in location, or cross-sectional arrangement as necessary. Where conduit runs cannot be installed as shown because of conditions not discoverable prior to digging of trenches,

- request the Architect's instructions before further work is done. Coordinate this work with other outside service work.
8. Seal active and spare conduits that enter the building with oakum or other plastic expandable compound until conductors are ready for installation.
 9. Provide labeled pull string for all conduits.
- B. Slope: Pitch ducts a minimum slope of 0.125 inch/ft down toward the manholes and handholes and away from the buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- C. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 12 times the conduit diameter, both horizontally and vertically, at other locations unless otherwise indicated.
- D. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.
- E. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches on center for 5-inch ducts, and vary proportionately for other duct sizes.
- F. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 ft. outside the building wall without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition.
- G. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
- H. Pulling Cord: Install 100-lbf test nylon cord in ducts, including spares. Label each line.
- I. Concrete-Encased Ducts: Support ducts on duct separators.
1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 ft. of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 3. Pouring Concrete: Spade concrete carefully during pours. Use a plank to direct concrete down sides of bank assembly to trench bottom.
 4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated.
 5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting; otherwise, use forms.
 6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
 7. Depth: Install top of duct bank at least 24 inches below the finished grade in areas not subject to deliberate traffic, and at least 36 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.

8. Stub-Ups: Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.
 9. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
- J. Direct-Buried Duct Banks:
1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
 2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 ft. of duct. Stagger spacers approximately 6 inches between tiers.
 3. Excavate trench bottom to provide firm and uniform support for duct bank.
 4. Install backfill.
 5. After installing first tier of ducts, backfill and compact. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction.
 6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
 7. Depth: Install top of duct bank at least 36 inches below finished grade unless otherwise indicated.
 8. Set elevation of bottom of duct bank below the frost line.
 9. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
 10. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
 11. Warning Planks: Bury warning planks approximately 12 inches above direct-buried ducts and duct banks, placing them 24 inches on center.

3.4 GROUNDING

- A. Ground underground ducts in accordance with the "Grounding System" specification section.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Demonstrate capability and compliance with requirements on the completion of installation of underground ducts and utility structures.

2. Pull aluminum or wood test mandrel through each duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
 3. Grounding: Test manhole grounding to ensure electrical continuity of bonding and grounding connections. Measure ground resistance at each ground rod and report results. Use an instrument specifically designed for ground-resistance measurements.
 4. Water Tightness: Make internal inspection of manholes 3 months after completion of construction for indications of water ingress. Where leakage is noted, remove water and seal leak sources. Reinspect after 2 months and reseal remaining leak sources. Repeat process at 2 month intervals until leaks are corrected.
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.6 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

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SECTION 260548

VIBRATION ISOLATION AND SEISMIC RESTRAINTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide vibration isolation and seismic restraints in accordance with the Contract Documents.
- B. Provide vibration isolation for the engine generator set, dry type transformers, UPS equipment, dimmer racks and at electrical connections to rotating or vibrating equipment.
- C. Provide seismic restraints for all electrical and fire alarm systems and equipment and raceways.

1.2 WORK INCLUDED

- A. Isolation Pads and Bases.
- B. Spring Isolators.
- C. Restrained Spring Isolators.
- D. Channel Support Systems.
- E. Restraint Cables.
- F. Hanger Rod Stiffeners.
- G. Anchorage Bushings and Washers.
- H. Seismic Restraints.
- I. Incidental Materials.

1.3 SUBMITTALS

- A. Manufacturer's product data sheets and installation instructions for each vibration isolator and seismic restraint.
- B. Plan and elevation diagrams showing all equipment, points of attachment, vibration isolators, seismic restraints, mounting methods, and hardware types and sizes.
- C. Drawings showing methods of suspension, support guides for conduits and equipment.
- D. Seismic restraint calculations. Seismic restraint calculations shall be certified by a Professional Structural Engineer registered in the State of the project.
- E. Certified field inspection report.

1.4 QUALITY ASSURANCE

- A. Provide control of excessive noise and vibration in the building due to the operation of machinery or equipment, and/or due to interconnected conduits. Installation of vibration isolation units, and associated hangers and bases shall be under the supervision of the vibration isolation manufacturer's representative.
- B. Vibration isolators and seismic restraints shall be of the same manufacturer.
- C. Seismic restraint external force acceleration criteria shall be 1.0 G for life safety equipment (emergency power system, fire alarm system, and equipment connected to the emergency power system). External force acceleration criteria shall be 0.5 G for non-life safety equipment.
- D. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades.
- E. STANDARDS
 - 1. SMACNA Guidelines for Restraint of Mechanical Equipment.
 - 2. Requirements for IBC SS (Short Period Spectral Response Acceleration)
 - 3. Requirements for NYC seismic code: 1.0 g acceleration.
 - 4. NFPA 101 – Life Safety Code.
 - 5. NFPA 70.
 - 6. New York City Building Code (2014)

1.5 FIELD INSPECTION

- A. Upon completion of the installations, the manufacturer's local representative shall field inspect the installations and submit a report verifying the completeness and performance of the installations. Contractor shall submit a report to the Engineer, including the manufacturer's representative's final report, indicating all isolation reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATION AND SEISMIC RESTRAINTS

- A. General
 - 1. All products shall be provided with a finish suitable for the application.
 - 2. Devices installed outdoors shall be weatherproof; steel components shall be hot dipped galvanized, hardware shall be cadmium plated, and springs shall be neoprene coated.
 - 3. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load.
 - 4. Springs shall have an additional minimum travel to solid equal to 50% of the rated deflection.
 - 5. Vibration isolators shall be selected in accordance with the equipment weight distribution so as to produce reasonably uniform deflection.
 - 6. In all installations, isolated electrical equipment shall be positioned so that it is free standing and does not come in rigid contact with the building structure or other systems.
- B. Mounting Method Type A
 - 1. Floor mounted captive spring isolators for seismic and restrained service.

2. Snubbing shall take place in all modes with adjustment to limit upward, downward, and horizontal travel to a maximum of ¼ inch before contacting snubbers.
 3. Leveling bolts for rigid bolting to equipment.
 4. Ports for spring inspection.
 5. Minimum of ¾" thick neoprene pad between the concrete housekeeping pad and the bottom of isolator.
 6. Mason Industries type SLR, or approved equal.
- C. Mounting Method Type B
1. Hanger rod spring isolators.
 2. 45° slack seismic restraint cables.
 3. Neoprene spring cup with a projecting bushing to prevent steel to steel contact.
 4. Steel retainer box encasing the spring and neoprene spring cup.
 5. Rod shall be able to swing 30° before contacting resilient bushing.
 6. Mason Industries type HD neoprene hanger and Type SCB seismic cable brace, or approved equal.
- D. Mounting Method Type C
1. Floor mounted bridge bearing neoprene mounts with all directional seismic capability.
 2. Two (2) separated and opposing molded bridge bearing neoprene elements contained in a ductile iron casting.
 3. Mounting holes in bottom plate for bolting to the concrete housekeeping pad.
 4. Mason Industries type BR, or approved equal.

2.2 MANUFACTURERS

- A. Manufacturer of vibration isolation and seismic control equipment shall have the following responsibilities:
1. Determine vibration isolation and seismic restraint sizes and locations.
 2. Provide vibration isolation and seismic restraints as specified.
 3. Provide calculations and materials if required for restraint of unisolated equipment.
 4. Provide installation instructions, drawings, and trained field supervision to insure proper installation and performance.
- B. Acceptable Manufacturers.
1. Amber/Booth Company
 2. Mason Industries
 3. Ace Mountings Co.
 4. Vibration Eliminator Co., Inc.
 5. Kinetics Noise Control.

PART 3 - EXECUTION

3.1 GENERAL

- A. Installation shall be in strict accordance with the seismic restraint calculations and the manufacturer's installation instructions.
- B. Verify that the mounting methods provide the required vibration isolation and seismic restraint and that there are no vibration short circuits.

- C. Conduit connected to rotating or vibrating equipment shall be flexible metal conduit or liquid tight flexible conduit. Any conduits that are supported by the building shall have resilient hangers or supports to isolate vibrations.
- D. All conduits connecting to switchboards close coupled to substations shall be supported by resilient supports with a minimum 0.5" static deflection.

3.2 MOUNTING SCHEDULE

Equipment	Mounting Method	Static Deflection
Engine Generator Set	A	3.0 inches
Dry Type Transformers-Suspended	B	1.0 inch
Dry Type Transformers, UPS Equipment, Dimmer Racks-Floor Mounted	C	1.5 inches

3.3 INSPECTION

- A. On completion of the installation of all vibration isolation and seismic restraint devices herein specified, the local representative of the isolation materials manufacturer shall inspect the complete system and report in writing any installation errors, improperly selected isolation or restrain devices, or other faults that could affect the performance of the systems. Contractor shall submit a report to the Architect, including the manufacturer's representative's final report, indicating all isolation reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.

END OF SECTION

SECTION 260573
POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide computer-based, fault-current and overcurrent protective device coordination studies and arc flash protection study of all electrical equipment indicated on the Contract Documents.

1.2 WORK INCLUDED

- A. The work includes "the power system studies" of the following:
 - 1. Short circuit studies
 - 2. Protection device evaluation studies
 - 3. Protection device coordination studies
 - 4. Arc flash studies
- B. The power system studies includes the following:
 - 1. Normal 13.2 kV Service Switchgear
 - 2. Normal 13.2 kV/480-277V Substation
 - 3. Standby 13.2 kV Automatic Paralleling and Synchronizing Switchgear
 - 4. 13.2 kV Standby Generators
 - 5. 13.2 kV Automatic Transfer Switches
 - 6. 480/277V Life-Safety Generator
 - 7. 480/277V Life-Safety Switchboard
 - 8. 480/277V Automatic Transfer Switches
- C. Overcurrent Protective Device Coordination: All overcurrent protective devices (OCPD) proposed for this project shall be selected to be selectively coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for all branches of both normal and emergency power. Best available settings shall be provided for the normal power system. Emergency power coordination shall coordinate to a level of 0.1 seconds.
- D. Delegated Design for Arc Flash Hazard Analysis: Prepare a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3 DEFINITIONS

- A. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- B. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- C. SCCR: Short-circuit current rating.

- D. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- E. PPE: Personal protective equipment.

1.4 SUBMITTALS

- A. The following submittals shall be made for system protective devices specified in all electrical specification sections. The release of electrical equipment submittals (panelboards, engine generators, switchboards, bus ducts, fused switches, circuit breakers, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Engineer requires a full submittal review period as delineated within these specifications to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by the project requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor's failure to coordinate simultaneous action submittals will not be considered by the Owner. The following submittals shall be in digital and hard copy form:
 - 1. Coordination-study input data, including completed computer program input data sheets. Provide editable electronic media, including all SKM files and breaker TCC's.
 - 2. Study and Equipment Evaluation Reports.
 - 3. Coordination-Study Report, signed, dated, and sealed by a qualified professional engineer in the state of the project.
 - 4. Arc-flash study input data, including completed computer program input data sheets.
 - 5. Arc-Flash Hazard Analysis Report; signed, dated, and sealed by a qualified professional engineer in the state of the project.
- B. Product Data: For computer software program to be used for the studies.
- C. Qualification Data: For Coordination Study Specialist and Arc-Flash Hazard Analysis Specialist.
- D. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399. For arc-flash analysis software, certifying compliance with IEEE 1584 and NFPA 70E.
- E. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.
- F. Operation and Maintenance Procedures: Provide maintenance procedures for use by the Owner's personnel that comply with requirements in NFPA 70E.

1.5 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this section. Manual calculations are not acceptable.
- B. Delegated Design System Study Specialist Qualifications: Comprehensive engineering analysis by a qualified Professional Engineer or personnel trained and employed by the equipment manufacturer in required calculation methodology.
 - 1. Analysis shall be performed by a Professional Engineer or personnel trained, employed, and supervised by a registered Professional Engineer.
 - 2. Registered professional engineer shall be a full-time employee of the electrical equipment manufacturer or a professional engineering firm.

- 3. Report shall be signed and sealed by a Professional Engineer with current registration in the state of the project.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.
- E. Comply with IEEE 1584 for Guide for Performing Arc Flash Hazard Calculations.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Computer Software Developers: Subject to compliance with requirements, provide products by the following:
 - 1. SKM Systems Analysis, Inc.
 - 2. EDSA Micro Corporation.
 - 3. ESA Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399 for fault-current and overcurrent protective device coordination studies.
- B. Comply with IEEE 1584 and NFPA 70E for arc-flash hazard analysis.
- C. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate coordination by computer-generated, time-current coordination plots.

2.3 SHORT-CIRCUIT STUDY REPORT CONTENT

- A. Executive Summary
- B. Study descriptions, purpose, basis and scope of the study.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Cable size and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, and panelboard designations.
 - 6. For both normal and emergency and standby power systems.
 - 7. Automatic Transfer Switches.
 - 8. Fused switches and circuit breakers
- D. Study Input Data: As described in "Power System Data" Article
- E. Short-Circuit Study Output:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.
 - h. Incident Energy and Flash Protection Boundary Calculations
 2. Arcing fault magnitude.
 3. Protective device clearing time.
 4. Duration of arc.
 5. Arc-flash boundary.
 6. Working distance.
 7. Incident energy.
 8. Hazard risk category.
 9. Recommendations for arc-flash energy reduction.
- F. Fault study input data, case descriptions, and fault-current calculations, including a definition of terms and guide for interpretation of the computer printout.
- G. Equipment specific Arc Flash Warning Labels.
- H. Recommendations for system improvements, where needed.

2.4 ARC-FLASH WARNING LABELS

- A. Provide a 3.5-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis.
- B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the final arc-flash hazard analysis.
1. Flash Hazard Boundary
 2. Short Circuit Current Available
 3. Shock Hazard when Cover is Removed
 4. Limited Approach Boundary
 5. Restricted Approach Boundary
 6. Prohibited Approach Boundary
 7. PPE Requirements, including the following:
 - a. Hazard Risk Category
 - b. Required Minimum Arc Rating of PPE in cal/cm²
 - c. Clothing Description
 8. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field-applied markings.
- D. Labels shall provide all flash boundaries, flash hazard levels, voltage levels, shock hazards and recommended PPE.

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.
 - 1. Proceed with coordination study and arc-flash study only after relevant equipment final submittals have been assembled, but prior to their submission to the Engineer.
 - a. Coordination study shall accompany submission of relevant equipment submittals.

3.2 POWER SYSTEM DATA

- A. Delegated Design System Analyst performing the short circuit, protective device coordination study, and arc-flash hazard analysis shall furnish the Contractor with a list of required data immediately after award of the contract. Contractor shall expedite collection of the data to ensure completion of the study and analysis, as required.
- B. For new equipment, use characteristics of the final submitted shop drawing for all equipment. For existing equipment, this Contractor shall field verify all required equipment ratings and characteristics needed for completing the studies.
- C. Source combination shall include present and future motors and generators indicated in the Contract Documents.
- D. Include fault contribution of existing motors in the study and analysis.
- E. Gather and tabulate the following input data to support coordination study:
 - 1. Product Data for overcurrent protective devices specified in these specifications 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 the incoming utility service entrance.
 - 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit breakers and fuses 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, X/R ratios, taps measured in per cent, and phase shift.
 - d. Generator short-circuit current contribution data, including short-circuit reactance, rated kilovolt amperes, size, rated voltage, and X/R ratio.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material insulation, and length.
 - f. Busway ampacity, impedance, lengths, and conductor material.
 - g. Motor horsepower and code letter designation according to NEMA MG 1.
 - h. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
 - i. Medium-voltage cable sizes, lengths, conductor material, and conductor construction and metallic shield performance parameters.
 - 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 capacity.
- 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 the utility company's overcurrent protective devices.
- f. Special overcurrent protective device settings or types stipulated by the utility company.
- g. Time-current-characteristic curves of devices.
- 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. A short-circuit current ratings indicated in the Contract Documents are based on Fault-Current study prepared by the Engineer during design and are based on available information and anticipated feeder lengths. Calculate the maximum available short-circuit current in amperes RMS symmetrical at circuit-breaker positions of the electrical power distribution system based on proposed feeder routing and actual equipment being proposed for the project. The calculation shall be for a current immediately after initiation and for a three-phase bolted short-circuit at each of the following:
 1. Electric Utility's supply termination point.
 2. Switchgear and switchboard buses.
 3. Transformers.
 4. Distribution panelboards.
 5. Branch circuit panelboards.
 6. Standby Generators and Automatic Transfer Switches.
 7. Enclosed Fused Switches.
 8. Enclosed Circuit Breakers.
- B. Study electrical distribution system from normal and emergency power sources throughout electrical distribution system for the Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculate short-circuit currents according to IEEE 551.
- E. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.
 1. Transformers, as appropriate for transformers included in the project:
 - 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.
- F. Study Report:
- 1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
- G. Equipment Evaluation Report:
- 1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated ½-cycle symmetrical fault current.
 - 2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to ½-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 ½-cycle symmetrical fault current.
 - 4. Notify the Engineer, in writing, of any existing circuit protective devices improperly rated for the calculated available fault current.

3.4 COORDINATION STUDY

- A. Provide a 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 ½-cycle short circuit currents.
 - 2. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 241 and IEEE 242 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
- 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short circuit current.
- E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
- 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.

- b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve 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.
 - h. Motor starting characteristics, damage points and overload relay.
 - i. Thermal damage curve for motors larger than 100 HP.
 - j. Generator short circuit decrement curve and damage point, and thermal damage curve.
- F. Completed data sheets for setting of overcurrent protective devices.
- G. Complete Schedule of breaker settings to summarize information contained on data sheets. Sample schedule has been included at the end of this section for preferred format.

3.5 ARC FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system where work could be performed on energized parts, including, but not limited to, the following:
- 1. Disconnect switches.
 - 2. Electrical substations.
 - 3. Electrical switchgear and switchboards.
 - 4. Emergency system boxes and enclosures.
 - 5. Enclosed circuit breakers.
 - 6. Meter Sockets and assemblies.
 - 7. Motor starter.
 - 8. Panelboards.
 - 9. Power transfer equipment (ATS).
 - 10. Transformers.
 - 11. Emergency Generator.
 - 12. Variable frequency drive
- C. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short circuit and coordination study model. Ground overcurrent protection relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.
- D. Calculate the arc-flash protection boundary and the corresponding incident energy calculations for multiple system scenarios to be compared and the greatest incident energy to be uniquely

reported for each equipment location. Calculations shall be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions.

1. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off).
 2. The maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.
- E. Incident energy calculations shall consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators to be decremented as follows:
1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
 2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible.
- F. For each equipment location with a separately enclosed main device, calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
1. When performing incident energy calculations on the line side of a main breaker, the line side and load side contributions must be included in the fault calculation.
- G. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device to compute the incident energy for the corresponding location.
- H. Arc Flash calculation shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash even, a maximum clearing time based on the specific location shall be utilized.
- I. Complete Arc Flash report shall be used for the preparation of Arc Flash Warning labels for electrical equipment.
- J. Provide an 8-hour instructor led Electrical Safety Training Course which includes NFPA 70E materials, including the selection of personal protective equipment. The training shall be certified and provided by an OSHA authorized Instructor.

3.6 CORRECT DEFICIENCIES, RE-CALCULATE AND REPORT

- A. After the Engineer's initial review, correct unsatisfactory conditions and recalculate to demonstrate compliance, resubmit overcurrent protective devices, as required, to bring the system into compliance.
- B. Revise and resubmit report multiple times, as necessary, to demonstrate compliance with requirements.

3.7 APPLICATION OF WARNING LABELS

- A. Install arc-flash warning labels under the direct supervision and control of the Arc-Flash Hazard Study Specialist.

3.8 FIELD ADJUSTMENTS

- A. The contractor and equipment vendors shall adjust relay and protective device settings according to the recommended settings provided by the coordination study. This shall be performed prior to equipment being energized.

END OF SECTION

SECTION 260800

COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. General

1. Work under this contract shall conform under requirements of Division 1, General Requirements, Conditions of the Contract, and Supplementary Conditions. This specification covers commissioning of the Electrical systems which are part of this project.
2. Furnish labor and material to accomplish complete electrical commissioning as specified herein.

- B. Commissioning work shall be a team effort to ensure that all Electrical equipment and systems have been completely and properly installed, function together correctly to meet the design intent, and document system performance parameters for fine tuning of operational procedures. Commissioning shall coordinate system documentation, equipment start-up, system calibration, testing and balancing, and verification and performance testing.

- C. The Commissioning Team shall be made up of representatives from the user, design professionals, major equipment suppliers, and construction trades. The sub-contractors and equipment suppliers represented on the commissioning team shall include, but not be limited to, switchgear, emergency generator system, test and calibration, fire alarm system manufacturer, lighting control manufacturer, electrical trade, and the BMCS contractor. The lead person for each firm who will actually perform or supervise the work shall be designated and be the representative to the commissioning team. Responsibility for various steps of the commissioning process shall be divided among the members of the commissioning team, as described in this section.

- D. The Commissioning Authority, retained by the Owner, shall have responsibility for coordinating and directing each step of the commissioning process.

- E. Electrical system installation, development of installation checklist, start-up, testing, calibration, preparation of O&M manuals, and operator training are the responsibility of this Contractor, with coordination, observation, verification and commissioning the responsibility of the Commissioning Authority. The commissioning process does not relieve this Contractor from the obligations to complete all portion of work in a satisfactory and fully operational manner.

F. Definitions

1. Commissioning: the process of ensuring that systems are designed, installed functionally tested and capable of being operated and maintained to perform in conformity with the design intent. For this project, the commissioning includes construction, start-up, acceptance, and training.
2. Commissioning authority: the designated person, company, or agent, retained by the Owner, who implements the overall commissioning process.
3. Commissioning Plan: A document defining the commissioning process, which is developed by the commissioning authority.
4. Commissioning report: the document that records the results of the commissioning process, including the as-built performance of the Electrical system and documents all sign-offs.

5. Commissioning specification: the Contract Document that details the objective, scope, and implementation of the construction and acceptance phases of the commissioning process as developed in the Commissioning Plan.
6. Commissioning team: those people responsible for working together in carrying out the commissioning process.
7. Functional performance testing (FPT): the process of determining the ability of the Electrical system to deliver services in accordance with the final design intent.
8. Design Professional: the Owner's Architectural, Engineering and Other Consultants who prepared the Contract Documents.
9. Verification: that full range of checks and tests carried out to determine if all components, subsystems, systems, and interfaces between systems operate in accordance with the Contract Documents. In this context, "operate" includes all modes and sequences of control operation, interlocks and conditional control responses, and specified responses to abnormal or emergency conditions.

G. Purpose

The commissioning is a process and its purpose is:

1. to clearly document the design intent
2. to verify that the systems installation and performance is in accordance with the plans, specifications and design intent.
3. to train the user's operators so that they fully understand the design intent and the operation and maintenance requirements of the equipment.

1.2 SCOPE OF WORK

A. Commissioning work of this Division shall include, but not be limited to:

1. Testing and start-up of the equipment.
2. Testing, adjusting and calibration of electrical equipment.
3. Cooperation with the Commissioning Authority.
4. Providing qualified personnel for participation in commissioning tests.
5. Providing equipment, materials, and labor as necessary to correct construction and/or equipment deficiencies found during the commissioning process.
6. Providing operation and maintenance manuals, and as-built drawings to the Commissioning Authority for verification.
7. Providing training and demonstrations for the systems specified in this Division.

B. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems, and sub-systems. The following equipment and systems shall be evaluated:

1. Wire and cable (600 volts and below).
2. Bus ducts.
3. Motor controllers and motor control centers, including variable frequency drives.
4. Engine generator(s) system and associated automatic transfer switches and switchboards.
5. Switchboards.
6. Life safety system (fire alarm).
7. Freeze protection.
8. Lightning protection system.
9. Transformers.
10. Ballasts.
11. UPS and PDU.
12. Emergency battery system and integral battery packs.
13. Grounding.

14. Lighting Control Systems.
- C. Timely and accurate documentation is essential for the commissioning process to be effective. Documentation required as part of the commissioning process shall include but not be limited to:
 1. Progress and status reports, including deficiencies noted.
 2. Minutes from all meetings.
 3. Pre-start, and start-up procedures.
 4. Training agenda and materials.
 5. As-built records.
 6. Commissioning report.
 7. Operational and maintenance (O&M) manuals.
- D. Detailed testing shall be performed on all installed equipment and systems to ensure that operation and performance conform to the Contract Documents. All tests shall be witnessed by the Commissioning Authority. The following testing is required as part of the commissioning process:
 1. Verification tests are comprised of a full range of checks and tests to determine that all components, equipment, systems, and interfaces between systems operate in accordance with the Contract Documents. This includes all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions.
 2. Functional performance tests (FPT) shall determine if the Electrical system is providing the required services in accordance with the finalized design intent.
- E. Comprehensive training of O&M personnel shall be performed by the Electrical Contractor, and where appropriate by other sub-contractors, and vendors prior to turnover of the building to the User. The training shall include classroom instructions, along with hands-on instruction on the installed equipment and systems. All training sessions shall be videotaped (or recorded on alternative audiovisual media) and turned over to the Users and Owner.

1.3 QUALITY ASSURANCE

- A. Commissioning Authority shall meet the following qualifications:
 1. Have a minimum of five (5) years of demonstrated commissioning authority experience in the commissioning of Electrical Systems similar in size and complexity to this Project.
 2. Commissioning Authority shall hold a Certified Commissioning Professional (CCP) designation from the Building Commissioning Association.
- B. The following reference is a guideline to the Commissioning process and shall be as applied as appropriate.
- C. References:
 1. ASHRAE Guideline 1-1996: The HVAC Commissioning Process
 2. ASHRAE Application Handbook – 1995: Chapter 39 – Building Commissioning.
 3. ASHRAE Guideline 4-1993: Preparation of Operating and Maintenance Documentation for Building Systems.

1.4 ROLES AND RESPONSIBILITIES

- A. User
 1. User will advise the Commissioning Authority regarding changes in the building occupancy and/or usage.

2. Assign maintenance personnel and schedule them to participate in meetings, training session as follows:
 - a. Construction Phase coordination meetings.
 - b. Initial User training session at initial placement of major equipment.
 - c. Maintenance orientation and inspection meetings.
 - d. Procedures meetings for Testing, Adjusting and Balancing.
 - e. Users training sessions.
 - f. Verification demonstrations.
 - g. Final review at acceptance meetings.
3. Provide qualified personnel for videotaping and editing of training sessions.
4. Video tape construction process, hidden shafts, etc.
5. Provide any utilities required for the commissioning process.
6. Provide detailed program clearly stating the User's objectives, parameters, budgets, etc. for this facility.

B. Commissioning Authority

1. Develop the commissioning requirements and all related testing, verification and quality control sections.
2. Prepare the commissioning program required as part of the Commissioning Specification. Include lists of all contractors for commissioning events by name, firm, and trade specialty.
3. Develop detailed pretest and final test reports forms to be used by the Commissioning Authority for data recording purposes throughout the testing process. The Commissioning Authority shall specifically develop these forms for each system and piece of equipment stalled on the project. All forms shall be submitted for approval a minimum of one hundred and twenty (120) days prior to initial testing.
4. Execute the commissioning program, through organization of all tests, meetings, demonstrations, training events and performance verifications described in the Contract Documents and the approved commissioning program. Organizational Responsibilities include preparation of agendas, attendance lists; arrangements for facilities and timely notification to participants for each commissioning event. The Commissioning Authority shall act as chairman at all commissioning events and assure the execution of all agenda items. The Commissioning Authority shall prepare minutes of every commissioning event and send copies to all those in attendance and the User within five (5) workdays of the event.
5. Review the Contract Documents define the scope of the commissioning process and the final performance of the system. This include verification that appropriate commissioning guidelines have been followed, and to document the performance of each piece of equipment and each system.
6. Review all approved submittals for coordination with the commissioning process and the performance testing within these specifications.
7. Schedule regular Construction Phase coordination meetings to include the User, Landlord and Contractor. This meeting shall be for the purpose of reviewing the complete commissioning program and establishing tentative schedules for electrical system orientation and inspections, O&M submittals, training sessions, system testing, job completion, test, adjust and calibration (TAC) work and verification and functional performance testing.
8. Schedule User training sessions so that they will be held at an appropriate timeframe relative to the turnover to the User. These sessions shall be attended by the User's O&M personnel, the Contractor, and the Commissioning Authority.
9. The Commissioning Authority shall be solely responsible for conducting and recording the results of periodic inspections, undertaken by the Commissioning Authority, of work in progress to ensure that all systems are installed according to specifications. The Commissioning Authority shall note any deficiencies discovered in writing. Once the

- deficiencies have been corrected, as reported by the Contractor, the Commissioning Authority shall re-inspect the work and report that the corrections have been made.
10. The Commissioning Authority shall assist the Contractor in recommending solutions to minor deficiencies.
 11. Receive and review the Operation and Maintenance (O&M) manuals as submitted by the contractor, and reviewed by the Design Professional.
 12. Witness equipment and system start-up and testing. Ensure the results are documented (including a summary of deficiencies), and incorporated in the O&M manuals. The Commissioning Authority shall record all test results on pre-test and final test forms for each piece of equipment.
 13. Prior to initiating the TAB work, the Commissioning Authority shall meet with the User, Contractor, and TAB Contractor. The TAB Contractor shall outline TAB procedures and get concurrence from the Design Professional and Commissioning Authority. Ensure that the TAB Contractor has all forms required for the job database and understands their importance and use.
 14. Schedule the O&M training sessions. All training sessions shall be on-site, except where otherwise specified. These training sessions are to be attended by the User, Commissioning Authority, the Contractors and equipment suppliers as required by the Contract Documents. The format shall follow the outline in manuals. This electrical system orientation and inspection should include hands on training. The Commissioning Authority shall be solely responsible for recording all demonstration and training sessions on videotape, or alternative approved media, and furnish two (2) copies of the recording media to the User. Each session shall clearly reflect the content of each training session. Video tapes or other approved media and enclosures shall be neatly labeled.
 15. Provide detailed FPT procedures for review by the Design Professional.
 16. Upon receipt of notification from the Contractor that the systems have been completed and are operational, the Commissioning Authority shall proceed to verify the TAB report and operation of the control systems in accordance with the Commissioning Specification.
 17. Conduct Verification tests.
 18. Record verification test data.
 19. Provide detailed checklists data sheets to document verification tests.
 20. Provide and install calibrated test instrumentation to monitor and record data as necessary.
 21. The Commissioning Authority shall document the results of all Functional Performance Testing.
 22. Observe and record Functional Performance Tests.
 23. Submit functional performance test report.
 24. Participate in re-testing, if necessary, if performance deficiencies are found, corrected and additional testing is requested.
 25. Review as-built drawings for accuracy with respect to installed systems. Review revisions to achieve accuracy.
 26. Ensure that the O&M manuals and all other as-built records have been updated to include all modifications made during the construction phase.
 27. Observe and record repeated Functional Performance Tests to accommodate seasonal tests and correct any performance deficiencies. Revise and re-submit the commissioning report.
 28. Prepare the final commissioning report.
 29. Assemble the final project documentation, which shall include the commissioning report and all as-built records. Submit this documentation to the User for review and acceptance.
 30. The CA shall verify that all O and M manuals; "as-built" documentation and training manuals and sessions are complete in every aspect and in accordance with the project specifications. The CA shall supplement the above documentation, as required, to make them complete.

C. Architect

1. Provide support to the Design Professional who must provide a service as a part of the commissioning process. This shall include providing adequate space for equipment installation and maintenance.
2. Conduct periodic inspections of work in progress to ensure that all systems and equipment are installed according to the specifications.

D. Electrical Design Professional

1. Provide Contract Documents.
2. The Design Professional retains responsibility for the system evaluation, adequacy of the system to meet design intent, capacity of the system, quality control check or any of the other elements of the system design.
3. Participate in inspections at the final construction stage.
4. Review verification and functional performance testing procedures submitted by the Commissioning Authority, for conformance with the Contract Documents.
5. Review TAC report and verification data sheets for system conformance to the Contract Documents. Issue a report noting deficiencies requiring correction to the Commissioning Authority.
6. Review functional performance testing report for deficiencies in meeting the finalized design intent.
7. Review as-built records as required by the Contract Documents and turn them over to the Commissioning Authority for inclusion in final project documentation.
8. Review and comment on the final commissioning report.

E. Mechanical Design Professional

1. Provide documentation or design narratives for mechanical services to be provided for specific Electrical equipment requirements.
2. Provide mechanical system information confirming compatibility with electrical service requirements specified by the electrical design professional for all electric equipment and systems. Provide information necessary for the basis of design.
3. Prepare Contract Documents that coordinate interfaces between life safety systems, HVAC systems and BMCS systems including commissioning specifications.
4. Attend construction phase coordination meeting scheduled by the Commissioning Authority.
5. Participate in the start-up of equipment and systems.
6. Participate in the electrical training sessions as required.
7. Participate in review of shop drawings for electrical equipment.
8. Prepare HVAC ladder wiring diagrams indicating power source connections to HVAC equipment and systems and interrelationships between life safety systems and HVAC systems and equipment, including a review of the automatic control and/or building automation system.
9. Prepare as-built mechanical service record drawings as required by the Contract Documents.
10. Verify that any space requirements for mechanical equipment are in accordance with relevant code requirements.
11. Participate in O&M personnel orientation and inspection sessions.

F. General Contractor

1. Include cost for commissioning requirements in the contract price
2. General Contractor shall coordinate the construction progress with the commissioning schedule to assure that the building envelope and systems that affect proper operation of electrical equipment and systems being tested are completed prior to testing.

3. Include commissioning requirements in the mechanical, electrical, and BMCS contracts, as well as all other sub-contractors, to ensure cooperation of all parties in the electrical commissioning program.
4. Ensure acceptable representation, with the means and authority to prepare and coordinate execution of the electrical commissioning program as described in the Contract Documents.
5. Issue a statement that TAC work has been completed, and submit the final TAC reports for review.
6. Issue a statement that systems have been calibrated.
7. Remedy deficiencies identified in verification tests.
8. Evaluate any performance deficiencies identified in the FPT report for non-performance with the Contract Documents.
9. The equipment suppliers shall document the performance of his equipment. Performance testing shall be witnessed by the Commissioning Authority.

G. Electrical Contractor

1. Include cost of the commissioning requirements in the contract price.
2. Include requirements for submittal data, O&M data, and training in each purchase order or sub-contract written.
3. Ensure cooperation and participation of specialty subcontractors such as fire alarm system and TAC.
4. Ensure participation of major equipment manufacturers in appropriate training and testing activities.
5. Attend construction phase coordination meetings scheduled by the Commissioning Authority.
6. Assist the Commissioning Authority in all verification and functional performance tests.
7. Prepare preliminary schedule for electrical system orientations and inspections, O&M manual submissions, training sessions, equipment start-up; TAC and task completion for use by the Commissioning Authority. Update the schedule as appropriate throughout the construction period.
8. Attend initial training session.
9. Conduct electrical system orientation and inspection at the equipment placement completion stage.
10. Continuously update drawings to the record condition to date, and review with the Commissioning Authority.
11. Gather O&M data on all equipment, and assemble in binders as required by the Commissioning Specification. Submit to Commissioning Authority prior to the completion of construction.
12. Coordinate with the Commissioning Authority to provide sufficient advance notice so that the witnessing equipment and system start-up and testing can begin.
13. Notify the Commissioning Authority a minimum of two (2) weeks in advance of the time for start of the TAC work. Attend the initial TAC meeting for review of the official TAC procedures.
14. Participate in, and schedule vendors and Contractors to participate in the training sessions as set up by the Commissioning Authority.
15. Provide written notification to the General Contractor/CM and Commissioning Authority that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.
16. The equipment supplier shall document the performance of his equipment. Performance testing shall be witnessed by the Commissioning Authority.
17. Provide a complete set of as-built drawings and records to the Commissioning Authority.

H. Test, Adjust, and Calibration Contractor

1. Include costs for commissioning requirements in the contract price.

2. Attend initial commissioning coordination meeting scheduled by the Commissioning Authority.
 3. Submit the TAC procedures to the Commissioning Authority and Design Professional for review.
 4. Attend the TAC review meeting scheduled by the Commissioning Authority. Be prepared to discuss the procedures that shall be followed in testing, adjusting, and calibration of the electrical system.
 5. At the completion of the TAC work, and the submittal of the final TAC report, notify the Electrical Contractor and the General Contractor/CM.
 6. Participate in training sessions as scheduled by the Commissioning Authority.
 7. At the completion of TAC work, and the submittal of the final TAC report, notify the Electrical Contractor and the General Contractor/CM.
 8. Participate in verification of the TAC report, which will consist of repeating any selected measurement contained in the TAC where required by the Commissioning Authority for verification or diagnostic purposes.
 9. The equipment supplier shall document the performance of his equipment. Performance testing shall be witnessed by the commissioning authority.
- I. Equipment Suppliers and Miscellaneous Contractors.
1. Include cost for commissioning requirements in the contract price.
 2. Provide submittals, and appropriate O&M manual section(s).
 3. Attend initial commissioning coordination meetings scheduled by the Commissioning Authority.
 4. Participate in training sessions as scheduled by the Commissioning Authority.
 5. Demonstrate performance of equipment as applicable.
- J. Mechanical Contractor
1. Include costs for commissioning requirements in the contract price.
 2. Include requirements for submittal data, O&M data, and O&M training in each purchase order or subcontract written.
 3. Enlist the support of the General Contractor/CM to ensure cooperation of other subcontractors such as the automatic controls and building automation systems contractor, as necessary.
 4. Ensure participation of major equipment manufacturers through their representatives.
 5. Ensure coordination, installation, and operation interfaces between life safety, HVAC systems, and BMCS Systems.
 6. Attend construction phase coordination meetings scheduled by the Commissioning Authority. Prepare necessary preliminary schedule for O&M personnel orientation and inspections, O&M manual submission, training sessions, equipment start-up, testing and adjusting, and job completion for use by the Commissioning Authority. Update the schedule throughout the construction period.
 7. Attend initial training sessions and conduct the mechanical system orientation and inspection at the equipment placement completion stage. Update drawings to record condition to date, and review with the Commissioning Authority.
 8. Gather O&M data on all equipment and assemble in binders as required by the commissioning specification. Submit to the Commissioning Authority prior to the completion of construction.
 9. Notify the Commissioning Authority of the item for each required test.
 10. Participate in and schedule equipment suppliers and contractors to participate in the training sessions as set up by the Commissioning Authority.
 11. Conduct a maintenance orientation and inspection with hands-on-training. Update drawings to record condition to date and review with the Commissioning Authority prior to the orientation.

12. Provide written certification to the General Contractor/CM and the Commissioning Authority that the work has been completed in accordance with the plans and specifications and that it is functioning as designed. Where the work has been subcontracted, this contractor shall be responsible for the initial certification, with the Electrical Contractor certifying that he/she has inspected the work and that it has been completed and is functioning as designed. This certification must be submitted to the Commissioning Authority prior to the final verification.
13. Demonstrate the operation of each piece of equipment to the Commissioning Authority. Schedule subcontractors as they apply to demonstrate the operation of the equipment and systems.
14. Turn over set of record mark-up drawings to the mechanical design professional for final incorporation into record documents.
15. Document the performance of all equipment. Performance testing shall be witnessed by the Commissioning Authority.

1.5 DOCUMENTATION

- A. The Commissioning Authority shall oversee and maintain the development of the commissioning documentation. The commissioning documentation shall be kept in three ring binders, and organized by system and sub-system when practical. All pages shall be numbered, and a table of contents page(s) shall be provided. The commissioning documentation shall include, but not be limited to, the following:
 1. Approved test and balance report for the systems being commissioned.
 2. All reviewed shop drawings of electrical equipment. Shop drawings shall be full size sheets folded as required to fit in binders.
 3. All pre-functional performance test checklists, signed by indicating personnel, organized by system and sub-system.
 4. All verification and functional performance test checklists/results, signed by indicated personnel, organized by system and sub-system.
 5. Three (3) copies of the operation and maintenance (O&M) manuals specified in other sections of these specifications shall be included with the commissioning documentation. The manuals shall be incorporated in the commissioning documentation prior to commencement of O&M training required in this and other sections of the specification. Preparation of O&M manuals shall be as specified in Part 3 of these specifications.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. The appropriate Contractor(s) shall furnish all special tools and equipment required during the commissioning process. A list of all tools and equipment to be used during commissioning shall be submitted to the Commissioning Authority for review. The User shall furnish necessary utilities for the commissioning process.

2.2 TEST EQUIPMENT – PROPRIETARY

- A. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the User upon completion of the commissioning process.

PART 3 - EXECUTION

3.1 GENERAL

- A. A pre-construction meeting of all commissioning team members shall be held at a time and place designated by the User. The purpose shall be to familiarize all parties with the commissioning process, and to ensure that the responsibilities of each party are clearly understood.
- B. The Contractor shall complete all phases of work so the systems can be started, tested, calibrated, and acceptance procedures undertaken. This includes the complete installation of all equipment, materials, conduit, wire, devices/controls, etc. per the Contract Documents and related directives, clarifications, and change orders.
- C. A commissioning plan shall be developed by the Commissioning Authority. The Contractor shall assist the Commissioning Authority in preparing the commissioning plan by providing all necessary information pertaining to the actual equipment and installation. If Contractor initiated system changes have been made that alter the commissioning process, the Commissioning Authority shall notify the User.
- D. Acceptance procedures are normally intended to begin prior to completion of a system and/or sub-systems, and shall be coordinated by this Contractor. Start of acceptance procedures before system completion does not relieve the contractor from completing those systems as per the schedule.
- E. The Commissioning Authority shall develop a detailed schedule for acceptance procedures and training. The Commissioning Authority shall work in a cooperative manner with the Contractor to assure that the commissioning process does not interfere with the completion of work in accordance with the overall schedule.

3.2 PARTICIPATION IN ACCEPTANCE PROCEDURES

- A. The Contractor shall provide skilled technicians to start-up and debug all systems within the electrical specifications. These same technicians shall be made available to assist the Commissioning Authority in completing the commissioning program. Work schedules, time required for testing, etc. shall be requested by the Commissioning Authority and coordinated by the contractor. Contractor shall ensure that the qualified technician(s) are available and present during the agreed upon schedules and of sufficient duration to complete the necessary tests, adjustments, and/or problem resolutions.
- B. System performance problems and discrepancies may require additional technician time, Commissioning Authority time, reconstruction of systems, and/or replacement of system components. The additional technician time shall be made available for subsequent commissioning periods until the required system performance is obtained.
- C. Qualifications of technicians shall include expert knowledge relative to the specific equipment involved and a willingness to work with the Commissioning Authority. Contractor shall provide adequate documentation and tools to start-up and test the equipment, system, and/or sub-system.

3.3 DEFICIENCY RESOLUTION

- A. In some systems, improper adjustments, misapplied equipment, and/or deficient performance under varying loads will result in additional work being required to commission the systems. This work shall be completed under the direction of the User, with input from the contractor, equipment supplier, and Commissioning Authority. Whereas all members shall have input and the opportunity to discuss, debate, and work out problems, the Design Professional shall have final jurisdiction over any additional work done to achieve performance.
- B. Corrective work shall be completed in a timely fashion to permit the completion of the commissioning process. Experimentation to demonstrate system performance may be permitted. If the Commissioning Authority deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the Commissioning Authority shall notify the User, indicating the nature of the problem, expected steps to be taken, and suggested deadline(s) for completion of activities. If the deadline(s) pass without resolution of the problem, the User reserves the right to obtain supplementary services and/or equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner shall be the contractor's responsibility.

3.4 ADDITIONAL COMMISSIONING

- A. Additional commissioning activities may be required after system adjustments, replacements, etc., are completed. The Contractor(s), suppliers, and Commissioning Authority shall include a reasonable reserve to complete this work as part of their contractual obligations.

3.5 ACCEPTANCE PROCEDURES

- A. Verification Tests
 - 1. Scope of verification tests
 - a. Operating tests and checks to verify that all components, equipment, systems, sub-systems, and interfaces between systems, operate in accordance with the Contract Documents. These tests are to include all operating modes, interlocks, specified control responses, specific responses to abnormal or emergency conditions, etc.
 - b. Verify the validity of the TAC report.
 - 2. Participants in verification tests
 - a. The Commissioning Authority shall be responsible for preparing the scope of these tests. The Commissioning Authority shall schedule the tests and assemble the commissioning team members who shall be responsible for the tests. Participating contractors, manufacturers, suppliers, etc. shall include all costs to do the work involved in these tests in their proposals. Following is a list of tasks and supporting information that shall be required.
 - b. Electrical Contractor – provide the services of a technician(s), electricians, including foremen, etc., who is (are) familiar with the construction and operation of the electrical systems. Provide access to the contract plans, shop drawings, as-built drawings, and equipment cut sheets, schematics, interfaces, interlocks, etc., of all installed equipment.
 - c. BMCS Contractor – provide the services of a controls engineer who is familiar with the details of the project. Provide details of the control systems, schematics, and a narrative description of control sequences of operation.
 - d. HVAC Contractor – provide a foreman HVAC/technician familiar with the construction and operation of the systems. Provide access to the contract plans, and all as-built schematics of sub-systems, interfaces, and interlocks.

3. Documentation and Reporting Requirements.
 - a. Provide checklists for each component, piece of equipment, system, and sub-system, including all interfaces, interlocks, etc. Each item to be tested shall have a different entry line with space provided for comments. Separate checklists shall be prepared for each mode of operation. Provide space to indicate whether the mode under test responded as required or not. Also, provide space for all necessary parties to sign off on each checklist.
 - b. All test procedures and data sheets shall be submitted to the design professional for review and acceptance.
4. Instrumentation
 - a. The Commissioning Authority shall furnish all measurement instrumentation for the verification tests. All instruments will have calibrated within the twelve-month period prior to these tests. Provide documentation of calibration.
5. Verification Procedures
 - a. The Commissioning Authority shall direct and witness the verification operating tests and checks for all equipment and systems.
 - 1) Set the system equipment (i.e., switchboard, generators, cable, bus duct, lighting controls, etc.) into the operating mode to be tested.
 - 2) The Commissioning Authority shall inspect and verify the position of each device and interlock identified on the checklist. Each item shall be signed off as acceptable (yes), or failed (no).
 - 3) This test shall be repeated for each electrical system being tested.
 - 4) Operating checks shall include all safety cutouts, alarms and interlocks with the life safety systems during all modes of operation of the electrical and mechanical systems.
 - 5) If during a test an operating deficiency is observed, appropriate comments shall be added to the checklist data sheet.
 - 6) Verification of the interface of the monitoring and control system, and the TAC criteria shall be included.
 - 7) Verification of the proper responses of monitoring and control system controllers and sensors shall be included.
 - b. The Commissioning Authority shall direct and witness the field verification of the final TAC report.
 - 1) The Commissioning Authority shall select, at random, ten (10) percent of the report data for verifications.
 - 2) The TAC contractor shall be given sufficient advance notice of the date of field verification. However, they shall not be informed in advance of the data points to be verified. The TAC contractor must use the same instruments (by model and serial number) that were used when the original data were collected.
 - 3) Failure of an item is defined as:
 - a) For all readings a deviation of more than ten (10) percent.
 - 4) A failure of more than ten (10) percent of the selected items shall result in the rejections of the final TAC report.
 - c. If the deficiencies are identified during verification, the General Contractor/CM must be notified, and action taken to remedy the deficiency. The final tabulated checklist data sheets shall be reviewed by the Design Professional and the Commissioning Authority, to determine if verification is complete, and the operating system is functioning in accordance with the Contract Documents.

B. Functional Performance Testing

1. Scope of Functional Performance Testing
 - a. Functional performance tests shall determine if the electrical systems are operating in accordance with the final design intent and in accordance with testing procedures outlined in the respective electrical specification sections.
2. Submittals
 - a. Detailed procedures for each series of tests shall be submitted to the Commissioning Authority for review and acceptance. The procedures shall include samples of the data sheets that will be part of the reports.
3. Participants in Functional Performance Tests
 - a. Participants in the functional performance tests shall be the same as those listed in the verification tests.
4. Instrumentation
 - a. In addition to the instrumentation requirements detailed under verification, the Commissioning Authority may need to provide data acquisition equipment to record data for the complete range of testing.
5. Functional Performance Test Procedures
 - a. The Commissioning Authority shall supervise and direct all functional performance tests.
 - b. For each test, the Commissioning Authority shall install the measuring instruments and logging devices to record test data for the required test period. The instrumentation shall monitor and record all operating conditions to allow for complete evaluation of the test results.
 - c. Measurement will be required to allow for calculation of total capacity of the system for each mode of operation under test.
6. Documentation and Reporting Requirements
 - a. All measured data, data sheets, and a comprehensive summary, describing the operation of the electrical system at the time of testing shall be submitted to the Commissioning Authority.
 - b. A preliminary functional performance test report shall be prepared by the Commissioning Authority and submitted to the Design Professional for review. Any identified deficiencies need to be evaluated by the Design Professional and GC/Construction Manager to determine if they are part of the contractor's contractual obligations. Construction deficiencies shall be corrected by the responsible contractor(s) and the specific functional performance test repeated.
 - c. If it is determined that the electrical systems are constructed in accordance with the Contract Documents, and the performance deficiencies are not part of the Contract Documents, the User must decide whether any required modifications needed to bring the performance of the electrical systems up to the finalized design intent shall be implemented, or if the tests shall be accepted as submitted. If corrective work is performed, the User shall determine if a portion or all required functional performance tests should be repeated, and a revised report submitted.

3.6 OPERATING AND MAINTENANCE MANUAL:

- A. The operating and maintenance manual shall consist of a sturdy binder with 8-½" x 11" sheets in accordance with the Contract Documents.

3.7 OPERATING AND MAINTENANCE TRAINING

- A. The Electrical Contractor, and appropriate sub-contractors, shall provide comprehensive operating and maintenance instruction on building systems in accordance with the Contract Documents prior to delivery. The instruction shall include classroom instruction delivered by competent instructors based upon the contents of the operating manual.
- B. Each classroom training period shall be followed by an inspection, explanation and demonstration of the system concerned by the instructors. All specified equipment shall be started up and shut down, with the exception of the sprinkler system.
- C. The Contractor shall be responsible for organizing, arranging, and delivering manner on a schedule agreeable to the User.
- D. The Contractor shall provide, at or before substantial completion, a proposed agenda and schedule of the above training for approval by the Commissioning Authority and the User.
- E. Each classroom training session and demonstration shall be recorded on videotape or alternative acceptable media and submitted to the User.

END OF SECTION

SECTION 260913

ELECTRICAL POWER MONITORING SYSTEM (EPMS)

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide an Electrical Power Monitoring System (EPMS) in accordance with the contract documents. Provide all materials, labor, and services required for installing EPMS in accordance with the intent of the Contract Documents and vendor provides documentation. This includes, but is not limited to, all conduits, networking equipment, labeling of equipment and wire runs, media conversion gateways, EPMS server, monitors, and other miscellaneous equipment. Furnish and install all incidental items not actually shown or specified, but which are required by good practice a complete, functional system.
- B. EMPS software/hardware/intergrator ventor shall be finished by the same manufacturer supplying the major standby and life-safety switchgears and paralleling switchgears sections.
- C. The installation of the EPMS shall include the following:
 - 1. Monitoring and control of the following:
 - a. 13.2 kV Automatic Paralleling and Synchronizing Switchgear.
 - b. 13.2 kV Standby Diesel Generators.
 - c. 13.2 kV Automatic Transfer Switches.
 - d. 480/277V Life-Safety Diesel Engine Generator and 480/277V ATS Switches.
 - e. 480/277V Life-Safety Switchboard.
 - f. 13.2 kV Outdoor Switches for Portable Resistive Load Bank.
 - g. 13.2 kV/480-277V Substation.
 - h. Existing 13.2kV/480-277V Substation (six (6) units).
 - i. Existing 13.2kV/480-277V Substations (six (6) units).
 - j. Existing 480/277V Life-Safety Diesel Engine Generator and existing 480/277V ATS Switches.
 - k. 13.2 kV Service Switchgear (Con Edison) six (6) feeder breakers.
 - 2. Monitoring only (no controls) of the following:
 - a. 13.2 kV Service Switchgear (Con Edison). (Six (6) input and six (6) output breakers associated with isolated transformers plus five (6) tie breakers).
 - b. 13.2 kV Delta/13.2 kV Wye Isolation Cast Coil Power Transformer (Con Edison).
 - c. 125 VDC Battery Systems.
 - 3. Mimic Panel for 13.2 kV Service Switchgear
 - a. For controls of the above service switchgear associated with Con Edison service shall be provided by the Mimic Panel, which shall be an independent system consisting of 3-position manual switches (controlling the breaker open, breaker closed, and DC power on) for input and output 13.2 kV breakers of the six (6) Con Edison services on primary and secondary of isolation transformers, plus five (5) tie circuit breakers of the "13.2 kV Service Switchgear" associated with Con Edison service.
Note: The Mimic Panel may also control the six (6) feeder breakers of the "13.2 kV Service Switchgear" assuming it is acceptable to Con Ed.
 - b. Mimic Board shall be provided as per Con Edison Standards and it shall be independent of the (EPMS).

4. Power Quality Meters

- a. Power Monitoring System shall include Power Quality Meters, as follows:
 - 1) 13.2 kV Service Switchgear (Section 261313): Provide one (1) Quality Meter at each feeder of Secondary Switchgear (total six (6)).
 - 2) 13.2 kV/480-277V Substation (Platform Substation): Provide one (1) Quality Meter for Primary Sections and one (1) for all main and feeders of the 480/277V Switchgear.
 - 3) New primary vacuum breakers associated with existing interior Level 5 West substations; one (1) per substation; total two (2) Quality Meters.
- b. Power Quality Meters shall continuously monitor the current per phase, real, reactive and apparent power, power factor, frequency sequence of events capture and recording, and operate through a Modbus RTU communications port, open protocol.
- c. Power Quality Meters shall be equal to:
 - 1) Siemens: Power Meter Sentron PAC 3200, Sentron PAC 4200, 9410..
 - 2) Eaton: Power Meter PXM2280, PXM2290).
 - 3) GE: Power Meter Model EPM 9650.
 - 4) ASCO: Power Quality Meter 5400.
Note: Any third party equipment will need to have an ASCO 5400 Series power quality meter mounted on it in order to communicate back to ASCO EPMS server, if ASCO EPMS is utilized.
 - 5) The power meter shall be able to be upgraded in the field without removing the meter.
 - 6) Provide power meters for all existing substations for installation by the Contractor under the supervision of EPMS manufacturer.

1.2 RELATED SECTIONS

- A. 261120 – 13.2 kV/480-277V Substation
- B. 261313 – 13.2 kV Service Switchgear (Con Edison)
- C. 261315 – 125 Volt DC Battery System
- D. 261316 – 13.2kV Outdoor Switches for Portable Load Bank.
- E. 262216 – 13.2 kV/13.2 kV Isolation Cast Coil Power Transformer
- F. 262313 – 13.2 kV Automatic Paralleling/Synchronizing Switchgear
- G. 262913 – 480/277V Life-Safety Switchboard
- H. 263213 – 480/277V Life-Safety Diesel Engine Generator
- I. 263214 – 13.2 kV Standby Diesel Engine Generators
- J. 263623 – 480/277V Automatic Transfer Switches
- K. 263625 – 13.2 kV Automatic Transfer Switches

1.3 RELATED DRAWINGS

- A. Electrical Power Monitoring System (Schematic Diagram).
- B. Electrical Power Monitoring System (Monitoring and Control Points).

1.4 DEFINITIONS

- A. Modbus RTU: An industry standard, high performance network communications protocol developed by Modicon.
- B. Open Protocol: A protocol which is published and used by other manufacturers and is, therefore, non-proprietary.
- C. RS 485 / EIA 485: A physical wiring standard for high speed, noise tolerant network communication often used with the Modbus RTU protocol.
- D. Ethernet: A high performance local area network standard providing the two lower levels of the ISO/OSI seven-layer reference model, the physical layer and the data link layer.
- E. Ethernet Gateway: A physical device that translates communications protocol to Ethernet communications protocol.
- F. Communications Protocol: A formal set of conventions governing the control of Inputs and Outputs within the communicating process.
- G. Client/Server architecture: A network architecture in which each computer on the network is either a Client or a Server. Servers are computers dedicated to acquiring, archiving, and displaying data. Clients are computers that present data from one or more Servers to the end user.
- H. OPC – OLE for Process Control. OPC is an open connectivity in industrial automation and the enterprise systems that support industry. Interoperability is assured through the creation and maintenance of open standards specifications.
- I. LAN: Local area network

1.5 SUMMARY

- A. This section includes the supply and installation of EPMS as detailed in the Drawings and as described in the Specifications.
- B. The Contractor shall furnish and install the equipment as specified herein.
- C. EPMS required components shall be provided to Equipment Manufacturers for mounting / installation.
- D. The EPMS vendor shall be the integrator / coordinator between all associated equipment vendors to ensure all equipment, Ethernet connectivity modules, meters and components are installed and programmed properly prior to the shipment of the equipment to the site.
- E. The contractor shall ensure all equipment in Related Sections are properly equipped as defined in this section. Equipment Manufacturers shall provide Ethernet with open modbus

protocol from each integral device to an aggregate Ethernet Switch. An open Ethernet Port shall be made available to connect to EPMS Ethernet network. Contractor shall coordinate with each equipment provider. In cases where only modbus/RS-485 is available, the contractor shall supply the EPMS vendor's Modbus Ethernet Module to convert RS-485 to Ethernet.

1.6 STANDARDS

- A. All equipment, material, work and testing supplied shall be in accordance with the latest edition and amendments of all applicable standards, codes, laws and regulations listed below:
1. American National Standards Institute (ANSI)
 2. Institute of Electrical and Electronics Engineers (IEEE)
 3. National Electrical Manufacturers' Association (NEMA)
 4. Local codes and laws.

1.7 SCOPE OF WORK

- A. General
1. The EPMS Contractor shall be responsible for the following:
 - a. Provide all materials, labor, and services required installing EPMS in accordance with the intent of the Contract Documents and vendor provided documentation. This includes but is not limited to all conduits, networking equipment, labeling of equipment and wire runs, media conversion gateways, EPMS Server, monitors, and other misc. equipment.
 - b. Furnish and install all incidental items not actually shown or specified, but which are required by good practice to provide a complete functional system.
 - c. Coordinate the details of facility equipment and construction for all specification Divisions, which affect the work covered under this Division.
 - d. Coordinate all activities with the overall construction schedule.
 - e. Develop bill of materials, perform material management and efficient use of the materials whether they are issued by Owner or purchased by the Contractor.
 - f. Ensure materials in excess of those required to complete the project are kept in their original condition and packaging for restocking.
 - g. Intent of Drawings: EPMS vendor network drawings are for reference. Drawings show only general locations of equipment, raceways, cable trays, wiring, etc.
 - h. The Contractor shall be responsible for the proper installation and routing of equipment, cable, raceways, cable tray, and related components according to the Contract Documents, vendor shop drawing requirements and subject to prior review by Owner and Engineer. Physical installation may deviate from vendor provided drawings, but Contractor must provide a fully functional EPMS that meets the technical requirements regardless of unanticipated changes that deviate from vendor drawings.

1.8 SUBMITTALS

- A. The Contractor shall submit the following information for review and approval:
1. System Description of the EPMS monitoring functionality and devices to be monitored.
 2. Any required equipment shutdowns, the duration of the shutdown, and projected schedule that is required shall be identified in the submittal.
 3. Projected project timeline shall be submitted to include site inspections, installation, equipment shutdowns, start up, commissioning, and training. The project timeline shall be submitted in the form of a Gantt chart. Any points on the timeline that requires the

approval of the owner and/or consulting engineer that may delay the project shall be clearly identified. Any other risks for delays in the project timeline or instances where the timeline may be improved shall be clearly identified.

4. Site Specific Network Drawings showing an overview of the network architecture for the EPMS. This is to include required EPMS hardware, networking components, and devices monitored. Cable types (CAT 5e/6, multi-mode fiber, RS-485, discrete wires) and connections are to be clearly identified.
5. A Points list for each device to be monitored as indicated on the Network drawings shall be provided.
6. A Preliminary Bill of Materials including EPMS hardware and software, networking components, engineering, training, and start-up required to meet the intent of the contract documents.
7. Cut sheets and/or drawings for all hardware being provided must be included. In instances where a cut sheet is not available, a detailed description of the device's functionality and mechanical drawings shall be provided.
8. Screen shots of the EPMS graphical user interface shall be available with descriptions explaining the screen and its functionality.
9. Any Optional equipment and/or devices to be monitored that the EPMS vendor feels can contribute additional value to functionality of the EPMS that are not included in the contract documents shall be listed in a separate section. The value creation of the additional hardware and/or engineering required for implementation shall be clearly described. The additional price impact to add each additional optional equipment and/or devices shall be clearly listed. No optional equipment and/or devices are assumed to be included in the base proposal to meet the contract documents. However, the Owner and/or Consulting engineer after review has the discretion to add any of the listed additional equipment and it is assumed all required provisions for the implementation has been fully accounted for in the listed pricing.
10. EPMS Installation manuals shall be provided that describes the process required for initial set up and installation of a fully functioning EPMS. The installation manual should be used to assist individuals who will install and connect the system, configure the system, and set up users and their access levels.
11. EPMS User Guides shall be provided that explains the functionality of the graphical user interface and user interactions with the EPMS software application. The User Guide should be used to assist individuals who will monitor the EPMS.
12. Software Licenses required and installed for the EPMS software application shall be listed.
13. Develop graphic screens and diagrams of the system and review with the Owner and Engineer prior to submission of sub-drawings for approval.

1.9 QUALITY ASSURANCE

- A. The EPMS vendor shall be a manufacturer of electrical power equipment with understanding and proven track record of the design and implementation of this type of product for at least 10 years.
- B. The Manufacturer shall be ISO 9001 certified.
- C. The EPMS provider shall maintain a national service organization of company-employed personnel located throughout the contiguous United States. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year. Must have service organization with at least 100 service personnel.
- D. A list of 5 customer sites with a fully functioning EPMS system shall be supplied.

- E. Two days of functional training shall be included in the proposal at the owner's location of the EPMS installation after a fully functioning EPMS installation. A Factory Authorized trainer from the Vendor shall be made available to demonstrate the system functionality, answer any questions, and provide training materials.

1.10 WARRANTY

- A. EPMS manufacturer warrants the equipment to be free from defects in material and workmanship for eighteen months from date of shipment, as per PowerQuest warranty publication, 3219.

PART 2 - PRODUCTS

2.1 EPMS SOFTWARE

- A. Manufacturers

- 1. Subject to compliance with requirements, provide a EPMS manufactured by:
 - a. ASCO Power Technologies
 - b. GE
 - c. Eaton
 - d. Siemens
 - e. Square D

- B. System Overview

- 1. The EPMS shall be a server-client based system providing monitoring, trending, event logging, automated reporting, and email notifications for specified equipment in the critical power distribution system without any further configuration or setup required after complete installation by the Contractor. The user interface will display dynamically adjust to the client's screens form-factor.
- 2. Minimum of (25) Clients shall be capable of remotely logging into the system.
- 3. Comply with NIST security standards using AES 128-bit encryption for security.
- 4. Secured HTTP (HTTPS) is supported utilizing client's own digital certificate.
- 5. Operating System Software: Based on 64-bit Microsoft Windows Server Operating System. Software shall have the following features:
 - a. Multiuser and multitasking to allow independent activities and monitoring to occur simultaneously at different workstations.
 - b. Graphical user interface to allow pulldown menus and a menu-free format.
 - c. Capability for future additions within the indicated system size limits.
 - d. Data can be brought up on multiple screens across the LAN using multi-level password protected access to data. In continuation the operator will be able to monitor and control from any location.
- 6. Peer Computer Control Software: Shall detect a failure of workstation and associated service and shall cause other workstations and associated server to assume control of all system functions without interruption of operation. Drivers shall be provided in both Central Computers to support this mode of operation.
- 7. The EPMS shall be capable of displaying a Dynamic One Line that includes change of color and state of devices as per Related Sections, but also real-time bus animation with a unique color for each source of power source, including each Utility source, each UPS battery source, and Emergency Generators. The Dynamic One Line will have full Pan and Zoom functionality.

8. An easily discernible audible alarm and a blinking visual alarm, easily viewable at a standard fixed location on commonly used screens without pop-up windows to impede user operations is required. Current alarms will be viewable from a single screen that groups at the user's request by either device type or alarm type and allows for user acknowledgement of active alarms.
9. Alarm notifications are distributed to configured users' email accounts into a single concentrated message containing the first alarm condition and all subsequent alarm condition till the expiration of a user defined consolidation timer. The timer will reset and sequence will start with the next alarm condition to occur.
10. An Event log shall provide a list of alarms by severity, alarm active time stamp, alarm deactivated time stamp and Alarm acknowledgement time stamp.
11. Provide a Modbus TCP/IP Ethernet Port for connection to BMS and other monitoring systems. All Data shall be accessible from a single Ethernet IP Address. Each individual Device shall be accessed by its own independent device address.
12. A repository for uploaded documents, drawings and user manuals that is accessible from any client computer shall be made available for the upload of documents.
13. Network Time Protocol synchronization shall be supported by the EPMS Server. Any monitored devices capable of supporting NTP Protocol shall also be time synched in order to maintain an accurate sequence of events.
14. A Diagnostic page shall provide detailed diagnostic information of sent and received data.
15. EPMS shall provide the following reports:
 - a. A Test and outage report shall be capable of automatically being generated when an outage occurs. ATS transfer time shall be logged and indicate a pass fail status when used for Joint Commission on Accreditation of Healthcare testing. Generator power loading graphs shall be provided with start time and run time of the engines. A pass fail status shall be indicated when used for Joint Commission on Accreditation of Healthcare testing. Outage Report will be automatically generated at the end of the test/outage event and saved on the server and automatically emailed to users.
 - b. An Energy usage and demand report provides energy consumption on a daily, weekly, or monthly interval. The data is populated into charts for each monitored device configured for the energy report. Report can be scheduled to generate once a week or month and emailed to users. Report can be downloaded and printed in various file formats, such as TIFF, PDF, RTF, Web Archive, Excel, CSV and XPS.
 - c. An Alarm report shall be provided capable of summarizing the top 10 alarms by equipment type, alarms for specified time period, and alarm details for monitored equipment. Report can be scheduled to generate once a week or month and emailed to users. Report can be downloaded and printed in various file formats, such as TIFF, PDF, RTF, Web Archive, Excel, CSV and XPS.
 - d. An Activity report that monitors logins, attempted logins, setting changes and user-initiated control tagged with user names shall be provided. User login names are hidden in this report to prevent from being distributed. Report can be scheduled to generate once a week or month and emailed to configured users. Report can be downloaded and printed in various file formats, such as TIFF, PDF, RTF, Web Archive, Excel, CSV and XPS.
 - e. A Settings report shall be capable of providing the network configuration the EPMS. The Device Name, Location, IP address and device address at a minimum must be made available. Report can be downloaded and printed in various file formats, such as TIFF, PDF, RTF, Web Archive, Excel, CSV and XPS.
 - f. A Historical Trend Dashboard capable of displaying (8) simultaneous parameters trending historical data from configured monitored devices shall be made available.

16. EPMS shall provide the following additional reports when equipped with ASCO 5400 Series Power Quality Meter:
 - a. A Fault Location report shall display the estimated distance from the main measurement node to the fault node. Graphical data shall include fault graphs, voltage and current waveforms and the distance graphs.
 - b. Event-based report shall include parameters selected by the user, based on either a schedule or event at any desired resolution including event logs, waveform, trend, and energy parameter aggregations.
 - c. Transient Report shall include the source, time of occurrence, duration and deviation to the threshold of all transients occurring within any pre-selected site and configuration.
 - d. Power quality compliance report shall be in accordance with EN50160 and include the limits, values and characteristics of voltage at the measured node.
17. Four Levels of Security Access shall be supported. Monitor, Control, Supervisor and Administrator level users shall have view only capabilities. Monitor shall be able to view-only, Control shall be able to view and control equipment, Supervisor shall be able to view and change settings, and Administrator shall have access to all-of-the above. For security purposes, All non-Monitor level users must be automatically logged out after a period of inactivity for security purposes

C. Interface Summary

1. Overview
 - a. System Overview shall show the basic status of monitored devices. Selecting any device shall navigate to that devices detail screen. An administrative and control level user will be able to select a single, group of, or all automatic transfer switches and perform a transfer from the overview screen.
 - b. Users shall be able to upload a minimum of four (4) static images, drawings, floor plans, emergency plan and procedures.
 - c. The Dynamic One Line Screen shall display the Single-Line Diagram for the buildings critical power system.
2. Library
 - a. There shall be a tree view of folders and files for navigation of documents.
 - b. A Viewing Area shall load a selected file for viewing. In instances where a file requires another program or application to view, the file will not be displayed in the viewing area, but can be downloaded to open in the other program or application.
3. Tables
 - a. The Tables screen shows a network summary of all monitored and controlled devices. The user can view the overall status and critical parameters of devices. This network summary is a tabular view. Devices shall be grouped together by type. To make changes to any device details administrative access level is required.
4. Device Details
 - a. The Device Detail screen shows and allows a user to select a specific category of monitored devices.
 - b. All devices will have a detail screen showing more granular data related to the selected device. The user shall be able to monitor the selected equipment's status, alarms, discrete data, analog data and event log.
5. Alarm Summary

- a. Provide an alarm screen that will have a display which will group alarms by devices experiencing alarm conditions. The user will be able to toggle the view between a device mode view and an alarm type mode. The alarm type mode will allow the user to see alarms grouped by the type of alarm conditions.
 - b. When viewing in alarm view mode view the alarms occurring on devices will be shown grouped by the alarm type. The alarms will be shown color-coded by the severity as predefined by the user and the quantity of alarms being experienced. Selecting an alarm type will allow the user to view and sort by severity code, name, time and status.
 - c. In the event of an alarm an audible alarm shall sound. The menu bar of the screens above shall have a mute button to silence the audible alarm. Muting the audible alarm will have no impact on the alarm status itself.
6. Historical Alarm Log
- a. The user will have the ability to view historical alarms. All alarms will be displayed with the user able to view and sort by alarms' severity code, name, date, status, acknowledged date and user.
 - b. The User shall be able to filter and print out historical alarms by date range.
7. Historical Trending
- a. User shall have the ability to select eight or more parameters that will be available for simultaneous trend monitoring.
 - b. The EPMS software will allow the user to select up to eight concurrent trend lines from user selected time spans for various devices and can simultaneously view them on a single dashboard with 1 minute up to 3 months' time frame.

2.2 EPMS HARDWARE

- A. Minimum Server System Requirements
1. Microsoft Windows Server 2012 Operating System
 2. Touch enabled 23" HD LCD monitor, Resolution 1920x1080
 3. Keyboard and mouse
 4. Intel Xeon Processor, minimum 6 Cores
 5. 8GB RDIMM, 1600MT/s, Low Voltage
 6. 1TB Hard Drive
 7. Video Card, 512MB dedicated memory
 8. (2) Ethernet LAN 10/100/1000 Ports
- B. One (1) PC Client Workstations, at a minimum, shall be provided with the latest Windows operating system, 23inch HD Touch Display, Keyboard and Mouse, Intel Dual-Core Processor, 8GB RAM, 500GB Hard drive, 512MB Video Card and an Ethernet Port.
- C. One (1) Industrial Workstations shall be Wall- or Desktop-Mount Touchscreen workstation, shall be provided with latest MSWindows operating system, 21inch HD Touch Display, minimum dual-core Intel processor, 500GB Hard Drive and an Ethernet Port.

2.3 NETWORKING

- A. All Ethernet switches shall be industrial and comply with UL508, UL 60950-1, IEEE 802, FCC Part 15 and EN61000, IEC 60068-2-27, standards with redundant power supply for increased reliability. The switches shall include IP30 protection,

- B. All Devices must communicate via open Modbus TCP/IP or Modbus RTU. Modbus / RTU and hardwired signals for monitoring and control require a vendor supplied Ethernet Module to enable interface to the network.
- C. A private Local Area Network shall be provided for EPMS monitored equipment and consist of industrial Ethernet network equipment with a minimum of 100 Mbps Ethernet (Cat 5E) and Fiber (1300nm, 50/125μm).
- D. 1GigE Fiber backbone and fast Ethernet drops. The fiber backbone shall use a redundant ring topology with a recovery time <20ms.

2.4 UPS

- A. Provide required size UPS, minimum of 30 minutes of operation of workstation station equipment.
- B. Batteries, sealed valve regulated, recombinant lead calcium.
- C. Accessories
 - 1. Transient voltage suppression
 - 2. Input harmonics reduction
 - 3. Rectifier/charger
 - 4. Battery disconnect device
 - 5. Static bypass transfer switch
 - 6. Internal maintenance bypass/isolation switch
 - 7. External maintenance bypass/isolation switch
 - 8. Output isolation transformer
 - 9. Remote UPS monitoring
 - 10. Battery monitoring
 - 11. Remote battery monitoring

PART 3 - EXECUTION

3.1 FACTORY TEST

- A. The following standard factory procedures and tests shall be performed on the equipment provided under this section:
 - 1. Configure and load all software on Power Management Engineering Station at the manufacturer's factory.
 - 2. Test and operate computer and software in a simulated system made for minimum of twenty-four (24) hours.

3.2 INSTALLATION & DELIVERY

- A. The Contractor shall coordinate with the EPMS vendor the shipping of all equipment and material to required locations.
- B. All equipment shall be adequately protected, braced and secured to prevent physical and environmental damage during transit and handling. All material not mounted or installed on the major equipment during shipping shall be properly crated and shipped with the associated equipment.

- C. All Equipment shall be handled and stored indoors in a controlled environment with precautions taken to prevent any damage to the equipment while in storage.
- D. Coordination meetings shall be held prior to startup, as needed during installation and a final meeting to close out the project.
- E. Contractor shall verify and coordinate work with drawings and specifications, coordinate with other trades for startup and installation of EPMS, and include any adjustments as necessary to complete work and avoid interference with other trades.
- F. EPMS vendor shall provide assistance to the installing contractor during the commissioning of the equipment.

3.3 MAINTENANCE AND SERVICES

- A. Software Maintenance
 - 1. 5-Years of remote phone support and annual software maintenance shall be included for the EPMS application.
 - 2. An internet accessible connection shall be required for remote support and software maintenance. The owner shall provide the EPMS vendor with remote internet access to the EPMS server as required to comply with this section.
- B. Field Services
 - 1. EPMS vendor must have direct employment of a minimum of 100 dedicated field service technicians.
- C. Tests and Certification
 - 1. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.
 - 2. The EPMS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, and installation and servicing in accordance with ISO 9001.

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SECTION 260914

BATTERY MONITORING SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. A daily monitoring system for lead acid and nickel cadmium batteries used as back-up power. Daily battery monitoring system consists of a means for monitoring battery voltages, Ohmic value, temperature and current. Custom wiring harnesses shall not be used and no load greater than 4 amps shall be used for measuring Ohmic values.
- B. Windows embedded software, hardware, cabling and associated accessories shall be included with the system.

1.2 RELATED SECTIONS

- A. 260913 – Electrical Power Monitoring System (EPMS)
- B. 261313 – 13.2 kV Service Switchgear (Con Edison Service)
- C. 261315 – 125 Volt DC Battery System
- D. 262313 – 13.2 kV Automatic Paralleling/Synchronizing Switchgear
- E. 263213 – 480/277V Life-Safety Diesel Engine Generator
- F. 263214 – 13.2 kV Standby Diesel Engine Generator
- G. 263625 – 13.2 kV Automatic Transfer Switches

Note: Control voltage for all 13.2 kV switchgears is 125 VDC.

1.3 REFERENCES

- A. Underwriters Laboratory (UL): Safety
 - 1. Safety: UL 61010-1:2012
- B. International Organization for Standardization (ISO)
 - 1. ISO 9001: Quality management systems – Requirements for quality of manufactured goods.
- C. New York City Electric Code (NYCEC)
- D. National Fire Protection Association (NFPA):
- E. NFPA 70: National Electric Code.

F. Definitions:

1. Battery: A DC electrical storage system consisting of cells or jars connected in series to achieve the required DC voltage. Strings are connected in parallel to achieve the required back up time.
2. String: A sub-division of a battery. A group of cells or jars connected in series.
3. Jar: A housing which contains multiple cells.
4. Cell: The basic unit of a Jar, traditionally consisting of lead acid or nickel-cadmium and delivers a nominal 1.2 to 2 VDC.
5. Pilot Cell: One jar of a string selected to obtain temperature readings.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Pre-installation meeting: Conduct a pre-installation meeting at the job site attended by Owner, Engineer, manufacturer's technical representative, installer, and contractors of related trades. Coordinate installation, and other requirements specific to the project.

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer current technical literature for each type of product.
- B. Shop Drawings; Submit detailed drawings showing:
1. Assembly details of standard components. Indicate necessary dimensions, arrangement of components, clearances and access requirements.
 - a. Include detailed wiring diagrams for power and control wiring.
- C. Delegated-Design Submittal: For battery monitoring system indicated to comply with performance criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Quality Assurance Submittals
1. Manufacturer Installation Instructions: Provide manufacturer's written installation instructions including proper material storage, and maintenance instructions.
 2. Submit copy of manufacturer's warranty.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
1. Manufacturer shall have comparable Battery Management Systems (BMS) in operational service a minimum of ten (10) years.
 2. Manufacturer shall be registered and certified by ISO 9001.
 3. Manufacturer shall have a minimum of 2 sources for all major manufactured components, both shall be ISO 9001 registered and certified.
 4. Upgrades to the system shall have backward compatibility so that major components are not required to be replaced.
 5. Repair process is facilitated by component replacement and should not require returning the system to the manufacturer.
- B. Installer Qualifications:
1. Installer shall be authorized, trained, and certified to install BMS by the manufacturer.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials and components in manufacturer's original, unopened, undamaged packaging with identification labels intact.
- B. Store materials on dry, level, firm, and clean surface.

1.8 WARRANTY

- A. Warranty:
 - 1. Standard form in which manufacturer agrees to repair or replace products that are defective in materials or workmanship within the specified warranty period.
 - a. Warranty Period: One (1) year from date product is placed in service, or 15 months for date of shipment from manufacturer, whichever occurs first.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. NDSL Inc.; Raleigh, NC 27612 919-790-7877 (www.cellwatch.com)
 - 1. Basis of Design: "Cellwatch Battery Monitoring System."
- B. BTECH Battery Monitoring System.
- C. Canara UPS and Battery Monitoring System.

2.2 PERFORMANCE CRITERIA

- A. Battery Monitoring System (BMS):
 - 1. Provide transient voltage surge suppression for system components.
 - 2. Battery types monitored by semi-permanent connection to battery system:
 - a. Valve regulated lead acid (VRLA) Sealed batteries: Ohmic value range 50 $\mu\Omega$ to 65 m Ω .
 - b. Flooded cells or Value Regulated lead acid 2v VRLA: 1 $\mu\Omega$ to 15 m Ω .
 - c. Ni-CAD batteries: Ohmic value range of 50 $\mu\Omega$ to 25 m Ω .
 - d. Inter-tier and Inter-Cell straps from 1 $\mu\Omega$ to 65 m Ω
 - 3. Components shall have the following regulatory approvals:
 - a. CE listings for electrical noise emissions and susceptibility.
 - b. Emissions: EN61326-1:2007, FCC Part 15B and ICES-00
 - c. Immunity: EN61326-1:2006
 - d. The following listings are for electrical safety:
 - 1) CAN/CSA C22.2 No. 61010-1-12
 - 2) CAN/CSA C22.2 No. 61010-2-030-12
 - 3) UL 61010-12:2012
 - 4) UL 61010-2-030:2012
 - 4. System Capacity:
 - a. Potential Voltage value measurement points: 1 to 30,000.
 - b. Potential Ohmic value measurement points: 1 to 30,000.

- c. AC Ripple Voltage measurement: 1 to 124.
 - d. Float Voltage measurement 1 to 124.
 - e. Supports different voltage cells from 1.2vdc to 16vdc on the same system using the same components.
 - f. Current Sensors: 1 to 124.
 - g. Temperature Sensors: 1 to 124.
 - h. Integrated Battery Monitoring Unit (iBMU) – Component capacity: 31 Control Units (CU).
 - i. Control Unit (CU) – Component capacity:
 - 1) 254 Data Collection Modules (DCMs)
 - 2) 4 current measurement inputs.
 - 3) 4 temperature measurement inputs.
 - 4) 4 volt free relay contact for external alarms.
 - 5) Visual indicator for Powered On / Communications Active Thermal Runaway Controller
 - 6) The system meets IFC 608.3
 - 7) Four relays will be incorporated to disconnect each string. Relays will be rated up to 30vdc or 250vac at 5amps.
 - 8) Visual indicators will be used on each Control Unit to indicate when a string is in Thermal Runaway.
5. Measurement ranges:
- a. Point Voltages: 1.2v DC to 16v DC nominal.
 - b. Temperature measurement: plus 36 to 176 degrees F.
 - c. Ohmic value range: 1 to 65,000 $\mu\Omega$.
 - d. Current measurement: Scalable 10– 5000 amps depending on number of conductors used
6. The system shall not require any calibration at installation, yearly intervals or when jars are replaced.
7. The BMS shall be modular. Components of the BMS shall be reconfigurable to allow for changes in battery layouts and have the ability to add or remove BMS components without changing the entire system. New components or revisions shall be backward compatible.

B. Software:

- 1. System shall operate using Windows 7 embedded operating system and shall be capable of loading operating system and initialize scanning without user intervention.
- 2. Monitoring capabilities:
 - a. Monitored Data: Provide for each [Cell] [Jar], in the BMS. Each operation listed shall be capable of being programmed with upper and lower alarm operating limits.
 - 1) Voltage. (The BMS shall be able to support different voltage cells on the same system)
 - 2) Ohmic value (including inter-cell link resistance). (System should not damage the battery or have a measurable impact on the battery due to ohmic value measurement.
 - 3) Charge/Discharge current.
 - 4) Pilot cell temperature.
 - 5) Ambient temperature.
 - 6) Individual jar temperatures
 - 7) Thermal Runaway conditions

- b. Alarm conditions; program shall be capable of indicating the following either by [visual alarm indicator]:
 - 1) The system shall be configurable for monitored data that exceeds predetermined or programmed limits set for the entire system, or by battery, string or individual cells or jars.
 - a) Cell or Jar Voltage
 - b) String Voltage
 - c) Ripple Voltage
 - d) Ohmic Value
 - e) Current
 - f) Temperature
 - 2) Current Discharge Event: Occurs when the current outflow exceeds the predetermined and programmed limits set.
 - 3) Current Recharge Event: Occurs when the current inflow exceeds the predetermined and programmed limits set.
 - 4) Ohmic value should be automatically and uniquely programmable for each jar/cell for the entire system or per string.
- c. Monitoring frequency: The customer shall have the ability to set the frequency of data collection for voltage and ohmic value. Voltage data shall be able to be logged constantly, every hour or every 6 hours. Ohmic value shall be logged every 12 or 24 hours.
 - 1) Continuously measure the following at an interval of more than once per minute:
 - a) Charge current.
 - b) Discharge current.
 - c) Pilot jar temperature.
 - d) Ambient temperature.
 - e) Individual jar temperature
 - f) Individual Jar voltage during discharge.
 - g) String voltage during a discharge
 - h) Ripple voltage
 - 2) Float voltage measurement: Measurement set between 4 times each day.
 - 3) Ohmic measurement: Measurement set to 1 time each day.
- 3. Monitored Data and Analysis: All retrieved data shall be stored and may be displayed as a spreadsheet in most formats (e.g. Microsoft Excel). The system shall have the ability to store at least 10 years of historical data on the iBMU. All measurement records can be extracted to a CSV file for easy viewing.
 - a. Daily Archival:
 - 1) Monitored data shall be captured on a daily basis.
 - 2) A trend analysis of monitored data shall be provided.
 - 3) Ability to display archived data and trend analysis.
 - b. Analysis Graphs: Displayed as line or bar charts, except trend analysis and discharge graphs which shall be displayed as line graphs.
 - 1) Each cell or jar monitored data for the current day.
 - 2) Each cell or jar monitored data for the complete history stored.
 - 3) Most recent voltage and ohmic reading for each string.
 - 4) A trend analysis of monitored data for each year of operation.

- 5) An analysis of the best and worst performing Cells, Jars or Strings in a system discharge. Provide the capability of adding all Cells, Jars in the system
 - 6) Alarm condition – Current outflow event: Discharge analysis showing all battery voltage curves for performance analysis. Graph shall be able to show one to all cells or jars in the system. Analysis graphs shall be capable of allowing user defined colors.
 - 7) Analysis graphs shall be printable, each graph individually or all graphs.
 - 8) Graphs of historic data should provide support for panning and zooming.
 - 9) Graphing tool should support overlay of alarm setting for each cell or jar as an overlay to the actual measurement.
 - 10) Graphs should provide support for dual axis plotting of measured parameters in a single graphic view.
4. The system shall support Modbus TCP/IP and SNMP interfaces.
 5. The system shall incorporate a separate program to manage alarm data. It shall include the ability to sort events by type, alarm value, time and start or end date. All reports can be generated and exported to a CSV file. All active alarms shall be shown in red, acknowledged alarms shall be denoted with a check mark. Users must be able to filter alarm events by using the battery, string or cell/probe selections. As an option the user can select only batteries, strings and cells/probes that have alarmed will be available for filtering.
 6. The system shall be able to provide reports for:
 - a. Total String/Battery Float Voltage
 - b. Individual Jar/Cell Float Voltage
 - c. Discharge Voltage per Jar/Cell
 - d. String Current
 - e. Ambient Temperature
 - f. Pilot Temperature

2.3 COMPONENTS

- A. Battery Monitoring Unit (iBMU): The iBMU will control all aspects of the monitoring process including: retrieving, displaying and saving data; indicating alarm activation; processing data for historical trending; real time calculations; and control outputs to trigger external functions. The data will be presented on a customer supplied and connected color screen or over an Ethernet network connection via MODBUS over TCP/IP, SNMP, via an integrated webpage, using Remote Desktop, or a customer supplied and connected KVM over IP. A KVM over IP option allows the iBMU to be accessible via the network but isolated from the network as the KVM connects directly to the Video, Monitor, and Mouse ports on the iBMU.
 1. Mounting: Wall or rack mounted.
 2. iBMU hardware – minimum requirements:
 - a. 1.6Ghz processor
 - b. 1GB RAM.
 - c. 16 GB Solid State Hard drive+
 - d. Windows 7 embedded operating system.
 - e. Fanless Mother Board
 - f. 2 Network Interface Connector (NIC) 10/100/1000 MHz Ethernet Connections
 - 1) One static service port (192.168.0.128/255.255.255.0)
 - 2) One dynamic (DHCP enabled)
 - g. 1 VGA Video Port
 - h. 1 RS 485 Port for connections to the Control Unit(s)
 - i. 6 USB Ports

- j. Communicates with up to 31 Control Units
 - 3. Power: 110 VAC, 300 Watts, must be powered from a UPS backed supply
 - 4. Component connections: RS485 cable, Belden 8102 or 88102.
 - 5. Language: English
 - 6. Standard connections for external components:
 - a. Ports: Printer, [1 USB port].
 - b. Modem: via external USB Modem device
 - c. 2 USB ports
 - d. 2 Network Interface Connector: 10/100Mhz Ethernet connection
- B. Control Unit (CU): The Control Unit shall communicate to the DCMs via a fiber optic loop. The functions of the Controller include; conversion between digital RS485 and optical signals, up to four independent current readings per Control Unit, up to four independent temperature reading per Control Unit for ambient and/or pilot cell temperatures and the facility for four volt free contacts to be used as alarm and control outputs. A total of 31 RS-485 Addresses can be connected to a single IBMU. The Control Unit must support a network up to 2000' from the iBMU.
- 1. Mounting: Wall mounted.
 - 2. Power: 110 VAC, 20 Watts, must be powered from a UPS backed supply
 - 3. CU hardware – minimum requirements:
 - a. Controls 254 Data Collection Modules (DCMs)
 - b. Includes 4 current inputs.
 - c. 4 temperature probe inputs.
 - d. 4 alarm triggered volt free relay contacts.
 - e. 10 alarm triggered volt free relays for Thermal Runaway Controller
 - f. Interface for generator extension via RJ45 connector
 - 4. Sensing inputs:
 - a. Temperature- Solid state probe
 - 1) Resolution- 0.05 degrees C
 - 2) Accuracy- +/- 1 degree C
 - 3) Range- 2 to 80 degrees C
 - b. Current- Solid state magnetic core sprung clamp 2" (50mm) capacity 1,000 amps or 4.5" (112mm) 2,500 amps
 - 1) Resolution- 1.0 amps
 - 2) Useful Range- +/- 10 to maximum amps of clamp
 - 5. Component connection: RS485 cable, Belden 8102 or 88102.
- C. Generator Kit : The system shall be capable of monitoring small remote batteries typically used for generators up to 4000ft from the BMU
- D. Data Collection Module (DCM): Data collection modules shall measure voltage and Ohmic Value for of up to four measurement points to which they are connected. All electrical wiring shall be affixed to the DCM prior to shipment and no cable crimps shall be required during installation. DCMs shall have an option for measuring the temperature on the negative post of each jar. DCM shall utilize fiber optic cable for communications to ensure reliability, noise elimination and safety. Electrical wiring between DCMs is NOT acceptable. Each DCM shall support a transmitter (white or blue connector) and a receiver (black connector) that is fiber cabled to provide a fiber connection between each DCM and continues until a loop is formed returning to the Control Unit. Maximum distance between DCMs will be up to 150'. The maximum rating of any DCM is 80VDC standard.

1. Mounting: Dual Lock.
2. Conductors shall be minimum 22 and maximum 14 AWG, 300 v rated, 15 amp maximum, insulated wire meeting the requirements of UL 1015
3. Conductors shall be color coded.
4. All wiring that connects to the battery should be acid resistant.
5. Each DCM can measure up to 4 jars or cells data. Data collection includes:
 - a. Voltage
 - b. Ohmic Value
 - c. DCM shall have a sleep mode that after 25 hours of no communication with the Control Unit it shall reduce the power requirement to less than 2ma to conserve battery life.
 - d. Average current draw during ohmic testing shall be less than or equal to 2 amps.
 - e. Voltage range shall be 0 to 80vdc with 2mv resolution with accuracy of 0.1%, +/- 5mv.
 - f. Ohmic value range 1 to 65 milliohms with accuracy of 2%, +/- 8 micro ohms below 1m ohm and 1.5% above 1m ohm
 - g. Ripple voltage (across 4 jars, 40 Hz to 1K Hz) range 0 to 4 v rms with resolution of 2mv rms and an accuracy of 2%, +/-5mv rms.
6. Component connection:
 - a. Factory installed terminators on 36 inch wire harness to Jars.
 - b. Fiber optic cable for data communication between DCMs and the CU.

2.4 ACCESSORIES

- A. DCM Cables Specifications:
 1. Fiber optic cable shall be acrylic, 1.0mm core diameter and 2.2mm outside diameter with a 400-700 nm wavelength. The supplied cable must be acid resistant, highly isolated, and immune to electrical noise.
- B. Current Transducers (CT):
 1. Mounting: Battery lead, clamped around bus line
 2. Component connections: Standard 35' cable provided by manufacturer. Maximum distance is 150'.
 3. Solid state, magnetic core sprung clamp. 2" (50mm) capacity, 1,000 amp or 4.5" (112mm) 2,500 amp.
- C. Temperature Probe (TP):
 1. Mounting: bolted via 8mm (5/16") lug fitted or with removable adhesive pad
 2. Component connections: Standard 35' cable provided by manufacturer. Maximum distance is 150'.
 3. Solid state probe

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of electrical equipment. Connect in such a way as to facilitate future disconnecting with minimum interference with other components.
- B. Verify that power source for all equipment has surge protection as required by manufacturer.

3.2 PREPARATION

- A. Coordinate external enunciator's location and connection to BMS.
- B. Conduit installation:
 - 1. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Electrical Contractor to install conduit and provide 120VAC circuit with duplex outlet from the UPS output to provide power to the iBMU.
 - 3. Electrical Contractor to install conduit and provide 120VAC circuit with simplex outlet from the UPS output to provide power to the Control Units and Thermal Runaway Controllers.
 - 4. Electrical Contractor to add a network drop and coordinate with end user for provisioning an IP address.

3.3 INSTALLATION

- A. General:
 - 1. Installation shall maintain System UL listing.
 - 2. Mount components plumb and rigid without distortion of component chassis.
 - 3. Ground equipment in accordance with manufacturer's requirements.
 - 4. Install and wire components in accordance with the NEC.
 - 5. No custom wiring harnesses shall be required.
 - 6. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Chapter 3.
- B. Install components in locations within the manufacturer's installation guidelines.

3.4 CONFIGURATION and STARTUP

- A. Factory Authorized service representative must program the system utilizing the end user's designations for the system components.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate BMS and perform tests and inspections.
- B. Perform the following tests and inspections with factory authorized service representative:
 - 1. Operational Test: After installing components, and after electrical circuitry has been energized, start system to confirm proper operation.
 - 2. Test and adjust controls and alarms limits in accordance with manufacturer's recommendations.

3.6 DEMONSTRATION AND TRAINING

- A. A minimum of 2 hours on site customer training shall be completed by the installer before the system is turned over to the customer.
- B. Engage a factory authorized service representative to train Owner's personnel to adjust, operate, and maintain components.

- C. Completion of manufacturer provided Commissioning report and submission of completed report to the manufacturer for validation.

END OF SECTION

SECTION 261120

13.2 KV/480-277V SUBSTATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. 13.2 KV/480-277 substations, three-phase, four-wire, 60 hertz shall include:
1. One (1) primary vacuum circuit breaker. Breaker shall be rated 1200 amperes.
 2. One Transformer per section: 3000 KVA/4000 KVA, 13.2 KV to 277/480 volt, three-phase four-wire, 60 hertz (AA/FA) copper winding, VPI type transformer, with Basic Impulse Rating 95 KV BIL primary, 10 KV BIL secondary. Transformer monitor alarm status Hi-temperature shall be provided with remote monitoring capability by "power monitoring system".
 3. One Low Voltage Switchgear per section: 277/480 volt, three-phase, four-wire distribution section with one (1) main and feeder power breakers, as indicated on Contract Drawings. Provide fuses in Series with circuit breaker if required in order to protect ATS switches.
- B. The secondary unit substation shall be designed, assembled and tested in accordance with latest applicable Standards of NEMA, IEEE and ANSI, applicable to its three major sections.
- C. The transformer unit supplied shall consist of an HV terminal compartment and an LV terminal compartment transition sections may not be required if all components furnished by one (1) manufacturer. Connections between the primary circuit breakers and transformer shall be cable, and between the transformer and secondary shall be flexible copper bus braid.
- D. The manufacturer of the unit substation shall be the same as the equipment breaker manufacturer and all major components of the substations, such as primary protective devices, transformer and low voltage overcurrent devices. Secondary unit substations shall be manufactured by General Electric Company, Siemens Energy and Automation, Inc., Square D Company, or Eaton.
- E. The manufacture of the entire switchgear assembly, including 15 KV circuit breaker cubicles, transformers, secondary switchgear shall construct the assembly to conform to seismic number restraint requirements Determined by the Structural Engineer of the project.
- F. The following factory tests shall be made on all transformers, although not necessarily in the order listed. All tests shall be in accordance with the latest revision of ANSI Test Code C47.12.90 and/or NEMA TR1. A certified copy of testing results shall be submitted.
1. Resistance measurements of all windings on the rated voltage connection of each unit and at the tap extremes of one unit only of a given rating on this project.
 2. Ratio tests on the rated voltage connection and on all tap connections.
 3. Polarity and phase-relation tests on the rated voltage connections.
 4. No-load loss at rated voltage on the rated voltage connection.
 5. Exciting current at rated voltage on the rated voltage connection.
 6. Impedance and load loss at rated current on the rated voltage connection of each unit and on the tap extremes of one unit only of a given rating on this project.
 7. Temperature Test or tests shall be made on one unit only of a project covering one or more units of a given rating. When a transformer is supplied with auxiliary cooling

equipment to provide more than one KVA rating, temperature tests as listed above shall be made on the lowest KVA AA or FA rating and the highest KVA FA rating.

8. Applied potential test.
9. Induced potential tests.
 - a. Results of the above tests including no load loss data shall be submitted with final drawings in the form of certified test reports.

1.2 RELATED SECTIONS

- A. 26 05 73: Power Systems Study
- B. 26 09 13: Electrical Power Monitoring System (EPMS)
- C. 26 32 13: 480/277 Volt Life Safety Diesel Engine Generator
- D. 26 36 23: 480/277 Volt Automatic Transfer Switches

1.3 SHOP DRAWINGS

- A. Shop drawings for approval shall be prepared prior to starting manufacture of switchgear assembly.
- B. Shop drawings shall include but not be limited to the following:
 1. Structural Arrangement.
 2. Dimensional Plan and Elevations, Front View, Side Views, and other pertinent Elevation Views.
 3. Conduit Entrance Location and Dimensions.
 4. Bus Bar Locations and Configurations.
 5. Incoming and Outgoing Power Conductor Terminator Positions, and Complete Three Line Schematic Diagrams of all Switchgear Sections.
 6. Transformer Drawings.
 7. Neutral and Ground Bus Connections.
 8. Base Plans showing Dimension, Base Anchoring and Installation Details.
 9. Equipment Weights.
 10. Circuit Breaker and Component Drawings, Manufacturers Pertinent Literature.
 11. Control Wiring Diagrams.
 12. Performance Data on Switchgear Components.
 13. Plan Indicating Shipping Splits.
 14. Other information that is necessary for full documentation of switchgear and as requested.
 15. Sales literature.
- C. The switchgear manufacturer shall be responsible for providing the coordinating wiring diagrams showing wiring diagrams and interconnections to all switchgear and provisions for connecting to the power monitoring system.
- D. Submit operation and maintenance manual.
- E. Spare Parts:
 1. Submit a list of suggested spare parts.

1.4 FACTORY TEST

- A. Each section shall be tested at factory—designed for assembly at job site. Startup testing by manufacturer at job site, prior to 3rd party commission test.
- B. The manufacturer is to submit a detailed testing procedure for each piece of equipment being tested at least two weeks prior for approval by engineer and CA.

1.5 WARRANTY

- A. Manufacturer shall warrant specified equipment free from defects in materials and workmanship for one (1) year from the date of installation.
- B. Submit extended warranty proposal to Owner during closeout.
- C. Submit emergency contact information.

1.6 DEMONSTRATION

- A. Switchgear Manufacturer shall provide a factory-authorized service representative to train Owner's maintenance personnel in the following:
 - 1. In procedures and schedules related to startup and shutdown, troubleshooting, serving, and preventive maintenance.
 - 2. Review data in the maintenance manuals.
 - 3. Schedule training with Owner with at least three week's advance notice.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. General Electric
- B. Siemens
- C. Eaton
- D. Square D

2.2 13.2 KV CIRCUIT BREAKER

- A. GENERAL
 - 1. The vacuum circuit breakers shall be of the horizontal drawout design with ratings as noted below:
 - a. Interrupting rating 1000 MVA
 - b. Nominal voltage class 13.2 KV
 - c. Continuous rated current 1200 Amperes
 - d. Maximum symmetrical I.C. 40 KA RMS
 - e. Rated interrupting time 3 Cycles
 - 2. Breaker Operation
 - a. The breaker shall be electrically operated by the following control voltages:

- 1) 125 volt DC close, and 125 volt DC trip.
3. Circuit Breaker shall be as specified for the 13.2 KV service switchgear
 - a. All secondary wiring shall be No. 14 AWG or larger, 90°C, 600 volt switchboard wire, type SIS, 41 strand, tinned copper and provided with a permanent wire marking system identifying the "from-to" wire designation.
 - b. All current transformers and associated circuitry control wiring shall be terminated with insulated ring-tongue or locking spade terminals.
 - c. Terminal blocks shall be Marathon series 1500 or approved equal.
 - d. Two-pole, pullout disconnecting fuse blocks (with fuses) to be provided for each breaker to protect trip and close circuits.
 - e. Incoming line and feeder cable lugs shall be compression type of the size indicated elsewhere shall be furnished.
 - f. Terminal blocks for user configuration of load shedding shall be located at the rear of the cubicle.

2.3 TRANSFORMER SECTION

- A. VPI (Vacuum Pressure Impregnated Construction)
 1. The medium voltage transformers shall be VPI (Vacuum Pressure Impregnated) construction and shall be mounted in a suitably ventilated indoor NEMA 1 enclosure with sidewall mounted primary and secondary terminations.
 2. The coils and all clamping structure and bus work shall be assembled on the core, and then dried at atmospheric pressure in an oven through which hot air is continuously circulated.
 3. The totally assembled core and coil assembly shall be vacuum pressure impregnated in polyester varnish.
 4. The total VPI process shall apply a one (1) cycle polyester protective shield to the bus, core, and support structure. The varnish shall be cured on the core and coil assembly following an established temperature vs. time baking cycle in a hot air circulating oven.
 5. The VPI process shall effectively impregnate the entire core and coil assembly, which results in a unit which is virtually impermeable to moisture, dust, dirt, salt air, and other industrial contaminants.
 - a. The transformer shall be rated as indicated on the Contract Documents:
 - 1) Step-down Transformers: Primary voltage, 13200 volts, delta; Secondary voltage or 480Y/277 volts, 4-wire, 60hz with 2-2½% full capacity above normal and 2-2½% full capacity below normal primary taps as indicated on the Contract Documents. Impedance shall be, in general, 5.75% to 8%. The transformer shall have an average temperature rise of 115°C above a 40°C maximum, 30°C average ambient.
 - b. Step up transformers inrush current shall not exceed 12 times the full load current for transformers up to 3000KVA.
 - c. The Basic Impulse Levels (BIL) shall be a minimum of 95 kV for the 15 kV class.
 - d. The coil design shall be the type to provide the most efficient, reliable and compact winding. Transformer coils shall be of the continuous wound construction.

- e. The coils shall be wound with copper conductors. The conductors shall be insulated with 220°C insulation.
 - f. The transformer enclosure shall be ventilated indoor NEMA 1 type and fabricated of heavy gauge, sheet steel construction. Enclosures are to be provided with lifting devices bolted or welded to the base structure and shall have jacking pads designed to be flush with the enclosure. The base is to be constructed of structural steel members to permit skidding or rolling in any direction. Provisions shall be made to completely isolate the core and coil from the enclosure. There shall be no metal-to-metal contact. Neoprene vibration isolation pads shall be installed by the manufacturer between the core and coil and the enclosure base structures to prevent the transmission of structure borne vibration. The core shall be visibly grounded to the ground bus or ground pad by means of a flexible grounding conductor sized in accordance with applicable UL and NEC Standards. There shall not be bolts through the internal isolation pads unless holes for bolts are oversized and rubber washers are used with metal washers to assure no metal-to-metal contact.
 - g. The entire enclosure shall be finished utilizing a continuous process consisting of degreasing, cleaning and phosphatizing, followed by electrostatic deposition of a polymer polyester powder coating and baking cycle to provide uniform coating of all edges and surfaces. The coating shall be UL recognized. The coating color shall be ANSI 61.
 - h. Transformer sound levels shall be warranted by the manufacturer, per NEMA Standards Publication #TR-1.
 - 1) Transformer medium voltage dry-type distribution 3 phase up to 2500KVA shall be energy efficient, as per DOE 2016.
 - i. Metal-oxide, gapless type distribution class lightning arresters shall be installed by the manufacturer on the line side of vacuum circuit breaker side of the transformer to provide additional protection against high voltage lightning or switching surges. Transformer should include factory-installed RC Snubber circuit.
 - j. Force air cooling (FA), when specified, shall increase the continuous self-cool rating of the transformer by 33%. Forced air cooling shall include three phase electronic digital temperature monitor, fans, control wiring, control panel with test switch, indicating lights, alarm and alarm silencing switch.
6. FACTORY TESTING
- a. Each transformer shall undergo the following routine production tests per ANSI C57.12.01 and ANSI C57.12.91. Testing shall be accomplished using calibrated test equipment, which have recorded accuracy traceable to National Institute of Standards Technologies (NIST). Certification of Calibration shall be provided with test reports if requested.
 - b. In addition to routine testing, a 100% QC Impulse Test shall be performed on each transformer furnished.
 - c. Routine Tests shall include:
 - 1) Megger
 - 2) Ratio
 - 3) Resistance
 - 4) Phase Relation
 - 5) Load Loss, Impedance and Regulation
 - 6) No Load Loss and Excitation Current
 - 7) Applied Potential Test
 - 8) Induced Potential Test

- d. A temperature rise test shall be performed. The core and coil design and construction techniques shall be verified by a full short circuit test on similar or larger units in accordance with applicable ANSI standards.
- e. Provide certified production test reports for all manufactured transformers.

2.4 ACCESSORIES

- A. Standard transformer accessories shall include:
 - 1. Diagrammatic aluminum nameplate
 - 2. Step-lap mitered core
 - 3. Provisions for lifting core and coil assembly
 - 4. Base equipped with jacking pads and designed for rolling or skidding enclosure in any direction
 - 5. NEMA 1 heavy-gauge ventilated enclosure with removable panels front and rear
- B. Documentation for the Owner's review:
 - 1. Outline, nameplate and connection diagram drawings
 - 2. Installation/Operation Maintenance Manual
 - 3. Certified Production Test Report(s) containing minimum information per ANSI C57.12.91

2.5 ACCEPTABLE MANUFACTURERS

- A. ABB
- B. Square 'D'
- C. Siemens
- D. General Electric
- E. Cooper Power

2.6 SNUBBERS

- A. This transformer should be provided with snubbers at the primary since it is fed from vacuum breakers unless the transformer is of the transient voltage resistant type (TVRT) where the transformer will survive frequent switching from close-coupled vacuum circuit breaker.

2.7 SECONDARY SWITCHGEAR

- A. Furnish and install where indicated a dead-front type, completely metal enclosed, self-supporting structure independent of wall supports. Voltage rating shall be as indicated on the drawings. It shall consist of the required number of vertical sections bolted together to form one rigid switchgear. The sides and rear shall be covered with removable screw-on plates. All edges of front covers or hinged front panels shall be formed.
- B. Switchgear shall comply with the latest applicable Standards of ANSI C37.13, C37.16, C37.17, and C37.20; NEMA SG3 and SG5, and shall be UL labeled in accordance with UL 1558. Certified copies of design test reports shall be supplied demonstrating compliance with these Standards when requested by the Engineer. Rear of switchgear should have full-height rear hinged doors with 3-point latching mechanism and pad lockable handle.

- C. Small wiring, necessary fuse blocks and terminal blocks within the switchgear shall be furnished as required. Control components, such as control transformers, fuse blocks, relays, etc., shall be suitably marked for identification where mounted on the switchgear corresponding to appropriate designations on manufacturer's wiring diagrams. All groups of control wires leaving the switchgear shall be provided with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring. Non-essential and essential trip bus wiring and shunt trip wiring to be wired to rear of switchgear to terminal block for under voltage and under frequency trip signals.
- D. Switchgear shall be provided with adequate lifting means and shall be capable of being rolled or moved into installation position and bolted directly to floor sills provided with contractor supplied floor sills to be set level in concrete per manufacturer's recommendations.
- E. All major components including breakers, meters and trip units shall be of the same manufacturer as the switchgear. The switchgear shall be manufactured by Siemens Energy and Automation, Inc., General Electric, Cutler Hammer or Square 'D'.
 - 1. Construction
 - a. The switchgear shall be General Electric AKD-20, Siemens Type 'WL', Drawout Power Switchgear, Utilizing General Electric EntelliGuard G with Entelliguard TU trip or Eaton low voltage Magnum DS Drawout power circuit breaker with Eaton DigiTrip 520MC trip unit or Siemens Type 'WL' Power Circuit Breakers as herein specified. The entire assembly shall be suitable for 600 volts maximum AC Service. The minimum interrupting short circuit rating of all breakers shall be as indicated on the drawings.
 - b. Each vertical steel unit forming part of the switchgear line-up shall be a self-contained housing NEMA #1 having one or more individual breaker or instrument compartments, a centralized bus compartment and a rear cabling compartment. Each individual circuit breaker compartment, or cell, shall be completely segregated from adjacent compartments or sections by means of steel barriers at top, bottom and sides. It shall be equipped with drawout rails, levering out mechanism, primary and secondary contacts. Current transformers for feeder instrumentation, where shown on the plans, shall be located within the appropriate breaker cells. End sections shall include provisions for main bus extension for installation of future vertical section is applicable. Enclosure shall be fabricated with removable, hinged rear doors with three point latch and pad lockable handle to allow access to rear interior of switchgear.
 - c. The stationary part of the primary disconnecting devices for each power circuit breaker shall consist of a set of contacts extending to the rear through a glass polyester insulating support barrier; corresponding moving finger contacts suitably spaced shall be furnished on the power circuit breaker studs which engage in only the connected position. The assembly shall provide multiple silver-to-silver full floating high pressure point contacts with uniform pressure on each finger maintained by springs. Each circuit shall include the necessary three-phase bus connections between the section bus and the breaker line side studs. Load studs shall be equipped with insulated copper load extension busses terminating in solderless type compression lugs in the rear cable compartment of each structure. Bus extensions shall be silver-plated where outgoing terminals are attached. Front breaker doors and covers must be free of any ventilation opening.
 - d. The secondary disconnecting devices shall consist of floating fingers mounted on the removable unit and engaging flat contact segments on left hand side of the compartment. The secondary disconnecting devices shall be silver-plated and sliding contact engagement shall be maintained in the "connected" and "test"

- positions. Interlocks shall be provided to present a circuit breaker element of the incorrect frame size or interrupting rating from being inserted into the compartment.
- e. The removable power circuit breaker element shall be equipped with disconnecting contacts, wheels and interlocks for drawout application. It shall have four positions, "connected", "test", "disconnected" and "removed" all of which permit closing the compartment door. The breaker drawout element shall contain a gear levering "in" and "out" mechanism with removable lever crank. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering "in" or "out" of the cell.
 - f. All control wire shall be Type SIS, bundled and secured with nylon ties.
 - 1) Secondary control and communication connections, where required, shall be located in a separately accessed area that is accessible from the front of the switchgear without opening the breaker compartment door or exposing any power cables or bussing.
 - g. Provide a rear non-hydroscopic insulating barrier in between the cable compartment and the main bus to protect against inadvertent contact with main or vertical bus bars.
 - h. Provide a non-hydroscopic insulating barrier full height and depth between adjacent vertical structures in the cable compartment.
 - i. Provide a traveling type circuit breaker hoist rail mounted on top of switchgear.

F. Bussing

- 1. All bus bars shall be copper. All bus work shall be rated to withstand maximum short-circuit stresses when connected to a supply system having fault capacity specified on schedules of contract drawings. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. The horizontal bus system shall be fully insulated with a fluidized epoxy coating. Joint covers shall be furnished over main horizontal bolted connections.
 - a. Main bus shall be rated, as shown on Contract Drawings.
 - 2. Automatic safety shutters shall be provided to protect the operator when the breaker is withdrawn.
 - 3. Provide full 100% capacity neutral.
 - 4. A ground bus shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchgear. Compression lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided as indicated on the drawings.
 - 5. All hardware used on conductors shall be high-tensile strength and zinc plated. All terminals shall be of the anti-turn solderless type suitable for copper or aluminum cable of sizes indicated.
 - 6. Bus isolation barriers shall be arranged to isolate the busses on either side on each main and tie circuit breaker from each other.
- All equipment shall be power management ready with MODBUS, RTU open protocol communication capability, all factory prewired for the Power Monitoring System.

G. Circuit Breakers

- 1. Main, tie and feeder protective devices shall be drawout power circuit breakers, Siemens Type 'WL', or General Electric EntelliGuard G with EntelliGuard TU Trip. Frame ratings shall be 800, 1600, 2000, 3200, or 4000 amperes as shown on the drawings. All breakers shall be 100 percent rated. Eaton and Square D are acceptable.

2. Breakers shall be manually operated (MO) unless electrically operated (EO) is indicated on the drawings. Electrically operated breakers shall be complete with control switch plus red and green indicating lights to indicate breaker contact position.
 3. Power circuit breakers shall have a minimum symmetrical interrupting capacity of min. 100,000 amperes RMS at rated voltage (unless otherwise shown on drawings). Main and tie breakers shall have short time rating of 100,000 A RMS at rated voltage. Main and tie-breakers shall be supplied without instantaneous pick-up.
 4. Main breakers shall be electrically operated.
- H. Solid State Programmer – Siemens ETU-766 or GE GTUTK20
1. Each low voltage power circuit breaker shall be equipped with a self-powered microprocessor-based trip device static programmer to sense overload and short circuit conditions. Trip devices shall be interchangeable so that any trip device with the same ratings can be used with any same frame size circuit breaker. The device shall measure true RMS currents. Peak sensing devices will not be accepted. All adjustment setting switches shall be digitally encoded type with gold contacts.
 2. The trip device shall include an adjustable long time current setting with switchable thermal memory. Eleven (11) current settings shall be available to provide adjustment from 0.5 to 1.0 times the circuit breaker current sensor rating. Long time pickup shall be fixed at 1.1 times the current setting selected. A long time pickup LED shall be included. Five (5) long time delay bands shall be provided. Devices that require current setting adjustment as a function of a removable rating plug will not be acceptable.
 3. Short time pickup shall be adjustable from 2 to 12 times current setting selected. Five (5) short time delay bands shall provide adjustment from 0.08 to 0.40 seconds. A switchable I₂t ramp shall be included. Instantaneous tripping shall be adjustable from 2 to 15 times current sensor rating. This adjustment range shall be provided regardless of circuit breaker frame size.
 4. Ground fault pickup shall be adjustable from 20 to 60 percent of ground sensor rating. It shall not be possible to exceed 1,200 ampere maximum pickup. Three (3) time delay bands and an I₂t ramp shall be included when ground fault protection is provided.
 5. An LCD electronic target shall be provided to indicate trip from overload short circuit or ground fault. Retention of target information shall not rely on batteries. A continuous self-checking watchdog circuit shall be provided to monitor and indicate improper operation of the protective microprocessor.
 6. Trip unit to include Arc Reduction maintenance mode that can be manually activated by maintenance personnel. When activated, CB shall trip with no intentional delay when fault in instantaneous range is detected in compliance with NEC 240.87.
- I. Surge Protective Device (SPD): Secondary of unit substation shall be provided with SPD and associated 3-pole, 100 amp. fusible switch equal to Siemens TPS or GE Tranquell HE-SPD, 480Y/277 volts.

2.8 GROUND FAULT PROTECTION

- A. Ground fault protection shall be provided on the 480 volt circuit breakers on main and feeder circuit breakers. Alarm indication shall be recorded on the power monitoring system.

2.9 NAMEPLATES

- A. Engraved nameplates shall be furnished for all main and feeder circuits including control fuses and also for all indicating lights and instruments. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating. Furnish Master nameplate giving switchgear designation, voltage ampere rating, short circuit rating, manufacturer's name, general order number and item number. The master and circuit

breaker nameplates shall be lamacoid type, with white background and black letters, screwed on.

2.10 MIMIC BUS

- A. (Color selected by purchaser) acrylic mimic bus shall be supplied on front of the double ended substation to outlining the one-line diagram power circuits and shall indicate the arrangement of the circuit breaker and all items in the circuit.

2.11 FINISH

- A. All exterior and interior steel surfaces of the switchgear shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchgear shall be the manufacturer's standard. ANSI 61 Light Gray—substation coordination.

2.12 CONTROL POWER TRANSFORMERS

- A. Control power transformers with primary and secondary protection shall be provided. Spare primary and secondary fuses shall be supplied for each transformer. The CPT shall be a minimum of 5 KVA or as required by the manufacturer.

PART 3 - EXECUTION

3.1 Protect sub-station continuously from dust and moisture.

3.2 Install substation on 4 inch high concrete housekeeping pad which shall follow the contour of substation with 6" inch clear all around.

3.3 Provide channel steel sills below each substation where the switchboard frame is not suitable for use as a floor sill.

3.4 FEEDER INSTALLATION AND TERMINATION

- A. Group cables paralleling one another and arranged so as to permit easy insertion of a clamp-on ammeter on each side.
- B. All line and load side conductors emanating from the top or bottom of the switchgears shall be lashed to cable braces provided in the switchgears. Lashing shall be performed as per the manufacturer's recommendations to maintain the integrated equipment rating. Lashing material shall be nonmetallic fire and heat resistant with a tensile strength of 2,000 pounds. In general on service entrance cable run and bend the cable in a manner so as to rest directly against the cable braces. Make six (6) revolutions around the 'A' and 'B' phase and the six (6) revolutions around the 'B' and 'C' phase cables. With the remaining lashing material make four (4) to five (5) revolutions between each of the phase cables tying a knot to the cable braces as the last revolution is complete. All revolutions must be as tight as possible to prevent magnetic stress during short circuits. Load cables in general should be lashed with four (4) revolutions around the cable and the brace, then tied in a knot after the last revolution.

- 3.5 At the completion of the work, each switchgear shall be field tested by a representative of the manufacturer as described below. A report recording each item of the testing shall be certified by the manufacturer and submitted to the Engineer. (See commissioning at end of section for further specifications).
- A. Operation of each disconnecting means under load.
 - B. Observation of cable bracing, both incoming and outgoing, certifying that it is in accordance with the manufacturer's recommendations.
 - C. Verification of setting of all ground fault systems. Test each system by checking coordination between ground fault and phase to ground fault of a one pole lighting branch circuit.
 - D. Verification of torque for all nuts and bolts on buswork.
 - E. Concrete pad shall be installed for all free standing electrical distribution equipment.
 - F. Concrete work shall be provided under other Section. Electrical Contractor shall supervise and coordinate concrete work to ensure that proper grounding cable, rods, conduit, etc., are located as detailed and as required.
 - G. Mounting height of each overcurrent/disconnect device in the above equipment shall not exceed 6'-6" from the above.

3.6 STARTUP AND COMMISSIONING OF EQUIPMENT

- A. The electrical contractor shall include in the bid price the cost of equipment start up and commissioning services. This service shall be performed out by the equipment provider in accordance with the manufacturer's recommendation. A minimum of five (5) man days shall be included for each lineup of MV & LV switchgear. The service provider shall set all relays and overcurrent protective devices in accordance with the Systems Coordination Study recommendations.

3.7 HIGH VOLTAGE CIRCUIT BREAKER

- A. Work on a high voltage equipment requires isolation of the incoming electric utility company line if previously energized. The isolation will be arranged by the electrical contractor and performed by the electric utility company.
- B. All procedures to be performed by the Contractor require coordination with the Owner, the Engineer, the electric utility company, and with any work planned or in progress on associated equipment by Contractor's personnel or any other persons.
- C. Contractor shall be required to perform the following prefunctional procedures prior to energizing:
 - 1. Assure isolation of circuit breakers from load network.
 - 2. Vacuum clean all components, interior of housing, and floor.
 - 3. Clean all insulators and barriers with appropriate solvent.
 - 4. Inspect all components for evidence of physical damage. Clean contacts and inspect for damage.
 - 5. Check alignment and wipe of contacts.
 - 6. Clean operating mechanism and inspect for damage.
 - 7. Tighten all bolted connections to appropriate torque values.

8. Perform contact resistance test on all breaker contacts and bus joints.
 9. Check settings of open relays as specified in coordination study.
 10. Test all relays in accordance with the manufacturer's recommendations and the settings shown in the coordination study.
 11. Verify all safety grounds removed.
 12. Confirm ratings of all power and control fuses.
 13. Close switch after all necessary preparations have been made for energization.
 14. Perform vacuum interrupter integrity tests on all vacuum bottles in circuit breaker
 15. Perform insulation resistance tests on all circuit breaker primary and secondary bus detail.
- D. Contact resistance tests shall be performed using a test current of 100 amperes.
- E. Adjustments and minor repairs of the equipment shall be included as part of the prefunctional testing.
- F. Upon energization of circuit breaker functional tests shall be performed on all controls including—circuit breaker tripping/closing via relay contacts and control switches, automatic throw over schemes, lockout relay functions, breaker control switches, CT's (including passing current through CT's to confirm relay performance), timing relays, and safety devices.

3.8 HIGH VOLTAGE FEEDER

- A. Work on a high voltage feeder requires isolation of the feeder (if previously energized).
- B. Contractor shall be required to perform the following pre-functional procedures prior to energizing feeder:
1. Inspect cable terminations for evidence of physical damage.
 2. Inspect shield grounding for damage.
 3. Tighten bolted connections to appropriate torque values.
 4. Perform high potential VLF insulation resistance tests on cable circuit.
- C. High potential insulation resistance tests shall be performed on each phase of each cable circuit by applying VLF test voltage between each phase and ground. Voltage steps, maximum test voltages, and time durations shall be as specified by the final cable manufacturer or NETA specifications (only if the cable manufacturer doesn't specify).
- D. All cable tests shall performed in accordance with IEEE Standards.

3.9 TRANSFORMERS

- A. Work on a transformer requires isolation of the transformer from the high voltage feeder and from the load network if previously energized. The procedures required to isolate the transformer from the high voltage feeder and from the load network shall be performed by the Contractor.
- B. Contractor shall be required to perform the following prefunctional procedures prior to energization:
1. Assure isolation of transformer from load network.
 2. Vacuum clean windings, frame; interior of housing, floor, and ventilation louvers for dry-type transformers prior to energizing.
 3. Use low pressure (maximum 25 psi) compressed dry nitrogen only if necessary to dislodge dirt from spaces between windings (repeat vacuum cleaning if this is done).
 4. Inspect all components for evidence of physical damage.

5. Inspect temperature indicator.
 6. Inspect heaters.
 7. Inspect all control wiring.
 8. Inspect grounding switch.
 9. Verify all electrical interlocks.
 10. Clean all insulators and barriers with appropriate solvent.
 11. Tighten all bolted connections to appropriate torque values.
 12. Verify transformer tap connections.
 13. Check frame ground connection.
 14. Check neutral ground connection.
 15. Clean fans and check for proper operation.
 16. Perform time-voltage (polarization index) tests on primary and secondary windings.
 17. Perform high potential insulation resistance test on primary winding.
 18. Perform primary to secondary turns ratio test on each phase.
 19. Perform power factor testing of all transformer winding in accordance with NETA specifications.
 20. Verify all safety grounds removed prior to energization.
- C. Polarization index tests shall be performed on each winding by applying DC test voltage between the primary winding and ground with the secondary winding grounded, and between the secondary winding and ground with the primary winding grounded. Each test procedure shall consist of the application of a predetermined voltage for a predetermined period of time, with leakage currents recorded at uniform intervals. Test voltages and time durations shall be as directed by the Engineer.
- D. High potential insulation resistance tests shall be performed on the primary winding by applying DC test voltage between the primary winding and ground with the secondary winding grounded. The test procedure shall consist of a step-voltage test in predetermined uniform steps up to a maximum test voltage, with leakage currents recorded after a stabilization time at each step. Voltage steps, maximum test voltages, and time durations shall be as directed by the Engineer.
- E. The primary to secondary turns ratio tests shall be performed on each phase winding pair (H1-H2 to X1-XO, H2-H3 to X2-XO, and H3-H1 to X3-XO) at the specified tap position.
- F. All transformer tests shall performed in accordance with IEEE Standard 62 (Recommended Guide for Making Dielectric Measurements in the Field), ANSI Standard C57.12.91 (Test Code for Dry-Type Distribution and Power Transformers), ANSI Standard C57.94 (Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers), and ANSI Standard C57.12.01 (General Requirements for Dry-Type Distribution and Power Transformers).
- G. Adjustments and minor repairs of the equipment, or any component thereof, shall be included in the Work.
- H. Upon energization of transformers functional tests shall be performed on all transformers including—primary switch tripping via over-temperature relay contacts, lockout relay functions, ground switch operation, verify secondary voltages via metering, CT's (including passing current through any differential CT's to confirm metering and relay performance) and safety devices (including any RTD devices).

3.10 LOW VOLTAGE SWITCHGEAR

- A. Work on low voltage switchgear requires isolation of the incoming electric utility line to the transformers. Equipment should not be energized prior to performing the prefunctional testing.
- B. Contractor shall be required to perform the following prefunctional procedures:
 - 1. Assure isolation of bus detail from load equipment.
 - 2. Vacuum clean all components, interior of housing, and floor prior to energization including circuit breaker cubicles and all other compartments.
 - 3. Clean all insulators and barriers with appropriate solvent.
 - 4. Inspect all components for evidence of physical damage.
 - 5. Tighten all bolted connections to appropriate torque values.
 - 6. Perform contact resistance test on all bus joints.
 - 7. Check settings of all relays as specified in coordination study.
 - 8. Test all relays in accordance with the manufacturer's recommendations and the settings shown in the coordination study.
 - 9. Verify all safety grounds removed.
 - 10. Visual inspection of transient voltage surge suppression devices.
 - 11. Confirm ratings of all power and control fuses.
 - 12. Perform current transformer ratio tests on all relaying CT's as well as saturation tests.
 - 13. Perform turns ratio tests on all relay and metering PT's to ensure correct ratios.
 - 14. Perform insulation resistance tests on all switchgear primary and secondary bus detail.
 - 15. Perform inspections of all switchgear control wiring.
 - 16. Verify size and type of power conductors to all switchgear sections.
 - 17. Perform primary injection testing on all circuit breakers once all settings have been received from the short circuit and coordination study.
 - 18. Perform contact resistance measurements on all circuit breakers.
 - 19. Verify correct operation of all controls, indications and interlocks.
 - 20. Verify grounding connections are completed as per the NEC.
 - 21. Verify proper load cable terminations are made per the specifications.
 - 22. Perform load testing (Heat Run) of the switchboards and perform Infrared scanning of all electrical connections during this heat run. Contractor to provide all load banks hook-up and disconnects of all load banks.
- C. Contact resistance tests shall be performed using a test current of 100 amperes across all bus joints.
- D. Adjustments and minor repairs of the equipment shall be included at as part of the prefunctional testing at no extra charge to the client.
- E. Upon energization of switchgear functional tests shall be performed on all switchgear controls including—circuit breaker tripping via relay contacts, automatic throw over schemes, lockout relay functions, ground switch operation, breaker control switches, PT's (verify secondary voltages), CT's (including passing current through CT's to confirm metering and relay performance), timing relays, and safety devices.

END OF SECTION

SECTION 261313

13.2 KV SERVICE SWITCHGEAR

PART 1 - GENERAL

1.1 DESCRIPTION

- A. General: Provide 13.2 KV Drawout metalclad switchgear in accordance with the Contract Documents.

- B. Intent:

The intent of this specification is to provide six (6) Con Edison 13.2 KV services with three (3) primary switchgears and one (1) secondary switchgear (collector bus switchgear).

- C. All work shall comply with Con Edison EO-2022, and EO-4035.

- D. Primary Switchgear shall be of the Arc type Mitigation type (Circuit breakers are controlled remotely by the mimic panel. Refer to Power Monitoring System Section 260913).

1. Incoming Cubicle: Should be prepared by manufacturer to receive incoming Con Ed cables. Includes neon detectors, phasing receptacles, etc.

Control wiring: Manufacturer shall provide required conductors, etc., for wiring all AC & DC control devices.

Potential Transformers: All customer' required PT's shall be provided as required drawout assemblies.

2. Con Ed Metering Transformer Cubicles: Manufacturer shall prepare these cubicles for field installation by the installing contractor of Con Ed issued CT's and PT's, including bus bars, insulator brackets, etc.
3. Circuit Breaker and Cell Cubicles: Manufacturer shall provide a 1200 ampere drawout vacuum circuit breaker approved by Con Ed. The cell shall be retrofitted to include the required drawout features such as shutters, interlocks, primary bushings, current transformers, racking mechanism, etc. Relaying shall be as required by Con Ed and
4. Each primary switchgear lineup shall be suitable for two (2) Con Edison services in NEMA Type #1 enclosure.
5. G&T Device and Ground Switch, as per Con Edison requirements (EO-2022).
6. Con Edison requires an interlock between the primary and secondary breaker such that if the primary trips, the secondary must open and the secondary cannot re-close unless the primary is closed first (they do not want to close primary into a load).

- E. Secondary Switchgear shall be of the ARC-Mitigation type, as described in paragraph 2.19.

1. Provide collector bus switchgear consisting of multiple 1200 ampere drawout vacuum circuit breaker NEMA Type 1 cubicles.

- F. Busses

Equip the complete switchgear with a 3-phase insulated copper bus bar system, including required brackets, insulators, hardware, insulated joints, etc. Prefabricate the bus bars at factory to simplify field installation.

- G. Include testing or commissioning of this equipment.
- H. All work shall be executed by the Contractor under the supervision of the manufacturer.
- I. Submit separate price for the following work:
 - 1. G&T Device Up to Latest Standards

G&T Ground and Test device shall be locked in any operating position, (open closed, ground and disconnect position). G&T device requires modification to bringing it to the latest standards.
- J. Utility Company
 - 1. All work shall comply with all applicable Con Edison Specification EO-2022 and EO-4035 (latest revision). Parallel Design Configuration. All six (6) line and load breakers; included tie breakers shall be normally closed.
- K. Equipment to be furnished is shown on attached one-line drawings, data sheets and arrangement drawing, which form part of this specification. All work shall be done and completed in a thorough workmanlike manner and in accordance with the best modern practices in manufacturing and fabrication. All materials used in the construction of the apparatus shall be selected as the best available for the purpose for which used, considering strength, ductility, accuracy, insulation, and best engineering practice.
- L. All vacuum breakers shall be electrically operated with a 125 volt DC voltage.
- M. Service switchgear shall be capable to communicate with a power monitoring system via Modbus RTU connectivity signals, etc., dry contacts, analog 4-20 ma.

1.2 RELATED SECTIONS

- A. 260573 – Power Systems Study
- B. 260913 – Electrical Power Monitoring System
- C. 262313 – 13.2kV Automatic Paralleling/Synchronizing Switchgear
- D. 263214 – 13.2 kV Standby Diesel Engine Generators
- E. 263625 – 13.2 kV Automatic Transfer Switches

1.3 SUBMITTALS

- A. Submit shop drawings and product information for approval and final documentation in the quantities listed according to the Conditions of the Contract. All transmittals shall be identified by customer name, customer location, and customer order number.
- B. Documents for Approval:
 - 1. General arrangement drawing showing dimensioned elevation and floor plan, side views, foundation details and one-line diagram, indicating any shipping splits.
 - 2. Complete arrangement drawing showing layout of devices on the switchgear doors.
 - 3. Elementary or schematic diagrams.

4. Plan showing exact location and details of channel sill, anchor bolts and terminations of power bus and control cables.
5. DC Schematics.
6. Nameplate engraving drawings.
7. Bill of material. Provide list of all the devices and accessories to be furnished. The bill of material shall include complete identification and description of all the devices.
8. O & M Manuals

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications:

Engage a firm with at least 15 years' experience in manufacturing medium voltage metal clad switchgear and circuit breakers. The manufacturer of the metal clad switchgear assembly and the manufacturer of the circuit breakers shall be approval equal to G.E., Eaton, Siemens.

B. With requirements of latest revisions of applicable industry standards, specifically including the following:

1. ANSI/IEEE C37.20.2 - Metal-Clad Switchgear.
2. ANSI/IEEE C37.04 – Rating Structure for High Voltage Circuit Breakers.
3. ANSI/C37.06 – Preferred Ratings for High Voltage Circuit Breakers.
4. ANSI/C37.90 – relays and Relay Systems.

The entire design shall comply and be approved by Con Edison.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in convenient shipping groups. The largest section of the shipping split shall be limited to for easy transportation. Manufacturer shall verify the transportation route prior to determine the largest section.
- B. Circuit breakers shall be shipped separately and each in its own crate or packaging for protection.
- C. Accessories cabinet and bus bar splice material for shipping splits shall be shipped attached to the switchgear to prevent from loss during shipment.
- D. Contractor shall store the equipment so that condensation will not form in the equipment, with heaters connected to external power source.
- E. Contractor shall install temporary heaters, if necessary, to prevent condensation during storage. Provide heaters in switchgear with thermostats and shall be rated at 208V but connected to a 120V power source for extended life.
- F. Contractor shall handle and move the switchgear in accordance with manufacturer's recommendations.

1.6 MIMIC PANEL

- A. A mimic panel shall be provided in a room shown on drawings for controlling the breakers.
- B. Refer to Section 260913, paragraph 1.1 C. 3. for additional information.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The 13.2 KV metal-clad switchgear assembly shall be manufactured by G.E., Siemens, Eaton.

2.2 DRAWOUT SWITCHGEAR

- A. The standard circuit breaker circuit includes a jig-assembled compartment and a drawout circuit breaker in required ratings. The full switchgear assembly is fabricated around these compartments.
- B. Switchgear consists of metal-clad units and auxiliary compartments, and is characterized by the following:
1. All live parts are completely enclosed within grounded metal enclosures.
 2. Secondary control devices and their wiring are isolated by grounded metal barriers from all high-voltage primary devices, except for short lengths of certain secondary wiring.
 3. Major parts of the primary circuit such as circuit breakers, transformers and buses are isolated.
 4. The circuit breaker is of the drawout type, equipped with self-coupling primary and secondary disconnecting contacts and is arranged with a disconnecting mechanism for moving it physically between connected and disconnected positions.
 5. Interlocks are provided to insure proper sequence and safe operation. Circuit breakers cannot be disconnected from the high voltage bushings with closed contacts; nor can they be connected with closed contacts.
- C. Switchgear consists of the following basic assembly sections:
1. Circuit breaker compartment.
 2. Drawout circuit breakers.
 3. Relay and metering compartment(s).
 4. Front accessible control voltage compartment behind front door.
 5. Required auxiliary compartments.
 6. Potential transformer drawout compartment(s).
 7. Rear bus bar and power cable compartment(s).
- D. RATINGS

The switchgear, circuit breakers, bus bars, and all materials, as applicable, shall conform to the following ratings:

<u>95 kV BIL Interrupting</u>	<u>S.C. Withstand</u>	<u>Chasing and Latching Capability (Momentary)</u>
63kA (1500 MVA)	40kA	130kA

Maximum Voltage Available: 15kV

Breaker Control: 125 VDC

Provide manufacturer's test certificate and report.

2.3 DRAWOUT CIRCUIT BREAKER

- A. Circuit breaker shall be 15 kV class, 3 pole, single throw automatic and electronically and mechanically trip free with a 40 KA interrupting rating at K=1.0. Circuit breaker position shall be equipped with two (2) normally open and two (2) normally closed auxiliary contacts in addition to the auxiliary switches required for normal circuit breaker control and operation.
- B. Circuit breaker shall be air insulated utilizing individual vacuum interrupters, mounted on epoxy insulators, suitable for the ratings as indicated in above.
- C. Circuit breaker pole shall include an indicating device that corresponds with the erosion of the contacts within the circuit breaker, over time.
- D. Breaker should meet endurance requirements per Table 17 of ANSI/IEEE C37.06.2009 Standard. (Schedule of operating endurance capabilities for circuit breakers)..
- E. The circuit breaker shall include self-aligning secondary (control voltage) and primary (high voltage) disconnecting contacts that are automatically connected as the circuit breaker is inserted (or withdrawn) while observing mandated interlocks.
- F. The circuit breaker drive mechanism shall be stored energy, electrically operated with any one of the following control voltages.

DC voltage: 125 volts DC

AC voltages shall be: 120 volts AC

- G. The mechanical drive shall be electrically operated, and shall contain in addition, mechanical close and trip buttons, as well as mechanical charge capabilities.

Panel display shall include: Spring charge indicator, "Open" semaphore, "Closed" semaphore.

- H. Circuit breaker drawout mechanism shall consist of a screw racking device available through the front closed door.

The circuit breaker shall include three positions:

- 1. Withdrawn position.
- 2. Test position.
- 3. Connected position.

Each position shall be marked by a positive detent, and shall be visible with the door closed.

Circuit breakers may be racked in or out manually in which case the operator stands in front of the circuit breaker being racked. Alternatively, for racking operation remote from the circuit breaker, electric racking is available with cable length as preferred.

- I. The breaker front panel shall be a grounded steel barrier that effectively isolates the instrument and control compartments. The front panel shall have the following control and indication features.
- J. Breaker open-close indication.

- K. Closing springs charged-discharged indication.
- L. Operations counter.
- M. Switchgear shutters are to be metal and shall be permanently marked to indicate the "Bus" or "Feeder" side primary stationary disconnects. Phase markings shall also be included.
- N. It shall not be possible to insert or remove a circuit breaker element from the connected position while the interrupters are in the closed position. The stored energy mechanism shall be discharged automatically prior to the circuit breaker element being withdrawn from the cubicle.
- O. Manual operating devices for racking the circuit breaker elements in and out of their cubicle shall be provided.
- P. An extension jumper shall be provided for each Switchgear assembly so that the circuit breaker, and the circuit breaker's operation, may be checked with the element outside of the circuit breaker cubicle.
- Q. The circuit breaker's operating mechanism shall be fully accessible by removing the front metal panel from the breaker and without removing the circuit breaker from the guide-rail assembly.
- R. The vacuum circuit breaker shall be capable of back-to-back capacitor switching of 20 MVAR. Test documents shall be presented documenting this performance.
- S. All bus work shall adhere to NYC code for maximum current per square inch for all service bus work.

2.4 ENCLOSURE

- A. Switchgear shall consist of breaker and auxiliary units, as indicated in drawings, assembled to form a rigid, self-supporting, metal-enclosed structure. Indoor metal clad switchgear shall be enclosed in a fully gasketed enclosure and shall include suitable access doors, front and rear doors with provision for padlocking; protected ventilation openings as required; interior lighting, utility outlets with protective devices; and equipment heaters with protective devices. Heaters are to remain energized with no switch or thermostat provided. In each unit, major primary circuit parts (breaker, buses; transformers) shall be completely enclosed by grounded metal barriers, including a front barrier as part of the circuit breaker.
- B. Switchgear units shall be arranged as shown on attached drawings.
- C. For rigidity during fault conditions all connections to roll-out potential transformer trays and control power transformer trays shall be rigid bus bars insulated to full voltage rating of switchgear assembly.
- D. Circuit breaker compartments shall be designed to house 15.0 KV removable-element circuit breakers. Stationary primary disconnect contacts shall be silver-plated copper. Grounded metal safety shutters shall isolate all primary connections in compartment when breaker is withdrawn from connected position.
- E. Furnish nameplates for each device as indicated in drawings. Nameplates shall be black letters on white background. Nameplates shall be fastened by screws There shall be a master

nameplate] that indicates equipment ratings, manufacturer's name, shop order number and general information.

- F. Energized bare parts mounted on doors shall be guarded where the door must be opened for maintenance of equipment or removal of drawout equipment.
- G. Furnish full height hinged covers which can be bolted closed for each cable compartment. All rear doors shall be capable of being padlocked.
- H. Enclosure shall have provisions for close coupled coordination to cast coil type secondary unit substation transformer.
- I. Provide a mimic bus on front of the enclosure. Mimic bus shall be adhesively backed plastic, or equal

2.5 ACCESSORIES

- A. Auxiliary contacts: 8 Stages, Normally Open and Normally Closed.
- B. Under-voltage release: Trips out circuit breaker in the event of absent or low control voltages.
- C. Dual trip coils: in the event a trip coil fails, a second coil is available for trip functions.
- D. Trip coil monitoring on each circuit breaker.

2.6 DRAWOUT CIRCUIT BREAKER CELL

- A. Each drawout cell shall be constructed of 11 gauge steel. Front doors shall be constructed of 11 gauge steel. Exterior standard color is ANSI 61, with other colors available by special order.
- B. Included shall be an automatic metal shutter mechanism that is operated by movement of the circuit breaker. The shutters shall open in the connected position, and shall be closed in the disconnect and test positions.
- C. Each circuit breaker cell shall contain the female component of the circuit breaker secondary plug.
- D. Each circuit breaker cell shall include six insulated primary bushings of ratings suitable to shoe selected above. The insulation shall be sufficient to protect current transformers installed over each primary bushing.
- E. Each cell to include remote motorized racking mechanism with closed-door position indication. Racking controlled by plug-in hand-held pendant.

2.7 SAFETY OPERATION

- A. The circuit breaker and cell shall contain sufficient safety ramps, cams, or other mechanical devices to assure the following:
 - 1. Circuit breaker may not be installed, withdrawn, or moved with closed primary (MV) contacts.
 - 2. Movement of the circuit breaker shall discharge all springs in the operating mechanism.
 - 3. Movement of the current circuit breaker shall trip open the circuit breaker (if closed), prior to the primary contacts parting.

- 4. Shutters may be locked closed (by padlocks).
- B. Optionally, the specifications may include front doors that are mechanically restrained when closed, to prevent the door from blowing open in the event of an internal short circuit.

2.8 METERS AND RELAYS

- A. Multifunction microprocessor type Eatoy PXM-2290 each circuit breaker or equal.
- B. Protective relays are provided as specified and are generally of the multiprocessor type, semi-flush mounted, drawout, with built-in test facilities.
- C. Meters and relays may be mounted on the front doors of the switchgear, or in the auxiliary cells over the switchgear.
- D. All protective relays shall be Solid State Multilin 350 or 850 per circuit requirement. Provide minimum the following functions:
 - 27: Under Voltage
 - 87: Differential
 - 86: Lockout
 - 51: Time Overcurrent
 - 50: Inst. Overcurrent
 - 59: Over Voltage
- E. Protective Multilin Relays are acceptable:
 - 1. GE Multilin 845 Transformer Protection Relay.
 - 2. GE Multilin 850 Feeder Protection Relay.

2.9 HIGH VOLTAGE BUS BAR SECTION

- A. All high voltage bus connections between compartments are accomplished at the rear section of circuit breaker. So all bus bars in switchgear connections are completely insulated with cycloalaphatic epoxy. Due to corona and potential cracking problems, slip-on sleeve type insulation is not permitted. Insulation is non-hygroscopic, non-tracking and fire retardant. All joints are booted or otherwise insulated. Insulation to power cables by installer.
- B. Bus bar conductor material shall be electrical grade copper, rectangular bar, with silver plated joints of adequate cross section laminates designed for the required continuous current carrying capabilities by ANSI standards to temperature rise and documented by design tests. The bus system is suitably braced to withstand specified short circuit conditions. Bus bars are passed between compartments via insulated windows located in common cubicle walls to required configuration.

2.10 INSTRUMENT TRANSFORMERS

- A. Current transformers shall be installed over the primary bushings, and shall be available for servicing from the front of the circuit breaker cell. Current transformers may be located elsewhere only if space over primary bushings is not available.

Each current transformer shall be terminated on shorting terminal blocks with ring type terminals, only.

- B. Potential transformers shall be installed in drawout assemblies that are suitably interlocked and protected. Potential transformers can be installed in the cell, over a circuit breaker in the same vertical section.

Optionally, fuse blow-out signaling devices may be provided, that will signal in the event that a fuse ruptures for any reason.

All fuses shall be current limiting.

- C. Primary connections to the transformers shall be insulated and enter the compartment through porcelain bushings.

2.11 CONTROL AND INDICATING LIGHTS

- A. Indicating lights shall be of the series resistor type with color caps designed for maximum visibility, low wattage consumption of the lamps (maximum 2 watts) and long service life shall be provided. Green and red indicating lights shall show the open and closed positions of the circuit breaker. Light Emitting Diode (LED) lights shall be utilized.

2.12 CONTROL AND AUXILIARY SWITCHES

- A. Control switches shall be rotary, multi-position, cam-operated, multi-stage type with dust cover and silver-to-silver contacts rated 600 volt and 20 amperes. Breaker control switches and selector switches shall have "pistol grip" handles. Meter switches shall all have "knurled knob" handles. Lockout switches shall have "oval" handles.
- B. Each circuit breaker unit shall be provided with a breaker control switch and two indicating lights, red (breaker closed) and green (breaker open). Control switches shall be three-position (close-off-trip) with spring return to center. Pistol grip handles to be provided.
- C. Each incoming line main circuit breaker, bus tie circuit breaker, and feeder circuit breaker unit shall be provided with a Truck Operated Cell (TOC) auxiliary switch. The TOC switch shall operate when the circuit breaker is racked into the connected position only. The Mechanism Operated Contact (MOC) auxiliary switch shall operate when the breaker closes and in either the connected or test positions. The TOC switch shall have a minimum of two normally open and two normally closed contacts rated at 10 amperes and 125 VDC. The MOC auxiliary switch shall have a minimum of five normally open and five normally closed contacts rated 10 amperes. All auxiliary switches shall be wired to terminal blocks located in the breaker compartment.

2.13 SPECIAL CONTROLS

- A. In order for the standby generator to start automatically, and all ATS switches transfer to standby power, normal power has to be failed in all six (6) Con Edison Services since all served the Collector bus of the service switchgear and all Con Edison Services are connected in parallel.
- B. For partial failure (when two (2) Con Edison Services failed) the standby generators shall not start. When three (3) or more Con Edison Services failed, then the service switchgear should be provided with programmable logic controller to open the feeder breaker of the service switchgear in a sequential manner to energize the standby generators via the corresponding medium voltage ATS. (It could be a possibility that a portion of the load is supported by the standby generator system and portion of the load supported by Con Edison.)

2.14 WIRING

- A. Each switchgear line up shall be completely assembled, wired, and tested at the factory, including all buses, connections, insulators, terminals, and terminal blocks.
- B. Secondary wiring shall be firmly laced and secured and terminated in approved molded-type terminal blocks conveniently located with respect to shipping splits and control conduit terminals.
- C. Terminal blocks shall be mounted such that the wires to them can be grouped and laced together in a neat and workmanlike manner. A sufficient number of terminal connections including 15 percent of spare terminals shall be provided for all control and instrument wiring.
- D. All secondary wiring shall be No. 14 AWG or larger, 90°C, 600 volt switchboard wire, type SIS, 41 strand, tinned copper and provided with a permanent wire marking system identifying the "from-to" wire designation.
- E. All current transformers and associated circuitry control wiring shall be terminated with insulated ring-tongue or locking spade terminals.
- F. Terminal blocks shall be Marathon series 1500 or approved equal.
- G. Two-pole, pullout disconnecting fuse blocks (with fuses) to be provided for each breaker to protect trip and close circuits.

2.15 NAMEPLATES

- A. Each cubicle shall be provided with engraved laminated plastic nameplates, white with black lettering and with identification as specified and indicated on the plans. Size to be specified by purchaser. Each exterior device shall have an identification plate including fuse blocks, interior devices, etc.

2.16 HEATERS

- A. Long life tubular heaters shall be supplied for each unit of outdoor Switchgear. Each shall be rated to deliver required watts at 208 volts. Each heater shall have a protective perforated metal cover. A 120/208V external source shall supply power to the heaters.

2.17 CERTIFIED TEST REPORTS

- A. Certified Test Reports of design and / or conformance in accord with the latest applicable ANSI standards shall be provided prior to award of contract. These tests shall be made with the circuit breaker specified connected in the cubicle of the same design as being provided in accord with these specifications. Such tests shall be made in a nationally recognized U. S. laboratory.
- B. The manufacturer shall provide five certified copies of test reports covering all factory tests made on the equipment and insulating materials.

2.18 MIMIC BUS

- A. Furnish factory installed mimic bus of service switchgear, accurately depicting phase bus work, utility inputs, outgoing connections and disconnecting means.

- B. Fushing bus 1/8 inch thick heat- and impact-resistant beveled bakelite 1/2 inch wide, secured to sheet metal with cadmium plated screws.
- C. Bus to be black color.

2.19 ARC MITIGATION

- A. All six (6) feeder breakers of secondary service switchgear shall be provided with SEL-751 Feeder Protection Relay, Directional Overcurrent, Arc-Flash Detection and High Impedance Fault Detection by Schweitzer Engineering Laboratories, Inc., or equal.
- B. The best way to minimize the impact of an Arc-Flash event by reducing the detection and circuit breaker tripping times. The Arc-Flash detection-based (AFD) protection can act on the circuit breaker in a few milliseconds and limit the Arc-Flash energy.
- C. The Arc-Flash protection option in the SEL-751 relay shall add four (4) fiber-optic AFD inputs and protection elements. There are two (2) types of application by SEL-751:
 - 1. Point-Sensor Applications
 - a. The Arc is detected by transmitting the Arc-Flash light via fiber-optic cable to the relay. If the relay optical receiver does not detect this light, the relay declares a malfunction and alarm.
 - 2. Fiber Sensor Application
 - a. One end of fiber-optic cable shall be connected to the optical detector of the relay and the other to the LED transmitter in the relay.
- D. Program one (1) of the available inputs of SEL-751 Relay to receive a dry contact to put the unit into a "maintenance mode" to reduce potential arc flash when working in front of the switchgear.

2.20 TEST CABINET FOR POWER/VACUUM CIRCUIT BREAKERS

- A. Provide one (1) Test Cabinet for vacuum circuit breakers. The test cabinet equal to General Electric GEK-105263B shall be used to operate a Power/VAC circuit breaker that has been removed from the metal-clad equipment.
- B. It shall provide convenient means of accessing the electrical close and trip circuits of the breaker during maintenance and inspection procedures.
- C. It should be provided in cabinet mounted with 8 foot cable, storage bracket, control power selector switch, close pushbutton switch for closing the breaker, trip pushbutton for opening the breaker, indicating light, fuse block, etc., 125 volt indicating light.

2.21 MOTORIZED REMOTE RACKING FOR VACUUM BREAKERS

- A. Motorized remote racking for vacuum breakers shall permit to operate motorized remote racking of the breaker standing at a safe distance, well outside the ARC-Flash boundary of the equipment. The operator can remotely select, disconnect, test, or connect positions for the circuit breaker.
- B. Self-powered when switchgear is energized provide external 120 VAC power.

- C. Unit shall be provided with 25 ft. cord.
- D. Motorized Remote Racking Device shall be equal to Eaton VCP –W-MR2.

2.22 OTHER ACCESSORIES

- A. Temporary grounding set for live-front switches and transformers.
 - 1. Ball-studs and clamps include a three-way copper terminal block, four (4) bronze ground clamps, and three (3) 6 ft. lengths of 2/o copper clear jacket ground cable with threaded-stud fermules equal to Hubbell Power Systems #T600 2246 "Ball Socket Set." (Provide four (4) sets of cables.)
 - 2. Hot Stick – "Shotgun" equal Hubbell Part #C4030291 for grip-all clampsticks, most versatile tool in a line worker's hands. (Two (2) required.)

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. See field service below.
 - 2. The electrical contractor shall provide the services of a New York State Licensed Professional Engineer to stamp and seal all details of seismic requirements for electrical equipment including but not limited to switchgear, transformers, power panels etc. and submit as a shop drawing for review of the Engineer.

3.2 DEMONSTRATION

- A. Switchgear Manufacturer shall provide a factory-authorized service representative to train Owner's maintenance personnel in the following:
 - 1. In procedures and schedules related to startup and shutdown, troubleshooting, serving, and preventive maintenance.
 - 2. Review data in the maintenance manuals.
 - 3. Schedule training with Owner with at least three week's advance notice.

3.3 FIELD SERVICE

- A. The switchgear manufacturer shall supply field service.

Technician(s) for installation and start up after equipment has been delivered. One man-day per breaker unit shall be included in the base price. This shall be included in all travel and living expenses. A separate price shall be quoted on a per man-day basis for any additional or lesser number of days needed by the buyer.

- B. Field service technician shall be a qualified technician having a minimum of 8 years field experience in the installation, operation, and maintenance of switchgear.

3.4 OPERATION AND MAINTENANCE MANUAL (PREPARED BY CONTRACTOR)

- A. Installation, operating, and maintenance instructions shall cover all the equipment furnished including all protective relays, power fuses, auxiliary relays, etc. and shall include characteristic curves for each different current transformer, protective relay, and power fuse.

3.5 TESTING OF 13.2 KV SERVICE SWITCHGEAR

- A. The service switchgear (primary and secondary) shall be tested in detail in accordance with all Con Edison testing requirements.
- B. All the testing shall be witnessed by Con Edison in accordance with Con Edison requirements, and as required by Javits and the Engineer.
- C. Testing shall be done to the satisfaction of Con Edison and the Engineer until Con Edison accepts the system.
- D. Tests of customer premises in preparation for restoring equipment to service, as per Con Edison Spec EO-4035 par. 11.

SITE TESTING OF 13.2kV EQUIPMENT-PRE-FUNCTIONAL & FUNCTIONAL REQUIREMENTS

Note: Include all tests required by Con Edison; utilize NETA certified testing

4.0 HIGH VOLTAGE CIRCUIT BREAKER

- 4.1 Work on a high voltage equipment requires isolation of the incoming electric utility company line if previously energized. The isolation will be arranged by the electrical contractor and performed by the electric utility company.
- 4.2 All procedures to be performed by the Contractor require coordination with the Owner, the Engineer, the electric utility company, and with any work planned or in progress on associated equipment by Contractor's personnel or any other persons.
- 4.3. Contractor shall be required to perform the following prefunctional procedures prior to energizing:
- Assure isolation of circuit breakers from load network.
 - Vacuum clean all components, interior of housing, and floor.
 - Clean all insulators and barriers with appropriate solvent.
 - Inspect all components for evidence of physical damage. Clean contacts and inspect for damage.
 - Check alignment and wipe of contacts.
 - Clean operating mechanism and inspect for damage.
 - Tighten all bolted connections to appropriate torque values.
 - Perform contact resistance test on all breaker contacts and bus joints.
 - Check settings of open relays as specified in coordination study.
 - Test all relays in accordance with the manufacturers' recommendations and the settings shown in the coordination study.
 - Verify all safety grounds removed.
 - Confirm ratings of all power and control fuses.
 - Close switch after all necessary preparations have been made for energization.
 - Perform vacuum interrupter integrity tests on all vacuum bottles in circuit breaker
 - Perform insulation resistance tests on all circuit breaker primary and secondary bus detail.
- 4.4 Contact resistance tests shall be performed using a test current of 100 amperes.
- 4.5 Adjustments and minor repairs of the equipment shall be included at as part of the prefunctional testing.
- 4.6 Upon energization of circuit breaker functional tests shall be performed on all controls including—circuit breaker tripping/closing via relay contacts and control switches, automatic throw over schemes, lockout relay functions, breaker control switches, CT's (including passing current through CT's to confirm relay performance), timing relays, and safety devices.

5.0 HIGH VOLTAGE FEEDER

- 5.1 Work on a high voltage feeder requires isolation of the feeder (if previously energized).
- 5.2 Contractor shall be required to perform the following pre-functional procedures prior to energizing feeder:
- Inspect cable terminations for evidence of physical damage.
 - Inspect shield grounding for damage.
 - Tighten bolted connections to appropriate torque values.
 - Perform high potential VLF insulation resistance tests on cable circuit.
- 5.3 High potential insulation resistance tests shall be performed on each phase of each cable circuit by applying VLF test voltage between each phase and ground. Voltage steps, maximum test voltages, and time durations shall be as specified by the final cable manufacturer or NETA specifications (only if the cable manufacturer doesn't specify).
- 5.4 All cable tests shall performed in accordance with IEEE Standards.

6.0 TRANSFORMER

- 6.1 Work on a transformer requires isolation of the transformer from the high voltage feeder and from the load network if previously energized. The procedures required to isolate the transformer from the high voltage feeder and from the load network shall be performed by the Contractor.
- 6.2 Contractor shall be required to perform the following prefunctional procedures prior to energization:
- Assure isolation of transformer from load network.
 - Vacuum clean windings, frame, interior of housing, floor, and ventilation louvers for dry-type transformers prior to energizing.
 - Use low pressure (maximum 25 psi) compressed dry nitrogen only if necessary to dislodge dirt from spaces between windings (repeat vacuum cleaning if this is done).
 - Inspect all components for evidence of physical damage.
 - Inspect temperature indicator.
 - Inspect heaters.
 - Inspect all control wiring.
 - Inspect grounding switch.
 - Verify all electrical interlocks.
 - Clean all insulators and barriers with appropriate solvent.
 - Tighten all bolted connections to appropriate torque values.
 - Verify transformer tap connections.
 - Check frame ground connection.
 - Check neutral ground connection.
 - Clean fans and check for proper operation.
 - Perform time-voltage (polarization index) tests on primary and secondary windings.
 - Perform high potential insulation resistance test on primary winding.
 - Perform primary to secondary turns ratio test on each phase.
 - Perform power factor testing of all transformer winding in accordance with NETA specifications.
 - Verify all safety grounds removed prior to energization.

- 6.3 Polarization index tests shall be performed on each winding by applying DC test voltage between the primary winding and ground with the secondary winding grounded, and between the secondary winding and ground with the primary winding grounded. Each test procedure shall consist of the application of a predetermined voltage for a predetermined period of time, with leakage currents recorded at uniform intervals. Test voltages and time durations shall be as directed by the Engineer.
- 6.4 High potential insulation resistance tests shall be performed on the primary winding by applying DC test voltage between the primary winding and ground with the secondary winding grounded. The test procedure shall consist of a step-voltage test in predetermined uniform steps up to a maximum test voltage, with leakage currents recorded after a stabilization time at each step. Voltage steps, maximum test voltages, and time durations shall be as directed by the Engineer.
- 6.5 The primary to secondary turns ratio tests shall be performed on each phase winding pair (H1-H2 to X1-XO, H2-H3 to X2-XO, and H3-H1 to X3-XO) at the specified tap position.
- 6.6 All transformer tests shall be performed in accordance with IEEE Standard 62 (Recommended Guide for Making Dielectric Measurements in the Field), ANSI Standard C57.12.91 (Test Code for Dry-Type Distribution and Power Transformers), ANSI Standard C57.94 (Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers), and ANSI Standard C57.12.01 (General Requirements for Dry-Type Distribution and Power Transformers).
- 6.7 Adjustments and minor repairs of the equipment, or any component thereof, shall be included in the Work.
- 6.7.1 Upon energization of transformers functional tests shall be performed on all transformers including—primary switch tripping via over-temperature relay contacts, lockout relay functions, ground switch operation, verify secondary voltages via metering, CT's (including passing current through any differential CT's to confirm metering and relay performance) and safety devices (including any RTD devices).

7.0 HIGH VOLTAGE SWITCHGEAR

- 7.1 Work on high voltage switchgear requires isolation of the incoming electric utility company line. Equipment should not be energized prior to performing the prefunctional testing.
- 7.2 Contractor shall be required to perform the following prefunctional procedures:
- Assure isolation of bus detail from load equipment.
 - Vacuum clean all components, interior of housing, and floor prior to energization.
 - Clean all insulators and barriers with appropriate solvent.
 - Inspect all components for evidence of physical damage.
 - Tighten all bolted connections to appropriate torque values.
 - Perform contact resistance test on all bus joints.
 - Check settings of all relays as specified in coordination study.
 - Test all relays in accordance with the manufacturer's recommendations and the settings shown in the coordination study.
 - Verify all safety grounds removed.
 - Visual inspection of transient voltage surge suppression devices
 - Confirm ratings of all power and control fuses.

- Perform current transformer ratio tests on all relaying CT's as well as saturation tests
 - Perform turns ratio tests on all relay and metering PT's to ensure correct ratio's.
 - Perform insulation resistance tests on all switchgear primary and secondary bus detail.
 - Perform inspections of all switchgear control wiring.
 - Verify size and type of power conductors to all switchgear sections.
- 7.3 Contact resistance tests shall be performed using a test current of 100 amperes across all bus joints.
- 7.4 Adjustments and minor repairs of the equipment shall be included at as part of the prefunctional testing.
- 7.5 Upon energization of switchgear functional tests shall be performed on all switchgear controls including—circuit breaker tripping via relay contacts, automatic throw over schemes, lockout relay functions, ground switch operation, breaker control switches, PT's (verify secondary voltages), CT's (including passing current through CT's to confirm metering and relay performance), timing relays, and safety devices.

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SECTION 261315

125 VOLT DC BATTERY SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide a dual 125 Volt DC Battery System consisting of:
 - 1. Batteries
 - 2. Battery Packs
 - 3. Battery Charger
 - 4. DC Distribution System with DC distribution panels and local DC panels
 - 5. Primary 3-phase, 3-wire, 480 volt AC; ATS switches.
 - 6. Rectifiers with 240 volt, 3-phase, 3-wire input and 125 volt DC output.
 - 7. 125 volt DC ATS Switches
- B. 125 volt DC battery system and the rectifiers will power the DC Distribution panels.
 - 1. Remote DC panels will be provided for 125 volt DC control power of:
 - a. 13.2 KV Service Switchgear.
 - b. 13.2 KV Generator Paralleling Switchgear.
 - c. 13.2 KV ATS Switches.
 - 2. Manufacturer of above equipment shall submit control load requirements for final sizing the capacity of DC system.
 - 3. The DC system shall contain bypass isolation AC and DC automatic transfer switches. All batteries shall be sized to be able to provide 200 operations of all 15 kV breakers.
- C. Each 125 V DC System shall be capable to carry the entire load in the event of failure of one of the systems.
- D. Equipment manufacturer shall submit DC loads and calculations based on equipment selected plus 20% spare capacity.

1.2 SUBMITTALS

- A. Product Data
 - 1. Submit manufacturer's catalog cuts.
 - 2. Submit power requirements for control power of all DC power devices and equipment.

PART 2 - PRODUCTS

2.1 STATION BATTERIES AND CHARGER

- A. The station battery installation shall include a battery, battery racks, a battery charger, DC distribution system and protective equipment.
- B. The station battery installation shall be housed where indicated.

2.2 BATTERY

- A. The battery shall consist of the required number of lead selenium cells, or approved equal, interconnected with proper connectors provided by the battery manufacturer to provide a nominal battery rating of 125 volts DC. Rubber or plastic numerals, of at least 1 inch in height, shall be provided by the battery manufacturer for field attachment to permit proper cell identification. Battery type should be approved by Con Edison.
- B. The battery shall have an ampere-hour capacity equal to at least 125 percent of the station's direct-current requirements including normal continuous loads plus intermittent loads or as indicated on drawings, whichever provides optimum capacity.
- C. Normal continuous load capacity shall be adequate for a 12-hour period.
- D. Intermittent load capacity shall be adequate so that at least three (3) openings and three (3) closings of each of the station's associated circuit breakers and can occur in an 12-hour period with no more than all circuit breaker simultaneously operating.
- E. Battery circuits shall be ungrounded. Batteries shall have a 20-year minimum life and a 5-year no cost replacement warranty.
- F. Ratings as recommended by the manufacturer of switchgear.

2.3 BATTERY RACKS

- A. Battery racks shall have welded steel frames and rails finished with two coats of paint of a color matching the battery charger enclosure. Racks shall be low enough to permit maintenance to be done by personnel standing at floor level.
- B. Rails shall have a top covering of plastic or rubber at least 1/16 inch thick.
- C. Paint, rubber, and plastic shall resist corrosion and action of the electrolyte.
- D. The installation shall be provided with a portable hydrometer syringe and thermometer. Where recommended by the manufacturer, the installation shall include a cell lifter.

2.4 BATTERY CHARGER

- A. The battery charger shall be listed under UL 1236. It shall be a constant voltage, output and battery eliminator filters, voltage-regulated, fully automatic type rated for full-float charging of the associated battery.
- B. The battery charger shall be convection cooled and suitable for operation on electric power supplied from the associated low-voltage alternating-current panelboard, shall have adequate capacity to fully recharge the associated depleted battery in not more than 4 hours while supplying normal direct-current loads, and shall have an efficiency of not less than 90 percent.
- C. The battery charger shall have input and output circuit breakers which automatically disconnect the battery charger when faults occur.
- D. The battery charger shall have an output ammeter and voltmeter, and equalizing-float selector switch, and an equalizing timer with a range of 0 to 24 hours.

- E. The battery charger enclosure shall be painted as specified for indoor cabinets and shall be provided with wall mounting brackets or shall be free-standing as required by its size and weight.
- F. Alarm assembly with local LEDs and summary relay contact for ac failure, high Vdc, low Vdc, positive and negative ground fault with individual alarm contacts for each of the alarms, shall be installed on the battery charger to actuate the associated SCADA alarms.
- G. A transistorized current limiter and a relay interrupter or equal shall protect against short circuits.
- H. A circuit breaker shall protection against overloads.
- I. Enclosure shall include the following features:
 - 1. An on/off control switch.
 - 2. Float and high-rate controls.
- J. Alarm lights and contract closure, which separately indicate each of the following conditions: Provide separate dry alarm contacts for the Power Monitoring or BMS System.
 - 1. AC power failure.
 - 2. High DC voltage.
 - 3. Low DC voltage.
 - 4. Ground fault.
- K. DC Voltmeter
- L. DC Ammeter
- M. Heavy-duty, pressure-type, terminal blocks for all external wiring connections.

2.5 RECTIFIERS

- A. Provide two (2) 40 KW Rectifiers, 208 volt AC input and 125 volt DC.

2.6 DC DISTRIBUTION PANEL

- A. Provide DC Distribution Panel with feeder branch circuit breakers, as shown on the drawings.
- B. Local DC panels with 2P branch circuit breakers.

END OF SECTION

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SECTION 261316

13.2 KV OUTDOOR SWITCHES FOR
PORTABLE LOAD BANKS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide outdoor NEMA 3R medium voltage free standing metal enclosed non-fused interrupter switches in accordance with the Contract Documents.
- B. System will consist of four (4) sections assembly to accept two (2) 2000KW 13.2 kV load banks. Each load outdoor switch shall consist of two (2) sections; one (1) containing the switch and the other containing terminals for accepting the portable load bank wiring.
- C. Provide kirk-key interlock to prevent the opening of the door when circuit breaker of the paralleling switchgear supplying the switch is closed. See detail on the drawings.

1.2 WORK INCLUDED

- A. Metal enclosed non-fused interrupter switches.
- B. Accessories.
- C. Mimic Bus

1.3 SUBMITTALS

- A. The manufacturer shall furnish, with each metal-enclosed interrupter switch assembly, a set of drawings complete with a bill of material and showing: typical front views and open side views for each bay as well as typical components, their positions, and available space for cable termination; an anchor bolt plan with dimensions and weights; a one-line diagram; and appropriate wiring diagrams.
- B. The manufacturer shall furnish a comprehensive instruction manual covering the installation of the switches and operation of the various components which includes parts list, fuse replacement, equipment adjustment and lubrication instructions.
- C. The submittal shall be coordinated with the medium voltage transformer submission that each switch will serve.
- D. All concrete housekeeping pads must be sized and illustrated.
- E. Conduit entrance locations and requirements must be identified.
- F. Test Reports
 - 1. Submit certified factory test reports.
 - 2. Submit certified reports of field quality testing.

- G. Submission shall be coordinated with the short circuit and coordination study specified in the Overcurrent Protective Device Coordination Study section of these specifications.

1.4 QUALITY ASSURANCE

- A. The metal-enclosed unfused interrupter switches shall conform to or exceed the applicable requirements of the following standards and codes:
 - 1. ANSI C37.20.3 (Standard for Metal-Enclosed Interrupter Switchgear).
 - 2. ANSI C37.20.4 (Standard for Indoor AC Medium-Voltage switches).
 - 3. The applicable portions of National Electrical Code (NEC), which specifies that the interrupter switches in combination with power fuses safely withstand the effects of closing, carrying, and interrupting all possible currents up to the assigned maximum short-circuit rating.
 - 4. ANSI 48 (Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminations).
 - 5. UL
- B. Equipment suppliers shall have local representation and shall have been actively engaged in the assembly, installation and service of this equipment for a period of at least 15 years.
- C. Equipment suppliers shall have full parts backup and a 24 hour per day service availability for this equipment.

PART 2 - PRODUCTS

2.1 GENERAL

- A. To ensure a completely coordinated design, the metal-enclosed interrupter switches shall be constructed in accordance with the minimum construction specifications suitable for exterior application NEMA 3R.

2.2 ENCLOSURE CONSTRUCTION

- A. In establishing the requirements for the enclosure design, consideration shall be given to all relevant factors such as controlled access; tamper resistance; corrosion resistance; protection from ingress of rodents and insects and the possibility of arcing faults within the enclosure.
- B. The enclosure of each switch shall be bolted type construction to maximize strength, minimize weight, and inhibit corrosion.
- C. The material for all external sides of the enclosure and the roof shall be 14-gauge hot-rolled, pickled and oiled steel sheet.
- D. Each switch containing high-voltage components shall be a complete unit in itself.
- E. The base shall be a continuous steel channel of a thicker gauge material that is used for the enclosure and shall extend completely around all four (4) sides of each switch. Channel shall be bolted to the concrete housekeeping pad.

- F. To guard against unauthorized or inadvertent entry, there shall be no access to the high voltage compartments through rear sheets of the metal-enclosed switchgear assembly.
- G. To guard against corrosion, all hardware (including door fittings, fasteners, etc.), all operating-mechanism parts, and other parts subject to abrasive action from mechanical motion shall be of either nonferrous materials, or galvanized or zinc-nickel plated materials. Cadmium plated ferrous parts shall not be used.
- H. Externally accessible hardware shall not be used for the support of any high voltage components or switch-operating mechanisms within the switch.

2.3 DOOR CONSTRUCTION

- A. Doors shall be constructed of 14-gauge hot-rolled, pickled and oiled steel sheets.
- B. Doors shall have 90-degree flanges and shall overlap with the door openings. For strength and rigidity, and to minimize exposure, the door flanges shall be welded at the corners and shall be formed (at the top and both sides as a minimum) with a double bend so that the sheared-edge flanges at the top and both sides fold back parallel to the inside of the door.
- C. Doors shall have a minimum of three (3) concealed galvanized steel or non-ferrous hinges with stainless-steel hinge pins.
- D. Each door shall be equipped with a door handle. The door handle shall be padlockable.
- E. In consideration of controlled access, tamper resistance, and arcing faults, each door over 40 inches in height shall have a minimum of three (3) concealed, interlocking, high-strength latches. Doors 40 inches in height or less shall have a minimum of two (2) such latches.
- F. All doors providing access to high-voltage components shall be provided with a sturdy, self-latching door holder, which shall be zinc-nickel plated and chromate dipped.
- G. A viewing window shall be installed in all switch enclosure doors and located to enable visible inspection of the switch blades and blown fuse indicators from outside the enclosure.
- H. Infrared inspection windows (set of 3) shall also be provided to allow for infrared scanning of load cable terminations without opening the enclosure door.

2.4 ACCESS CONTROL

- A. Access control shall be provided as follows:
 - 1. Doors providing access to interrupter switches shall be mechanically interlocked to guard against:
 - a. Opening the door if the interrupter switch on the source side of is closed, and
 - b. Closing the interrupter switch if the door is open.
 - 2. Doors and hinged-bolted panels providing access to the high-voltage components shall be provided with flush-mounted key-operated snaplocks and shall have provisions for padlocking.

2.5 INSULATORS

- A. The interrupter-switch and fuse-mounting insulators, main-bus support insulators, insulated operating shafts, and (if applicable) push rods shall be of a cycloaliphatic epoxy resin system with characteristics and restrictions as follows:
 - 1. Operating experience of at least 15 years under similar conditions.
 - 2. Adequate leakage distance established by test per IEC Publication 507.
 - 3. Adequate strength for short-circuit stress established by test.
 - 4. Conformance with applicable ANSI standards.

2.6 LOW-VOLTAGE COMPONENTS

- A. All low-voltage components, meters, instruments, and relays, shall be located in grounded, metal-enclosed compartments separate from the high voltage compartments to provide isolation and shall be arranged to allow complete accessibility for operation without exposure to high voltage.
- B. Space heaters, where used, shall have a grounded, perforated, galvanized steel guard.
- C. To provide isolation from high voltage, low-voltage wiring, except for short lengths such as terminal blocks or at secondaries of any sensing devices, shall be in grounded conduit.

2.7 CABLE TERMINATION SPACE

- A. To facilitate cable pulling and the installation of cable terminators, provisions shall be made for:
 - 1. Full front access for positioning and removal of the cable pulling sheaves.
 - 2. Free access without interference from non-removal structural members or from mechanical linkages between the interrupter-switch blades and operating mechanism.

2.8 SWITCH FINISH

- A. During fabrication, the areas of structural parts which may later become inaccessible, such as folded edges and overlapping members, shall be given an iron-oxide zinc-chromate anticorrosion primer to ensure that all surfaces are protected.
- B. Full coverage at joints and blind areas shall be achieved by processing enclosures independently of components such as doors and roofs before assembly.
- C. The finishing system shall be selected to provide adhesion, resiliency, durability, color stability, and stain resistance.
- D. After the enclosures are completely assembled and the components (switches, etc.) are installed, the finish shall be inspected for scuffs and scratches. Blemishes shall be carefully retouched to restore the protective integrity of the finish.
- E. Refinishing materials -- with complete instructions -- shall be included with each shipment of metal-enclosed switches for touch-up in the field.

- F. The finish shall be light gray, satisfying the requirements of ANSI Standard Z55.1 for No. 61. The average thickness of the paint film shall be 2.0 mils. Paint film shall be uniform in color and free from blisters, sags, flaking and peeling.

2.9 SWITCH FEATURES

- A. Lifting eyes shall be removable.
- B. Drip-proof Construction (Gasketing & Sealing)
 - 1. Door openings and openings for hinged bolted panels (and bolted panels providing access to low-voltage components) shall have resilient compression gasketing to prevent water from entering the enclosure.

2.10 BASIC COMPONENTS

- A. Metal Enclosed Interrupter Switches
 - 1. Switches shall have a one-time or two-time duty-cycle fault-closing rating equal to or exceeding the short-circuit rating of the switch. These ratings define the ability to close the interrupter switch alone (unfused), once or twice (as applicable) against a three-phase fault with asymmetrical current in at least one (1) phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current. Tests substantiating these ratings shall be performed at maximum voltage. Certified test abstracts establishing such ratings shall be furnished upon request.
 - 2. Switches intended for manual operation shall be operated by means of an externally operable, non-removable handle. The handle shall have provisions for padlocking in both the open and closed positions.
 - 3. Switches shall utilize a quick-make quick-break mechanism which shall swiftly and positively open and close the interrupter switch independent of the switch-handle or switch operator operating speed.
 - a. For manually operated interrupter switches, the quick-make quick-break mechanism shall be integrally mounted to the switch frame.
 - 4. Switches shall be completely assembled and adjusted by the switch manufacturer on a single rigid mounting frame. The frame shall be of bolted steel construction such that the frame intercepts the leakage path which parallels the open gap of the interrupter switch, to positively isolate the load circuit when the interrupter switch is in the open position.
 - 5. Switches shall be provided with a single blade per phase for circuit closing including fault closing, continuous current carrying, and circuit interrupting. Spring-loaded auxiliary blades shall be permitted.
 - 6. Circuit interruption shall be accomplished by the use of an interrupter which is positively and inherently sequenced with the blade position. Circuit interruption shall take place completely within the interrupter, with no external arc or flame.
 - 7. Switches shall have a readily visible open gap when in the open position to allow positive verification of switch position.
 - 8. Terminals on interrupter switches to which cable will be terminated shall be equipped with grounding provisions. Grounding provisions shall also be provided on the ground bus in such switches.
 - 9. Provide metal oxide surge arresters in accordance with IEEE C62.11.

2.11 RATINGS

- A. The distribution system will be grounded.
- B. The ratings for each medium voltage interrupter switch assembly shall be as designated below.
 - 1. System voltage: 15KV, 3-phase, 3-wire, 60 Hz Nominal as shown on drawings.
 - 2. Maximum Design Voltage: 15KV maximum.
 - 3. Impulse Withstand: 95 kV, BIL
 - 4. Main Copper Bus Ampacity: 600A Continuous.
- C. The momentary and duty-cycle fault-closing ratings of the interrupter switches, and interrupting ratings of the fuses shall equal or exceed the short-circuit ratings of the metal-enclosed switches.

2.12 LABELING

- A. Warning Signs
 - 1. All external doors and hinged bolted panels providing access to the high voltage compartment shall be provided with "Caution -- High Voltage -- Keep Out" signs.
 - 2. All internal protective screens providing access to the high voltage compartments shall be provided with "Danger -- High Voltage -- Keep Out -- Qualified Persons Only" signs.
 - 3. All internal protective screens providing access to the interrupter switches shall be provided with warning signs indicating that "Switch Blades May be Energized in Any Position."
 - 4. All internal protective screens providing access to fuses shall be provided with warning signs indicating that "Fuses May Be Energized in Any Position."
- B. Rating Nameplates
 - 1. The interrupter switches shall be provided with an external nameplate indicating the manufacturer's drawing number and the following: voltage ratings (kV nominal; kV maximum; kV BIL); main bus continuous rating (amperes); short-circuit ratings (amperes, RMS symmetrical and MVA three-phase symmetrical at rated nominal voltage); and the momentary and fault-closing ratings (amperes, RMS asymmetrical). The external nameplate shall include the UL classification markings comprised of "UL" in a circle; the word "Listed"; the assigned control number; and the product identity.

2.13 MIMIC BUS

- A. Provide a factory installed mimic bus on the switches, accurately depicting phase bus work, take-offs, connections, meters and disconnecting means per the factory record as-built drawings.
- B. Mimic bus shall be ¼ inch thick, heat and impact resistant, beveled bakelite, ½ inch wide, secured to the switch enclosure with cadmium plated screws.
- C. Mimic bus on the normal switches shall be ivory colored and red colored on the emergency switches.
- D. Mimic bus shall be installed prior to energizing the equipment.

2.14 ACCEPTABLE MANUFACTURERS

- A. Eaton
- B. Square 'D'
- C. Siemens
- D. General Electric
- E. S&C Electric Company

PART 3 - EXECUTION

3.1 GENERAL

- A. Terminate medium voltage cables according to the manufacturer's recommendations.
- B. Provide ground connections in accordance with the NEC.
- C. At the completion of the work, the Switches shall be field tested by the service organization of the manufacturer to insure that components and system functions are correct. Tests shall include operation of each disconnecting means; any kirk-key interlock system; and other tests as listed within these specifications.
- D. All equipment shall be installed on a 4" high concrete housekeeping pad.

3.2 DELIVERY AND SET-UP

- A. The switches shall not be delivered to the job-site until they are to be placed in its final location. Switches shall be protected from water and construction debris until and when energized. Heaters shall be kept energized to prevent condensation during storage.
- B. Complete assemblies shall be placed in the available space as shown on the Contract Documents.
 - 1. Provide not less than minimum working clearances according to the Code at the front, where access for connections are required.
 - 2. Space shall be available for the removal or disassembly of any other electrical equipment in the room.
- C. The Switches shall be completely assembled and all terminations torqued and completed for inspection.
- D. The interior of the Switches shall be completely cleaned and vacuumed of all foreign debris.
- E. The Switches shall be fully inspected by the manufacturer's authorized representatives before they are energized.
- F. Mimic bus shall be installed prior to energizing the service.

3.3 EXAMINATION

- A. Visually inspect switches for evidence of damage and verify that surfaces are ready to receive work.
- B. Visually inspect to confirm that all items and accessories are in accordance with the Contract Documents.
- C. Verify field measurements are as shown on the Contract Documents.

3.4 INSTALLATION

- A. Install in accordance with manufacturer's instructions, applicable requirements of the NEC and in accordance with recognized industry practices.
- B. Bending of medium-voltage cables should be avoided or minimized. All necessary bends should meet at least the minimum radii specified by the cable manufacturer.
- C. Where medium voltage cables are exposed in the switch, wrap the conductors with fire and arc proofing tape, similar to 3M scotch #77 or acceptable equivalent.

3.5 FIELD QUALITY TESTING

- A. Field inspection and testing will be performed by the Electrical Contractor and the equipment manufacturer's approved representatives.
- B. Visually inspect for physical damage.
- C. Perform mechanical operator tests in accordance with the manufacturer's instructions. Check blade alignment and arc interrupter operations of each load interrupter switch.
- D. Check torque of all bolted connections, including cable terminations, either by observing the bead of indicating compound to confirm that it is still intact, or with a torque wrench to confirm the joint is tightened to the manufacturer's specifications.
- E. Touch-up paint all chips and scratches with manufacturer-supplied paint and leave remaining paint with Owner.
- F. Perform insulation resistance test on each phase to ground and each phase to each other phase. Record and submit the results.
- G. Perform low-frequency withstand tests according to ANSI/IEEE C37.20.3.
- H. Perform contact resistance test across each switch blade; report any contact resistance in excess of 50 micro-ohms.

3.6 Provide a 36" wide x 1/4" thick insulation mat in the front and rear of the entire switch lineup rated for a dielectric test voltage of 30,000 volts.

3.7 WARRANTY

- A. Provide a 2-year warranty from the date of substantial completion for all defects in material and workmanship.

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SECTION 262200

LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide all low-voltage distribution transformers rated 1000V or less, as specified herein and in accordance with the Contract Documents.

1.2 RELATED DOCUMENTS

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

1.3 WORK INCLUDED

- A. Dry Type Transformers.
- B. Vibration Isolation.
- C. Mounting Supports.

1.4 SUBMITTALS

- A. Manufacturer's Data
 - 1. Submit manufacturer's data, including electrical ratings, heat release data, physical dimensions, noise ratings and weights for each type and size dry type transformer as indicated on the Contract Documents.
 - 2. Factory Test Results.
 - 3. Certified vibration isolation and seismic restraint details and product data indicating the number and location of each support and restraint; and the exact number, size and type of each anchor.
 - 4. Field Quality Control test reports, per Part 3 of these specifications.
 - 5. Detailed wiring diagrams identifying terminals for tap changing and connecting field-installed wiring.
 - 6. Operation and Maintenance Data.
 - 7. Termination Lugs Quantity and Size

1.5 REFERENCE STANDARDS

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
 - 1. U.L. Standard 506 - Transformers
 - 2. U.L. Standard 1561 – K-Factor Rated Transformers
 - 3. ANSI/IEEE C57.12.01 – General Requirements for Dry-Type Distribution and Power Transformers.
 - 4. ANSI/IEEE C57.12.91 – Test Code Dry-Type Distribution and Power Transformers.
 - 5. ANSI/IEEE C57.110 – Recommended Practice for Establishing Transformer Capability When Supplying Non-sinusoidal Load Currents.
 - 6. NEMA ST 1 – Specialty Transformers
 - 7. NEMA ST 20 – Dry-Type Transformers for General Applications

8. DOE2016 – U.S. Department of Energy, Energy Conservation Program,
9. Distribution Transformers Energy Conservation Standards DOE 10 CFR Part 431. Revised April 2013.
10. All dry type transformers shall be of the quiet type, operating at sound levels below NEMA ST 20 standards as follows: Sound levels shall be warranted by the manufacturer.

Size in kVA	Specification*	NEMA ST 20
0-9	35 dB	40 dB
10-50	40 dB	45 dB
51-150	45 dB	50 dB
151-300	50 dB	55 dB
301-500	55 dB	60 dB
501-700	60 dB	62 dB
701-1000	62 dB	64 dB

*The specified sound level is 2 to 5 dB below NEMA ST 20 standard and it shall be applied for specified temperature rise and K-factor equivalent kVA.

1.6 QUALITY ASSURANCE

- A. All equipment and material provided on this Project shall be UL or ETL listed, in accordance with the requirements of the Authority having jurisdiction, and suitable for its intended use on this Project.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
- C. Source Limitations: Obtain each transformer type through one (1) source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.7 DELIVERY, STORAGE AND HANDLING

- A. Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods when equipment is not energized and when units are not in a space that is continuously under normal environmental controls.

1.8 WARRANTY

- A. Comply with the requirements of Division 01 and Section 26 00 01 – "Electrical General Conditions"

PART 2 - PRODUCTS

2.1 DRY TYPE TRANSFORMERS

- A. Transformers shall be 115°C. temperature rise above 40°C. ambient. Transformers shall be capable of carrying a 15% continuous overload without exceeding a 150°C. rise in a 40°C. ambient.
- B. All insulating materials shall exceed NEMA standards and be suitable for 220°C. U.L. component recognized insulation system.
- C. Coils
 - 1. Coil conductors shall be continuous with terminations welded without auxiliary flux material. Coils shall be wound with copper magnet wire, vacuum impregnated with non-hydroscopic, thermosetting varnish. Coils shall be protected with an outer layer of glass tape or similar quality insulation. Provide each layer with end-fillers or tie-downs to ensure maximum mechanical strength. Tap terminations shall be to magnet wire. Primary and secondary magnet wire shall be braced directly to bus studs or lugs. Windings shall be continuous with no splices. One (1) coil per phase in the primary and secondary.
- D. Core
 - 1. Core shall be manufactured from a high-grade, non-aging 29 gauge silicon steel with high magnetic permeabilities, low hysteresis and eddy current losses. Magnetic flux densities shall be kept well below saturation to allow for a minimum of ten (10) percent over-voltage excitation.
 - 2. Laminations shall be cut with the direction of the grain and free from burrs. All laminations shall be core plated or annealed and firmly butted. The core laminations shall be clamped tightly and compressed to provide quiet operation and to prevent damage during shipment or rough handling.
 - 3. Taps for Transformers 25kVA and Larger: Provide NEMA Standard taps: two (2) 2.5% above and four (4) 2.5% below normal full capacity. For step-up transformers provide two (2) 2.5% above and two (2) 2.5% below normal full capacity.
 - 4. Taps for Transformers 7.5 to 24kVA: One (1) 5% tap above and one (1) 5% tap below normal full capacity.
 - 5. The core and coil assembly shall be grounded to the enclosure by means of a flexible copper grounding strap of adequate size.
- E. Enclosures
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
 - 2. Provide lifting brackets on all sizes.
 - 3. Ventilated openings shall be such as to avoid accidental access to live parts.
 - 4. The entire enclosure shall be degreased, cleaned, phosphatized and painted with one (1) coat of zinc chromate primer and two (2) coats of ANSI 61 gray enamel.
 - 5. NEMA 250, Type 2, ventilated.
 - 6. The following enclosure requirements shall be in accordance with UL Standard 506:
 - a. Ventilation Openings
 - b. Corrosion Resistance
 - c. Cable Bending Space
 - d. Grounding Provisions
 - e. Surface Temperatures
 - f. Wiring Compartment Temperature Rise Terminations

F. Mounting

1. Ventilated units up to 750 lb: Suitable for wall, floor or ceiling mounting
2. Ventilated units over 750 lb: Suitable for floor mounting only.

G. Vibration Isolation

1. All transformers shall have vibration isolation that isolates the enclosure from the core and the coil assembly. Additional vibration isolators shall be provided between trapeze or universal hangers of suspended transformer and its case and between transformer enclosure and floor for floor mounted units. Use flexible metallic conduit of 24 inch minimum length, with external grounding jumper for final connection to transformer enclosure.
2. Each dry type transformer shall be resiliently suspended on double deflection neoprene in the shear hanger rod isolator assemblies, capable of providing minimum 3/8 inch static deflection.
3. Trapeze mounted assemblies shall be equipped with seismic cables appropriate for building seismic zone.

H. Low Magnetizing Inrush Current

1. Provide low magnetizing inrush current type transformers rated for 4x the full load current rating of all step-up transformers.

2.2 EFFICIENCY LEVELS

- A. All transformers shall meet DOE 2016 efficiencies as identified in the table below.

Single Phase		Three Phase	
KVA	DOE 2016 Efficiency	KVA	DOE 2016 Efficiency
15	97.70	15	97.89
25	98.00	30	98.23
37.5	98.20	45	98.40
50	98.30	75	98.60
75	98.50	112.5	98.74
100	98.60	150	98.83
167	98.70	225	98.94
250	98.80	300	99.02
333	98.90	500	99.14
		750	99.23
		1000	99.28

2.3 SHIELDED ISOLATION (K-RATED) TRANSFORMERS

- A. Transformers indicated on the Contract Documents to be shielded isolation type or K-rated shall be provided with an electrostatic shield consisting of a single turn of copper placed between the primary and secondary windings and grounded to the transformer core.
- B. Shielded isolation type or K-rated transformers indicated on the Contract Documents shall be U.L. listed as suitable for non-sinusoidal current loads with a minimum K factor of K-13. The secondary neutral conductor and neutral pad shall be rated to carry 200% of the nominal phase current.
- C. Core and winding design shall be such as to minimize eddy current losses and to reduce the core flux density well below the saturation point to prevent core overheating caused by harmonic distortion.

2.4 ACCEPTABLE MANUFACTURERS

- A. Being listed as an approved manufacturer does not permit the manufacturer to provide standard manufactured equipment which does not comply with the performance and/or physical characteristic requirements.
- B. If it complies with these Specifications, dry-type transformers manufactured by one (1) of the following manufacturer's will be acceptable:
 - 1. General Electric
 - 2. Square 'D'
 - 3. Eaton/Cutler Hammer
 - 4. Siemens
 - 5. Hammond Power Solutions
 - 6. REX Power Magnetics

PART 3 - EXECUTION

3.1 GENERAL

- A. Where transformers are to be floor mounted, transformers shall be installed on a 4" high concrete housekeeping pad. Provide $\frac{3}{4}$ " thick neoprene pads between the transformer stand and housekeeping pad. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Contractor to confirm transformer is leveled.
- B. Provide grounding conductor from the transformer secondary to the nearest building ground for each separately derived system. Grounding electrode conductor shall be sized in accordance with NEC Section 250 for the derived phase conductors.
- C. Transformer taps shall be adjusted for rated output voltage under normal operating conditions.
- D. Correct any deficiencies identified by tests and retest until acceptable results are achieved.
- E. Provide engraved nameplates for each transformer. Nameplate for transformer to include the following:
 - 1. Manufacturer Information.
 - 2. UL Stamps.
 - 3. KVA Rating.
 - 4. Primary and Secondary Voltage.
 - 5. Tap Voltages and Percentages.

6. Insulation Class.
7. Temperature Rise.
8. Weight.
9. Impedance.
10. Wiring Configuration.
11. Enclosure Type.
12. Date of Installation.

3.2 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

3.3 FACTORY TESTING

- A. Ratio tests at the rated voltage connection and at all tap locations.
- B. Polarity and phase relation tests on the rated voltage connection.
- C. Applied and induced potential tests.
- D. No load and excitation current at rated voltage on the related voltage connection.

3.4 FIELD TESTING

- A. Verify Transformer Secondary Voltage.
 1. Ensure proper primary and secondary voltages.
 2. Compile a comprehensive listing of transformers, including ratings, locations and mounting type.
 3. Compare equipment nameplate data with the Contract Documents and specifications.
 4. Inspect physical and mechanical condition.
 5. Verify that resilient mounts are free and that any shipping brackets have been removed.
 6. Verify ground has been installed.
 7. Measure primary and secondary voltages.
 8. Insulation Resistance Tests.
 9. Perform an Infrared Scan of transformer connections.
- B. Submit all test results.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus ten (10) percent and not being lower than nameplate voltage minus three (3) percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus five (5) percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

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SECTION 262216

13.2 KV DELTA/13.2 KV WYE ISOLATION
CAST COIL POWER TRANSFORMERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This specification provides the technical requirements for the design, manufacture and test of 13.2 KV Delta/13.2 KV WYE 6000/7500 AA/FA, 80/80 deg. C rise above 30 average/40 maximum ambient, .5.75% \pm cast coil-type isolation outdoor transformers. Provide all accessories and equipment as described herein and shown on Project Drawings as necessary for a complete installation.
- B. Outdoor transformers are shown on the drawings; they shall include thermostatically controlled space heaters fed from an external source which remains energized when the transformer is de-energized (Blowers, 208v). Provide special ventilating grills that restrict the passage of rain or spray providing the degree of weather protection of a NEMA 3R enclosure.
- C. Transformers shall be designed to meet the sound level standards for dry-type transformers as defined in NEMATRI.

1.2 RELATED SECTIONS

- A. 260573 – Power Systems Study
- B. 260913 – Electrical Power Monitoring System
- C. 262313 – 13.2 kV Service Switchgear

1.3 CODES AND STANDARDS

- A. The ventilated dry-type transformers and protection devices in this specification are designed and manufactured according to latest revision of the following standards.
 - 1. Con Edison Standards EO-2022 and EO-4035
 - 2. IEEE C57.12.01, General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid Cast and / or Resin-Encapsulated Windings.
 - 3. ANSI C57.12.91, Test Code for Dry-Type Distribution and Power Transformers
 - 4. ANSI N45.2-1977
 - 5. CSA Z 299.3
 - 6. ISO 9001
 - 7. NRC 10CFR50 Appendix B
 - 8. MIL-I-45208A
 - 9. NEMA ST 20, Dry Type Transformers for General Applications
 - 10. UL
 - 11. DOE-2016

1.4 QUALITY ASSURANCE

- A. The manufacturer shall have a well-documented quality assurance program, which includes procedures for all activities in order entry, design, material procurement, manufacturing

processes, testing, shipping and post shipment. The manufacturer shall have specialized in the design, manufacture and assembly of dry-type distribution transformers for a minimum of 20 years. The transformer shall be manufactured by a company, which is certified ISO 9001, for design and manufacture of Power Cast Coil Dry-Type Transformers.

- B. The test floor shall have documented calibration program. All equipment shall receive regular calibrations. Calibration standards shall be traceable to National Bureau of Standards. Records of all equipment calibration shall be made available to the Buyer upon request. Measured values of electric power, voltage, current, resistance and temperatures are used in the calculations of reported data. To ensure sufficient accuracy in the measured and calculated data the test system accuracy requirements listed in ANSI C57.12.01 Table 3 shall be met as a minimum.

1.5 DEMONSTRATION

- A. A manufacturer shall provide a factory authorized service representative to train Owner's maintenance personnel.
- B. Review operation and maintenance manuals submitted by manufacturer.

1.6 WARRANTY

- A. Manufacturer shall warrant specified equipment free from defects in material and workmanship for one (1) year from the date of installation. Submit Extended Warranty.

1.7 SNUBBERS

- A. These transformers should be provided with snubbers at the primary since they are fed from vacuum breakers, unless the transformers are Transient Voltage Resistant Design (TVRT) where the transformer will survive frequent switching from close-coupled vacuum circuit breakers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The ABB Inc. Duracast Vacuum Cast Coil Transformer design is the basis for this specification with cast primary winding and cast secondary winding.
 - 1. Siemens Energy Automation.
 - 2. General Electric.
 - 3. Square 'D'.
 - 4. Eaton.

2.2 TECHNICAL REQUIREMENTS

- A. Construction
 - 1. The transformer shall be vacuum cast epoxy resin construction and shall be mounted in a suitably ventilated outdoor enclosure.
 - 2. The unit substation transformer shall be rated 6,000 kVA/7,500 kVA 3 phase, 60 Hertz air with a primary voltage of 13.2 kV delta connected and have a BIL rating of 110 kV and a secondary voltage of 13.2 kV wye connected and have a BIL rating of 110 kV with internal connection points grounding as shown.

3. The transformer is to have an impedance (per manufactures standard, 5.75%IZ, with +/- ANSI Standard Tolerance.)
4. Primary and secondary terminations shall be cable connection in air-filled terminal chamber.
5. Primary and secondary coordination bus assemblies, as required for connection to associated circuit breaker are to be of welded or bolted construction.
6. Cable entry from underground conduits.
7. Cable terminations and 15 kV, 500 MCM EPR cable to comply and be similar to cable utilized by Con Edison.
8. Terminal lugs by Electrical Contractor as per Con Edison requirements.
9. Approximate Dimensions: Ht 140 in x wd 140 in x DP 96 in.
10. Approximate Weight: 54,200 lbs.
11. 80/80 Degree C Rise above 30 average/ 40 maximum ambient
12. 12. 72 dB(a) guaranteed sound level (AA).
13. Taps +2-2. 2.5%
14. 14.Copper conductor
15. 15KV distribution class polymer surge arresters- HV
16. Electrical snubber circuit with (surge capacitors, arrestors, resistors, fuses clips, fuse holders, CTs, ludicating lights, monitoring
17. Copper ground Bus, .25" x 2.00
18. Monitoring: 15kv Glass Control power transformer 3 phase winding temperature ludicator (TCSIM)

B. Core Design

1. The transformer core shall be constructed of high-grade non-aging silicon steel laminations with high magnetic permeability and low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point. A step-lap mitered core joint shall be used to minimize losses, exciting currents and sound levels. The core laminations shall be clamped together with heavy steel members. The finished core and clamping structure shall be coated to protect against corrosion.

C. Temperature Rise

1. The average temperature rise of the transformer windings shall be rated at 80°C, and shall be built utilizing Class 220°C turn insulations, regardless of the temperature rise specified. The insulating system used, including epoxy, shall be rated 180°C or higher. The transformer shall not exceed the specified temperature rise when the unit is operated continuously at full nameplate rating. The transformer shall be capable of carrying 100% of the nameplate rating in a 30°C average, not to exceed 40°C maximum ambient in any 24 hour period.
2. With 80°C winding temperature rise, the unit can be designed with inherent overload capabilities. 80°C rise unit shall be capable of continuous operation at 17% above nameplate rating. This overload capability shall be achieved on the AA and FA rating and will be accomplished by allowing the transformers' ultimate rise to be 115 °C.

D. Coil Design

1. The high voltage and low voltage windings shall be constructed using copper conductors. The high voltage windings shall be vacuum cast in epoxy in a metal mold utilizing a proven casting process that insures the absence of voids. The vacuum cast coils shall also be reinforced with fiberglass mat.
2. The transformer shall be constructed of individually cast primary and secondary coils, coaxially mounted. The low voltage windings shall be wound separately and if not vacuum cast like the high voltage winding, shall be wound using epoxy resin impregnated sheet insulation with foil or sheet conductors. The low voltage coils shall

be hermetically sealed with epoxy and the coil shall be blocked radially to the core to ensure short circuit integrity.

3. The finished primary and secondary coil must be hermetically sealed in epoxy utilizing a proven manufacturing system that demonstrates its ability to minimize hot spots and partial discharge. An induced partial discharge test shall be performed on each winding. The induced partial discharge test shall be performed by measuring partial discharge levels beginning at 80% rated voltage and continuing in 10% step increments through 200% rated voltage. Partial discharge inception and extinction levels are defined as levels above 10 Pico-Coulombs and shall be recorded. Acceptance criteria is Partial discharge extinction at or above 120% rated voltage. The low voltage windings shall be wound separately and if not vacuum cast like the high voltage winding, shall be hermetically sealed in epoxy.
4. Taps Transformer primary winding shall have four 2-1/2 percent full capacity taps; two above and two below rated nominal voltage. No load tap connections shall be made by re-connectable links on the face of the primary winding and shall be located behind removable panels on the front of transformer enclosure. Taps shall be for de-energized operation only.

E. Dielectric Withstand

1. The impulse rating of the transformer must equal or exceed the basic impulse level specified by ANSI for the applicable voltage class. The basic impulse level shall be inherent to the winding design and is to be obtained without the use of supplemental surge arrestors.

F. Vibration Isolation

1. The transformer shall have vibration isolation pads installed between core and coil assembly and enclosure base structures to prevent the transmission of structure borne vibration.

G. Enclosure

1. The enclosure shall be constructed of heavy gauge sheet steel and shall be finished in ANSI 61 paint color, applied using an electrostatically deposited dry powder paint system. All ventilating openings shall be in accordance with NEMA 3R and the NEC standards for ventilated enclosures. The base of the enclosure shall be furnished with ground pads located on opposite diagonal corners. The base shall have jacking pads and shall be constructed of heavy steel members to permit skidding or rolling in any direction. The core shall be visibly grounded to the enclosure frame by means of a flexible grounding strap.
2. Transformer shall be certified to meet Uniform Building Code (UBC) Zone 3 seismic requirements with seismic table validation.
3. Outdoor enclosures shall be certified and constructed with NEMA 3R protection against rain, sleet and external ice construction.

H. Remote Temperature Monitoring

1. Provide provision for transformer temperature monitoring (by power monitoring system).

I. Nameplate

1. Transformer shall be furnished with a non-corrosive diagrammatic nameplate per ANSI C57.12.01, permanently attached with non-corrosive hardware. The diagrammatic nameplate shall include the name of the transformer supplier as well as the location where the transformer was manufactured and tested.

J. Forced Air Cooling

1. Forced air cooling shall increase the continuous self-cooled rating of the transformer by 33 1/3%, 7,500 kVA. The FA increase shall be possible with forced cooling without exceeding the specified maximum temperature rise. The forced air cooling shall be regulated automatically by sensors placed in the low voltage winding's air ducts. Forced air cooling shall include: three phase electronic digital temperature monitor, fans, control wiring, control panel with test switch, indicating lights, alarm and alarm silencing switch, all part of transformers.

K. Surge Arrestors: 36KV surge arrestors shall be provided on the transformers.

2.3 FACTORY TESTS

- A. After completion, each transformer shall undergo the following routine production tests per ANSI C57.12.01 and ANSI C57.12.91. Testing shall be accomplished using calibrated test equipment, which have recorded accuracy traceable to National Institute of Standards Technologies (NIST). Certification of Calibration shall be provided with test reports if requested.
- B. In addition to routine testing a 100% QC Impulse Test shall be performed on each transformer furnished.
- C. Routine Tests:
Minimum Passing Criteria:
 1. Megger
 2. Ratio
 3. Resistance
 4. Phase relation
 5. Load Loss, Impedance and Regulation
 6. No Load Loss and Excitation Current
 7. 100% QC Impulse Test
 8. Applied Potential Test
 9. Induced Potential Test
- D. A temperature rise test shall be performed on the first unit of each new design. The core and coil design and construction techniques shall be verified by a full short circuit test on similar or larger units in accordance with applicable ANSI standards.
- E. Provide certified production test reports for all manufactured transformers.
- F. Factory visit is required by Owner.

2.4 ACCESSORIES

- A. Standard transformer accessories shall include:
 1. Diagrammatic aluminum nameplate.
 2. Step-lap mitered core
 3. Provisions for lifting core and coil assembly
 4. Base equipped with jacking pads and designed for rolling or skidding enclosure in any direction
 5. NEMA 3R heavy-gauge ventilated enclosure with removable panels front and rear
 6. Four (4) full-capacity taps on HV winding, rated 2 ½%, 2-FCAN and 2-FCBN.

- B. Documentation for Owner's review:
 - 1. Outline, nameplate and connection diagram drawings.
 - 2. Installation/Operation/Maintenance Manual.
 - 3. Certified Production Test Report(s) containing minimum information per ANSI C57.12.91.

PART 3 - EXECUTION

Note: All work shall be executed by the Electrical Contractor unless otherwise noted. Manufacturer shall deliver equipment as directed by CM.

3.1 INSTALLATION

- A. Install transformer as shown on Project Drawings and in accordance with manufacturer's Instruction/Installation Manual.
- B. Provide concrete pad with sufficient structural support and in accordance with local codes and standards. Concrete pad requirements should be coordinated with transformer manufacturer.
- C. Grounding should be per Project Drawings and in accordance with local codes and standards and in compliance with the NEC.

3.2 SITE ACCEPTANCE TESTING

- A. Field-testing will be conducted at the expense of the Owner, if required for final acceptance. As follows:
 - 1. Inspect all components for evidence of heat, moisture, corona, tracking or physical damage.
 - 2. Inspect temperature indicators and inspect heaters.
 - 3. Inspect all control wiring.
 - 4. Inspect grounding switch.
 - 5. Check electrical interlock.
 - 6. Lubricate grounding switch mechanism as required.
 - 7. Verify all insulators and barriers are clean.
 - 8. Tighten all bolted connections to appropriate torque values.
 - 9. Check tap connections.
 - 10. Check frame ground connection.
 - 11. Check neutral ground connection.
 - 12. Clean fans and check for proper operation (where applicable).
 - 13. Perform time-voltage (polarization index) tests on primary and secondary windings.
 - 14. Perform high potential insulation resistance test on primary winding.
 - 15. Perform primary to secondary turns ratio test on each phase.
 - 16. Verify all safety grounds removed.
- B. Polarization index tests shall be performed on each winding by applying DC test voltage between the primary winding and ground with the secondary winding grounded, and between the secondary winding and ground with the primary winding grounded. Each test procedure shall consist of the application of a predetermined voltage for a predetermined period of time, with leakage current recorded at uniform intervals. Test voltages and time durations shall be as directed by the Engineer and approved by the CA.

- C. High potential insulation resistance tests shall be performed on the primary winding by applying DC test voltage between the primary winding and ground with the secondary winding grounded. The test procedure shall consist of a step-voltage test in predetermined uniform steps up to a maximum test voltage, with leakage currents recorded after a stabilization time at each step. Voltage steps, maximum test voltages, and time durations shall be as directed by the Engineer and approved by the CA.
- D. The primary to secondary turns ratio tests shall be performed on each phase winding pair (H1-H2 to X1-XO, H2-H3 to X2-XO, and H3-H1 to X3-XO) at the specified tap position.
- E. All testing to be witnessed by Owner, Engineer and CA.
- F. Certified Test Reprint

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SECTION 262313

13.2 kV AUTOMATIC PARALLELING/SYNCHRONIZING SWITCHGEAR

PART 1 - GENERAL

1.1 SCOPE

- A. Medium voltage (15 kV) freestanding switchgear with vacuum circuit breakers.
- B. It is the intent of this specification to provide a complete control and power distribution system for the operation of three (3) generator units, rated 4.0 MW at 0.8 PF, 13.2 kV volts, 3 phase, 3 wire, 60 Hertz. All components, testing, and services specified or required for a complete operable system shall be included. The switchgear shall consist of three (3) generator sections, one (1) Master Control Section (MCS), Graphic Display Panel Schedule Section (GDPS), and multiple distribution sections (refer to drawings).

1.2 RELATED SECTIONS

- A. 260573 – Power Systems Study
- B. 260913 – Electrical Power Monitoring System
- C. 261313 – 13.2 kV Services Switchgear
- D. 263214 – 13.2 kV Standby Diesel Engine Generators
- E. 263625 – 13.2 kV Automatic Transfer Switches

1.3 APPLICATION CODES AND STANDARDS

- A. ANSI/IEEE C37.20.2 - Standard for Metal-Clad Switchgear.
- B. ANSI/IEEE C37.04 and .06 - Standard ratings and preferred ratings for Indoor AC Medium-Voltage Circuit Breakers used in Metal-Clad Switchgear.
- C. ANSI/IEEE C37.11 - Requirements for electrical control for AC High-Voltage Circuit Breakers rated on a symmetrical current basis or a total current basis.
- D. ANSI/IEEE C37.09 - Standard Design and Production Testing.
- E. ANSI Z55.1 - Gray Finishes for Industrial Apparatus and Equipment.
- F. ANSI/IEEE C57.13 - Requirements for Instrument Transformers.
- G. NEMA SG4 - Alternating Current High Voltage Circuit Breakers.
- H. NEMA SG5 - Power Switchgear Assemblies.

1.4 MANUFACTURER'S QUALIFICATIONS

- A. Automatic Transfer Switches, Bypass Switches, Paralleling Switchgear, Switchboards, Monitoring and Control shall be supplied by single manufacturer.
- B. The equipment described, as a minimum, shall meet all of the requirements specified in this section. The equipment shall be the product of a manufacturer who has produced paralleling switchgear for a period of no less than 40 years. The manufacturer must provide integral electrical and mechanical design, fabrication and construction services for all cubicle structures, formed and punched bus bar, and control panel assemblies. Comprehensive documentation detailing electrical and mechanical designs shall be available upon request. The manufacturer must be certified under ISO 9001.

1.5 ORDER MANAGEMENT

- A. Management of orders shall be assigned to personnel employed and trained specifically and exclusively for project management; the use of field service representatives, design engineers or sales representatives for order management purposes shall not be acceptable. Each order shall be managed by both a factory-based project manager and a field-based project manager.

1.6 DOCUMENTATION

- A. Submittals for approval shall include the following:
 - 1. Elevation drawings with shipping splits identified and estimated weights.
 - 2. Outline drawings showing conduit entry areas and anchoring information.
 - 3. Single line diagram.
 - 4. Sequence of operation.
 - 5. Complete bill of material listing items by manufacturer's name, part number and description.
 - 6. Complete nameplate and status annunciator panel schedule.
- B. One complete set of as-built, engine and switchgear interconnect drawings, and material summary shall be shipped with the equipment.
- C. Operation and maintenance manuals shall contain:
 - 1. Complete Drawings, Layouts and Schematics.
 - 2. Material Summary.
 - 3. Component Instruction.
 - 4. Sequence of Operation.
 - 5. Spare Parts Information.
 - a. A quantity of three (3) manuals shall be required for distribution in [digital] [hardcopy] format.

1.7 TESTING

- A. The metal-clad switchgear shall consist of an enclosure containing circuit breakers, components and wiring, all factory assembled (except for necessary shipping splits) and operationally checked. The assembly shall be self-supporting and floor mounted on a level surface. The integrated switchgear assembly shall withstand the effects of closing, carrying and interrupting currents up to the assigned maximum short circuit rating.

- B. System Voltage: 13.2 kV nominal, three-phase solidly grounded, 60 Hz.
- C. Maximum Design Voltage: 15.0 kV.
- D. Impulse Withstand Basic Impulse Level: 95 kV.
- E. Power Frequency Withstand: 19 kV, 1 minute test.
- F. Main Bus Ampacity: 1200 amps, continuous.
- G. Momentary Current Ratings: Equal to the circuit breaker close and latch rating.

1.8 WARRANTY AND SERVICE

- A. Manufacturer shall warrant the equipment for eighteen months subject to terms and conditions of manufacturer's current warranty publication.
- B. Manufacturer shall have an established network of service centers capable of servicing the equipment.
- C. Service and factory representatives shall be on call 24 hours a day, 365 days a year. Personnel shall be factory trained and certified in the maintenance and repair of the specified equipment.
- D. Post-warranty service contracts shall be made available to the Owner by the manufacturer, or through factory service centers, to provide periodic maintenance and/or repair of the equipment.

1.9 CERTIFICATION

- A. Upon request, the manufacturer shall provide a letter certifying compliance with all the requirements of this specification. The certification shall identify, by serial number(s), the equipment that complies. No exceptions to the specification, other than those stipulated at the time of submittal, shall be included in the certification.

1.10 GENERAL REQUIREMENTS

- A. Switchgear Enclosure
 - 1. Structure. The enclosure shall be free-standing and floor supported, with front and rear access. An adequate number of anchor bolt holes shall be designed to place the base in direct contact with the foundation when bolted. The flatness of the floor surface upon which the equipment is installed shall deviate no more than 0.125 inches per 10 feet in any direction. All doors shall be formed from sheet stock of 11 gauge minimum.
 - 2. All steel parts, except galvanized, shall be cleaned iron phosphate pre-treatment applied prior to paint application.
 - 3. Paint color shall be ANSI-61 light grey; TGIC polyester powder, applied electrostatically through air. Following paint application, parts shall be baked to produce a hard durable finish. The average thickness of the paint film shall be 2.0 mils. Paint film shall be uniform in color and free from blisters, sags, flaking and peeling.
 - 4. Bus. The main bus is to be rated 1200 amps and be fully insulated for its entire length with an epoxy coating. The conductors are to be silver-plated copper and be of a bolted

design. Access to this compartment is gained from the front or rear of the structure by removing a steel barrier.

5. Wiring. Control wiring shall be UL 1015 rated for 600 volt. Current transformer circuit termination's shall be ring tongue type and include options for shorting terminal blocks.
6. Control wires shall be numbered every eight (8) inches or less and visible next to the terminals. Also, the wiring shall be permanently marked with termination numbers with the wire termination designations. These designations shall include the device and connection point where the wire is terminated. All wire markings shall be permanent and not noticeably fade or smudge. Low level signal circuits shall be separated and provided with shielded wire to minimize electromagnetic interference. Shielded wire shall be grounded at one point. Ethernet cabling shall be unshielded category 6.
7. Wiring between each section shall not be spliced, and shall be free of abrasions and tool marks. Connections between cubicles shall use labeled connection plugs. Wires shall be placed in wire duct or harnessed, and shall be supported to prevent sagging or breakage from weight or vibration. Inter-cubicle wiring harnesses shall be contained in overhead steel wire troughs. Communication cables and current transformer circuits shall be hardwired.
8. All wiring to hinged doors shall be run through door terminal blocks or connection plugs. Terminal blocks shall be provided for all external connections and placed in an accessible area not exposed to hazardous bus or cables, if possible. Current transformer circuits shall be connected through shorting terminal blocks.
9. Nameplates. Engraved laminated plastic nameplates, having black letters on white background, shall identify major components, vertical sections, and circuit breakers. Nameplates shall be attached with self-tapping screws. Other color combinations available optionally.

B. Components

1. Metering Instrumentation. Digital metering instrumentation consisting of industrial switchboard type meters, 1% accuracy. Current and potential transformer ratios shall be selected and coordinated for nominal and rated values for ammeters, voltmeters and kW meters.
2. Instrument Switches. Instrument switches shall be of the rotary type. Each switch shall be supplied with a titled escutcheon plate, suitably marked for each position. The switches shall have positive means of maintaining contact, which shall be silver to silver with a wiping action.
3. Current Transformers. Current transformers shall be furnished with VA burden ratings suitable to supply the metering and protective devices without affecting accuracy.
4. Potential Transformers. Three (3) wye-wye connected potential transformers shall be provided in turns ratio and VA burden rating to be compatible with the controls and voltage sensing as applied. Transformers shall have integrally mounted primary and secondary fuses.
5. Alarm and Status Indication. Visual and audible alarm and status indication lights, including spares, shall be furnished as indicated by customer. Visual alarms shall be reset only after the fault condition has been corrected. The audible alarm shall include a silencing circuit which after activation shall permit audible annunciation of subsequent failures. Lamp test shall be an integral feature of this indicator.
6. Control Fuses. Fuses shall be mounted in locations where they are readily accessible. Pull-out type fuses shall be provided for all primary circuits and shall be of the current limiting type.

1.11 ACCEPTABLE MANUFACTURER

- A. The equipment described is a SYNCHROPOWER® system as manufactured by ASCO Power Technologies.
 - 1. Russelectric
 - 2. Eaton
 - 3. Approved Equal

PART 2 - PRODUCTS

2.1 GENERATOR POWER AND CONTROL SECTION

- A. Each generator shall contain over-current protection, controls, relays and auxiliary devices associated with its respective engine generator set. It shall include the following:
 - 1. For each generator set, a medium voltage vacuum circuit breaker shall be furnished to provide over-current protection and paralleling functions. The breaker shall be rated 13.2 kV nominal volts, 15 kV maximum volts, a continuous current rating of 1200 amps and a maximum symmetrical interrupt rating of 40 kA / 1000 MVA. Breakers shall be 3 pole, electrically operated and draw-out with a solid state trip unit. Trip unit shall include adjustable long delay, short delay, and instantaneous trip settings as well as ground fault alarming. Breakers shall have stored energy closing. The draw-out feature shall provide for connected, test, and disconnected positions. In the connected position, the main line and load terminals, all auxiliary control contacts, and circuitry shall be connected, and the breaker shall be fully operable. In the test position, the breaker auxiliary control contacts, and circuitry only shall be connected, to permit automatic operation of the complete control system without actually connecting the generator to the main bus. In the disconnect position, main auxiliary control contacts, and circuitry shall be completely disconnected. The breaker draw-out mechanism shall be mechanically interlocked with the breaker to permit draw-out operation only when the breaker main contacts are open.
- B. Generator Control System
 - 1. The generator control system shall include a programmable logic controller and a Woodward DSLC-2 microprocessor-based synchronizer and load controller designed for use on three-phase AC generators and mounted in the switchgear. The controls shall combine synchronizer (with voltage matching capability), load sensor, load control, dead bus closing system interlock, VAR, power factor and process control. The load sharing network and VAR sharing network shall be completely integrated in the switchgear. The generator set controller shall include diagnostic alarming for annunciation. A dedicated Ethernet system shall provide seamless communications among all generator control units.
 - 2. The controls shall sense true RMS power and provide soft bump-less loading and unloading functions. It can either base load or set import/export/process power levels against the utility, or accurately share loads on isolated, multiple generator systems.
 - 3. Generator controls shall include the following functions, components, devices, and indicators.
 - 4. Reverse Power Protection (Device 32R)
- C. Generator Voltage Monitoring and Frequency Monitoring
 - 1. Generator set controller shall monitor voltage and frequency to insure the generator is not connected to the bus until frequency is at least 59 Hertz and 90% rated voltage.

2. Automatic Synchronizer

- a. The synchronizer shall include a differential voltage detector, differential frequency detector and differential phase detector. Analog voltage bias signal shall be provided for voltage matching and an analog speed bias signal shall be provided for frequency matching and phase angle control. Synchronizer shall issue a breaker close signal when frequency, phase and voltage conditions are met.
- b. The differential voltage detector shall compare the voltage of the oncoming generator to the paralleling bus. If the voltage is not within the factory set difference of plus or minus 5% (adjustable from 0 to plus or minus 10%), the voltage detector shall inhibit the circuit breaker from closing. When the oncoming generator voltage is within the preset acceptable limit, the inhibit shall be removed.
- c. The differential frequency detector shall compare the frequency of the oncoming engine generator set to the paralleling bus. If the frequency is not within the preset acceptable difference of plus or minus 0.5 Hz (adjustable from 0 to plus or minus 0.5 Hz), the frequency detector shall inhibit the circuit breaker from closing. When the oncoming engine generator frequency is within the acceptable limit, the inhibit shall be removed.

D. Multiple Circuit Interlock

Generator controls shall provide for first-up, first-on operation of the generator set. This device shall positively prevent more than one set from being simultaneously connected to a dead bus. Upon initiation of the connection of the first set to the bus, this circuit shall shift the control of the remaining sets to automatic or manual synchronizing at the operator's discretion.

E. Engine Starting Control

1. The engine starting control logic shall be a programmable controller and shall automatically start, protect, and monitor each engine generator set. The controller shall be provided with power supply, CPU and required I/O modules. Generator start control shall be hard wired so that the engine can be started if the controller is not available. The generator controller shall be dedicated for control exclusively of the engine and generator set and shall be independent of the Master PLC. Distributed I/O systems which rely on a master controller shall not be acceptable.

F. Engine Start/Stop Operation

1. The automatic engine control logic shall initiate operation of the engine upon receipt of a signal from a contact that closes for engine run, and opens for engine stop.
2. Five Position Engine Control Selector Switch
 - a. Lockout/Reset - When placed in this position, the engine shall not be capable of starting and/or running. If the engine was shut down due to the operation of a protective device, the shutdown malfunction shall be reset when the switch is moved to this position. If the engine is running when the switch is moved to this position, it shall immediately shutdown.
 - b. Off/Cooldown - When placed in this position, the engine shall shutdown after a cooldown period if the generator paralleling circuit breaker was closed while the engine was running.
 - c. Automatic - When placed in this position, the engine control shall be in readiness for fully automatic operation upon receipt of a start signal.

- d. Test Off-Line - When placed in this position, the engine shall start and run as if a start signal were received except it shall not be connected to the bus unless a start signal is received. When returned to the Automatic position, the engine shall shutdown.
 - e. Test On-Line - When placed in this position, the engine shall start, run, and connect to the bus as if a start signal were received. When returned to the Automatic position the circuit breaker shall open and the engine shall run for its cooldown period before shutting down.
3. Four Position Synchronizing Mode Selector Switch
- a. Permissive - In this position the governor controls are deactivated. However, the synchronizer shall operate as a passive synch check relay and signal the closing of the generator breaker when both sources are in phase.
 - b. Check - In this position the synchronizer is fully operational except it cannot close the generator breaker. The phase-lock feature holds the generator output in synchronism with the bus.
 - c. Off - In this position the synchronizer is turned off to allow for manual paralleling at the Master Cubicle.
 - d. Run - In this position the synchronizer is in the fully operational, automatic mode.
4. Engine Cooldown Time Delay
- a. The cooldown time delay shall be adjustable from 1 to 10 minutes (factory set at 5 minutes) and automatically bypassed for malfunction and manual shutdown of the engine generator set. The engine shall go into cooldown only if the generator paralleling breaker was closed during a run sequence.
5. Failure to Synchronize Time Delay Relay
- a. The failure to synchronize time delay shall be fixed at 60 seconds. It shall provide audible and visual indication, but it shall not terminate synchronizing attempts nor shut down the engine.

G. Alarm and Status Indication

- Visual and audible alarm and status indication shall be provided on each generator control section to include readout and annunciation for:

FUNCTION	COLOR
SHUTDOWNS	
Low Oil Pressure	RED
High Water Temperature	RED
Overcrank	RED
Overspeed	RED
Reverse Power	RED
Circuit Breaker Trip	RED
Generator Output Circuit Breaker Open	RED
Control Voltage Failure (DC voltage for the generator controls has been lost)	RED
PLC Stopped	RED
Circuit Breaker Close Failure (If the generator paralleling circuit breaker fails to close after 4 attempts when all of the conditions to close the breaker have been met)	RED
PRE-ALARMS	
Low Oil Pressure	AMBER
High Water Temperature	AMBER
ALARMS	
Fail to Synchronize (the synchronizer has not been able to synchronize the generator to the bus within 60 seconds)	RED
Controls Not In Automatic (the Engine Control Switch is in either Lockout/Reset or Off/Cool Down position –OR- the Synchronizing Mode Selector Switch is not in Run)	RED
STATUS	
Paralleling Circuit Breaker Open	GREEN
Paralleling Circuit Breaker Closed	RED
Paralleling Circuit Breaker Withdrawn	RED
Auto Start	GREEN
Generator Output Circuit Breaker Closed	RED

H. Generator Metering / Instrumentation.

- Ammeter 0 - 300 Ampere scale.
- Voltmeter 0 - 15000 Volt scale.
- Kilowatt meter 0 - 4000 Kilowatt scale.
- Frequency meter 50 - 65 Hertz scale.
- Position Ammeter and 7 Position Voltmeter selector switch means shall be included.

I. Power Manager XP

1. A backlit LCD display and membrane controls that shall sense a 3 phase 4 wire system.
2. Current input: 0 - 5 A ac nominal (via current transformers)
Voltage input: 0 - 600 V ac nominal (via potential transformers)
Frequency range: 40 - 100 Hz fundamental
True RMS measurements up to and including the 17th harmonic
3. The following parameters can be read from the LCD display:
 - a. Line-to-neutral voltages (VAN, VBN, VCN)
 - b. Line-to-line voltages (VAB, VBC, VCA)
 - c. Current on each phase (IA, IB, IC)
 - d. Active power, KW per phase and total
 - e. Reactive power, KVAR per phase and total
 - f. Power factor (PF)
 - g. Signal frequency (Hz)
4. Meter accuracy (% full scale)
 - a. Current (0.25%)
 - b. Voltage (1.00%)
 - c. Active Power (per element) (1.00%)
 - d. Reactive Power (per element) (1.00%)
 - e. Power Factor (1.00%)
 - f. Frequency (0.25%)

J. Failure to Synchronize Reset Switch

A means shall be provided to reset the "Fail to Synchronize" alarm.

2.2 MASTER CONTROL SECTION

The master control section shall contain *synchronized and redundant programmable logic controllers* capable of storing necessary control sequence algorithms, variable operation set-points, time delays and alarming levels. [*Redundant and synchronized distributed*] [*Distributed*] I/O stations shall include modular input and output cards for discrete and analog signals necessary to provide the integrated system operations specified below.

A. Priority Load Control

1. Discrete output modules shall be provided to control the necessary priority load blocks. The number of load blocks shall equal the number of engine generator sets, and shall be sized such that the connectable load of each block is not greater than the kilowatt rating of the generator set connected. As the generators are connected to the bus, the controller shall signal for the connection of the load blocks in an ascending sequential priority with the highest priority load requiring emergency power being connected first. Priority failure pass-along logic shall initiate the connection of low priority loads to the first generator on-line if start signals have not been received from high priority transfer switches.
2. Load shedding shall be done on a last-on, first-off basis. The generator bus shall have a solid-state frequency monitor, with integral time delay to initiate load shedding upon a reduction of bus frequency to 58 Hz or less, for a period of three seconds or more. Upon sensing a bus underfrequency, the system shall automatically shed the lowest priority load connected at the time of occurrence. This shed circuit shall override any manual load-add operation, and shall lock out the manual load-add circuitry. It shall give visual and audible alarm annunciation of bus underfrequency load shed.
3. Provide a means to reset bus underfrequency signal.

4. Provide a "load shed bypass/reset" push-button, for manual supervised operation over the load-shed, load-add control logic. One push-button shall be provided for each priority block except first priority. Logic shall be provided in the event that a bus overload occurs resulting in a reduction in bus frequency; the bypassed priority load shall be shed automatically through override logic control.
- B. Manual Paralleling Controls
1. A Synchroscope selector switch shall be provided to select any generator for manual paralleling operation. The positioning of the selector switch shall simultaneously connect the synch-check relay, Synchroscope, and "manual paralleling" push-button to the selected generator.
 2. A solid-state sync check relay shall be furnished for manual paralleling, to sense and compare the phase angle difference between the oncoming generator and the bus. This relay shall lockout the manual paralleling push-button until the oncoming generator is within 15 degrees of synchronism.
 3. Operation shall be arranged so the operator shall depress and hold the manual paralleling push-button. When the relative phase angle reduces to 15 degrees and going towards zero degrees, the sync check relay's output contact shall initiate the closing of the respective oncoming generator breaker.
 4. All manual paralleling interface controls and metering shall be grouped in a central location on the front of the master control section. This shall allow for multiple generators paralleling from one location within the switchgear. Manual paralleling controls and sync check relay shall be hardwired and shall not rely on touch screens or programmable controllers to perform manual paralleling functions.
- C. DC Control Power Selector – Best Battery System
1. Control power for the system logic shall be taken from 125V DC System batteries and/or an optional station battery system.
- D. System Test Switch
1. Provide a system no-load test switch to initiate a complete automatic system operation by simulating the closure of the remote engine start signal. This switch shall be mounted inside the master section to limit access to authorized personnel only.

E. Alarm and Status Indication

FUNCTION	COLOR
Manual Paralleling Available <i>(the light shall turn off when the selected generator paralleling circuit breaker is synchronized with the bus)</i>	GREEN
Bus Underfrequency Alarm	RED
Load Shed Circuits Activated <i>(separate indicator for each priority – indicates the load is connected to the de-energized Normal bus)</i>	AMBER
Load Shed Bypass <i>(separate indicator for each priority - indicates the load connected to the Emergency bus should be shed to the de-energized Normal bus)</i>	AMBER
Engine Generator Status Lights <i>(one set of lights for each engine-generator)</i>	
Running	GREEN
On Line	RED
Lockout	RED
System PLC Stopped	RED
PLC Power Source Failure <i>(a loss of the output from the DC-DC converter)</i>	RED
Emergency Mode <i>(occurs when an ATS sends an Engine Start signal)</i>	AMBER
Load Demand Active	AMBER
Bus Optimization Active	AMBER
Bus Loaded To Capacity	RED
Next Load Will Exceed Headroom	RED

F. Main Audible Alarm

1. Provide a main audible alarm. The alarm horn shall be the DC vibration type, subsequent malfunctions to resound the alarm if the horn had been previously silenced following an initial malfunction.

G. Paralleling Bus Metering / Instrumentation

1. Ammeter 0 - 1000 A scale
2. Voltmeter 0 - 15000 V scale
3. Kilowatt Meter 0 - 15 kW scale
4. Frequency Meter 0 - 60 Hz scale
5. Synchroscope
6. 4 Position Ammeter and 7 Position Voltmeter selector switches shall be included.

H. Master Controller

The master controller shall be programmed by Equipment Supplier and shall meet or exceed the following specifications:

1. 300 MHz Intel microprocessor and 10 Mbytes of user storage on random access memory (RAM), erasable programmable read only memory (EPROM), or electrically erasable programmable read only memory (EEPROM). RAM memory shall be backed up with a lithium battery for protection during voltage loss and spare parts capabilities.

2. The controller shall also be capable of supporting I/O and CPU fault diagnostics. This shall consist of CPU failure detection, watchdog timer error, I/O modular failure, and battery failure.
3. The controller shall have an execution speed of 4 milliseconds per 1000 words of ladder logic programming.
4. The controller shall have the capability to utilize up to 1024 discrete I/O points and 2048 memory registers.
5. The controller shall have the capability to interface to a remote I/O rack.

I. Master PLC Redundancy

1. This system shall consist of a programmable logic controller, an identical secondary controller and common and redundant I/O systems between the two controllers. Normally, the primary controller shall be the active one that controls the system I/O while the secondary controller shall be on standby, ready to take control of the system I/O. Any single failure to the active controller shall cause automatic switch over to the standby controller. As both controllers shall be synchronized, there shall be a bumpless transfer from one controller to the other. The bumpless transfer ensures that the I/O shall be held in their current state during the transfer.
2. If the active controller shall fail and control transfer to the standby controller, the failed controller can be turned off and repaired without effecting the rest of the system.
3. The redundant I/O systems shall perform in active and standby modes as described above for the controllers.
4. There shall be a manual means to transfer control from the active controller to the standby controller as described above.
5. Status indicators shall indicate which controller is active and if a controller is in run or stop mode.

2.3 OPERATOR INTERFACE TERMINALS

- A. A microprocessor-based, password protected, industrial touch panel shall be supplied allowing facility operators the ability to monitor, control and change setpoints and time delays of the Paralleling Switchgear. The industrial touch panel shall be a 22 inch LCD and located at the Graphic Display Panel Section of the paralleling switchgear.
- B. The touch panel shall interface with Controllers, Synchronizers, Load Controllers, Breakers, and Engine-Generators.

2.4 DISTRIBUTION SECTIONS

- A. Emergency distribution sections shall be provided with number and size of distribution circuit breakers as shown on the project drawings.
- B. All emergency distribution circuit breakers shall be drawout electrically operated. All circuit breakers shall be provided with Long Delay, Short Delay, Instantaneous, and Ground Fault alarm settings. Breakers shall be rated 13.2 kV, 15 kV maximum volts, a continuous current rating of 1200 amps and a maximum symmetrical interrupt rating of 40 kA / 1000 MVA.
- C. Provide circuit breaker control switches for all electrically operated circuit breakers. Control switches shall have built in indicating lights to indicate breaker status (open, closed, tripped).
- D. Distribution sections shall be provided with main bus of the same ampacity as the generator switchgear sections.

2.5 DESCRIPTION OF OPERATION

A. Automatic Operation

1. Whenever the engine generator selector switches are placed in their automatic position, with the synchroscope plant selector switch in the master control section in the "Off" position, the engine generator system shall be placed on standby in readiness for automatic starting and synchronization in the event of a power failure signal. In the event of a power failure, all engine generators shall start and come up to speed. The first generator to achieve 90% of rated voltage and frequency shall be connected to the stand-by bus. Pilot contacts shall operate simultaneously to permit connection of prioritized load control circuits to increase the load, within the firm capacity of the generators. Reduction of generator system firm capacity while operating in the automatic mode shall initiate prioritized load shedding control to reduce the total load to the capacity of the remaining generators.
2. A failure to synchronize time delay relay shall be furnished to terminate the operation of the synchronizer and sound a warning horn in the event the generators are unable to be synchronized within an adjustable period of time, approximately 0-3 minutes. After failing to synchronize automatically, the operator, at his discretion, shall be able to connect either one or all the machines to the emergency bus by selecting a generator using the synchroscope plant selector switch and by operating the manual synchroscope system in the master control section.
3. Over/under frequency and over/under voltage sensors shall be furnished to detect an abnormal condition on the emergency bus. An over/under voltage and an over-frequency failure shall cause an alarm horn to sound and a red fail lamp to light. An under-frequency condition shall initiate load shedding as well as sounding the alarm horn and lighting a red fail lamp.
4. Upon signals from all transfer switches that utility power has been restored and that the transfer switches have retransferred the load to the normal source, the generator circuit breakers shall be opened simultaneously and the engine generators shall be allowed to operate at no-load for a predetermined period of time until the expiration of the time delay period, at which time all generators shall be shut down sequentially and placed in readiness for the next power failure.

B. Load Demand Control (Optimization)

1. Load demand control logic shall be provided to sense the load connected to the bus and establish the proper number of sets to operate to maintain the connected load with the minimum on-line reserve generating capacity of 15% of the rating of a single set. The load demand control logic shall initiate the disconnection of a generator from the bus whenever the on-line reserve generating capacity exceeds 120% of a single generator.
2. Load demand shall have the option of being enabled or disabled by means of a key switch on front of master cubicle.
3. The load demand control logic shall have adjustable set points for initiating the addition to, and removal from, the bus of the generator sets. The load demand control logic shall sense the bus (KW) real load without the use of thermal transducers or meter relays. The load demand control logic shall be designed to maximize fuel economy while maintaining sufficient capacity to service the load.
4. Provisions shall be included to permit selection of the sequential order of operation of the engine generator sets whenever the system is operating in the load demand control mode. This logic circuitry shall permit revision of the operating order of the engine generator sets at any time without requiring shutdown of on-line sets. Visual indication of sequential assignment shall be inherent. Use compression type lugs with double bolt barrel.

C. ATS Remote Annunciator

1. General

- a. Provide and install Remote Annunciator for monitoring and control of transfer switches remotely over Ethernet.
- b. The Remote Annunciator shall be located remotely from paralleling switchgear, as shown on the drawings.
- c. The ATS Remote Annunciator is an 8-channel digital type.

2. Hardware Specifications

- a. The Remote Annunciator shall be listed to cUL-60950-1 and UL 1008 and include the following features and ratings:
 - 1) User-configured labels with ATS names and power sources.
 - 2) Dual 10/100 Base-T auto sensing and auto crossover Ethernet ports.
 - 3) LED indication of source acceptability, switch position, common alarm, time delay and Ethernet link activity.
 - 4) Push button for transfer/retransfer control operations and time delay bypass.
 - 5) Push buttons for Alarm Silence and Lamp Test.
 - 6) Key lock to enable and disable the transfer push button.
 - 7) Audible and visual alarm to indicate Communication Error ATS Locked Out Failure to Synchronize Extended Parallel and any of the 8 user-configured discrete inputs.
 - 8) Programmable watchdog timer that can generate a system reset upon timeout (min 1 sec).
 - 9) Factory reset capability.
 - 10) 100 ms power ride-through.

D. Software Specification

1. The Remote Annunciator shall contain embedded web pages accessible via various web browsers with the following capabilities:
 - a. Configuration for protocol and communications management with the ability of auto discovering transfer switches on network.
 - b. Ability to create and print customized labels for ATS names and power sources.
 - c. The ability to choose a continuous or periodic audible alarm with customizable interval time.
 - d. Ability to configure up to 8 discrete inputs as alarms.
 - e. View detailed packet status counters i.e. transmitted received and dropped packets with the ability to reset counters.
 - f. ATS source name configuration page which allows users to configure power source names and print labels.
 - g. Upgrade firmware locally without interfering with installation communications.
 - h. Dual 10/100 Base-T (RJ-45) Ethernet ports are provided to support TCP/IP communications for up to eight transfer switches via individual remote connectivity modules or daisy-chained serial modules into a single connectivity module. Additional features include:
 - 1) Supports Full Duplex Flow Control (IEEE 802.3x).
 - 2) 3.3V power supply with 5V I/O tolerance.
 - 3) Supports 3 LED's to indicate traffic link speed and collision.

E. Mounting

1. The Remote Annunciator is suitable for:
 - a. Surface mounting using mounting screws studs.
- F. Power Supply
 1. The Remote Annunciator shall be capable of accepting 24VDC 120 VAC VAC power source.
- G. Environmental
 1. The remote annunciator shall have an Ambient Operating Temperature range of -4 to 158 ° F (-20 – +70 ° C) @ 5~85% humidity and Ambient Storage Temperature of -40 ° to 185 ° F (-40 ° to 85 ° C).
- H. Remote Annunciator shall be equal to ASCO 5300 Series, or equal.
- I. Special Controls
 1. In order for the standby generator to start automatically, and all ATS switches transfer to standby power, normal power has to be failed in all six (6) Con Edison Services since all served the Collector bus of the service switchgear and all Con Edison Services are connected in parallel.
 2. For partial failure (when two (2) Con Edison Services failed) the standby generators shall not start. When three (3) or more Con Edison Services failed, then the service switchgear should be provided with programmable logic controller to open the feeder breaker of the service switchgear in a sequential manner to energize the standby generators via the corresponding medium voltage ATS. (It could be a possibility that a portion of the load is supported by the standby generator system and portion of the load supported by Con Edison.)

2.6 MIMIC BUS

- A. Furnish factory installed mimic bus of switchgear, accurately depicting phase bus work, generator inputs, outgoing connections, and disconnecting means.
- B. Furnish bus 1/8 inch thick heat- and impact-resistant, beveled bakelite 1/2 inch wide, secured to sheet metal with cadmium plated screws.
- C. Bus to be red in color.

PART 3 - EXECUTION

3.1 INSTALLATION ASSISTANCE

Install paralleling switchgear on structure concrete pad, which shall follow the contour of the switchgear.

- A. The manufacturer of the generator control switchgear shall provide the services of satisfactory trained technician to provide installation assistance.
- B. It shall be the responsibility of the installing contractor to verify that the following items have been completed and are ready to perform as specified before the arrival of the factory technician.

1. Inspect for obvious shipping damage.
 2. The switchgear is properly installed, anchored and grounded.
 3. Shipping splits have been reinstalled with the splits bolted together, interconnect wiring installed, and bus splice plates installed.
 4. Terminate all power cables.
 5. Install customer control wiring to external equipment including engines, batteries, building management systems, associated motor control, etc.
 6. The engine generator set is installed and ready to run.
 7. Associated motor controls, plumbing, building utilities are complete and operational.
- C. It shall be the responsibility of the Factory Technician to perform the following:
1. Verify contractor connections, control power availability, visually inspect relay settings.
 2. With the engine generator supplier's technical representative controlling the engines, verify that the switchgear and control equipment are fully operational, and perform per the sequence of operation specified. Equipment or services shall be provided by the engine generator set supplier.
 3. With the engine generator supplier's technical representative controlling the engines, demonstrate all functions of the control system, both automatic and manual, to the satisfaction of the Owner's representative.
 4. Provide documentation in the form of function checklists and recorded data for each section to the Owners representative.
 5. Provide plant operators with instruction on the plant operating procedures and major component maintenance after acceptance by the Owner's representative.
- 3.2 At the completion of the work, switchgear shall be field tested by a representative of the manufacturer as described below. A report recording each item of the testing shall be certified by the manufacturer and submitted to the Engineer.
- A. Operation of each disconnecting means under load.
 - B. Operation of all metering equipment.
 - C. Operation of all alarm devices.
 - D. Operation of all key interlocks.
 - E. Observation of cable bracing, both incoming and outgoing, certifying that it is in accordance with the manufacturer's recommendations.
 - F. Verification of setting of all ground fault alarms systems. Test each system by checking coordination between ground fault and phase to ground fault of a one pole lighting branch circuit.
 - G. Verification of torque for all nuts and bolts on buswork extermination.

END OF SECTION

SECTION 262416

PANELBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide panelboards in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Panelboards.
- B. Circuit Breakers.
- C. Fusible Switches.
- D. Surge Protective Devices (SPD)

1.3 SUBMITTALS

- A. Shop Drawings
 - 1. Show main devices and lug sizes; branch circuit device sizes and arrangement; bus ampacities; voltage, ampere, withstandability and short circuit rating of the panelboard and overcurrent protective devices; dimensions and construction; gutter and backbox dimensions; nameplate and legend; protective coating; and all pertinent details of panel, enclosure, cover, and method of securing cover and lock.
 - 2. Include fully detailed and dimensioned plan elevations of each panel at a minimum of ¼" scale.
 - 3. Submit plans indicating maximum dimensions for panelboards including clearances between the panelboards and adjacent surfaces and other items to meet the NEC.
- B. Product Data
 - 1. Submit manufacturer's catalog data for all circuit breakers and switch assemblies.
 - 2. Submit certification of U.L. compliance to integrated short circuit withstand requirements.
 - 3. Seismic restraint calculations and certificates.
 - 4. Short circuit and coordination study.

1.4 QUALITY ASSURANCE

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and recommendations of the following:
 - 1. Panelboards:
 - a. U.L. Standards #50 and #67.
 - b. Federal Standard W-P-115A Type II, Class 1.
 - c. NEMA Standard PB-1.
 - d. CSA Standard C22.2 No. 29-M.
 - e. NFPA 70

2. Circuit Breakers:
 - a. U.L. Standard #489.
 - b. Federal Standard W-C-375B
 - c. NEMA Standard AB-1.
 - d. CSA Standard C22.2 N. 5-M91.
 3. Fusible Switches:
 - a. Federal Standard W-S-865C.
 - b. U.L. Standard 98.
 - c. NEMA KS-1.
 4. Ground Fault Circuit Interrupters (GFCI):
 - a. UL 943.
- B. Testing Agency Qualifications
1. Member company of NETA and NRTL

PART 2 - PRODUCTS

2.1 PANELBOARDS

- A. Provide panelboards consisting of an assembly of branch circuit switching and protective devices (circuit breakers, switch and fuse units, or combination thereof) mounted inside a dead front enclosure. All panelboards shall be door-in-door construction. Provide the number and size of these branch circuit devices as indicated by the circuiting, on the Contract Drawings, and in the Schedules. Locations of circuit breakers shall be as indicated in the schedules.
- B. Provide the following modifications and additional equipment as shown on the Contract Drawings:
1. Main circuit breakers.
 2. Shunt trip circuit breakers.
 3. Ground fault circuit interrupting (GFCI) circuit breakers.
 4. Split buses.
 5. Integral remote control switches.
 6. Subfeed switches.
 7. Panelboard integral mounted relays and contactors.
 8. Feed-through lugs and/or bus.
 9. Feed-through cabling arrangement.
 10. Double lugs for multiple cables or for future provisions.
 11. Circumferential compression lugs where aluminum conductors are employed.
 12. Oversized gutters.
 13. Extra Capacity Neutral Bus – rated 200% of phase bus.
- C. Interiors
1. Provide a rigid removable assembly of copper bus bars and interchangeable bolted branch circuit devices.
 2. Material: Hard-drawn copper, 98 percent conductivity.
 - a. Aluminum bus bars shall have sufficient cross sectional area to provide a current density of 750A per square inch.
 - b. Copper bus bars shall have sufficient cross sectional area to provide a current density of 1000A per square inch.

3. Bus bars drilled to permit branch circuit devices of all sizes and number of poles to be interchangeable and installed in any spare space of sufficient size, without disturbing adjacent units; without removing main bus or branch circuit connectors and without machining, drilling, or tapping in the field.
4. Bus shall be arranged in sequence or distributed phasing so that multi-pole circuit breaker can replace any group of single circuit breakers of the same size.
5. Provide neutral bus in each panelboard.
6. Neutral bus shall be 200% rated when supplied from an oversized neutral feeder. Neutral bus shall be capable of terminating one conductor per panelboard pole position minimum.
7. Provide ground bus in each panelboard. On 208Y/120 volt panelboards provide isolated ground bus when served from a feeder that includes an isolated ground conductor. Each isolated ground bus shall be capable of terminating one conductor per panelboard pole position minimum.

D. Enclosure

1. Enclosure shall be code gauge steel box, galvanized.
2. Provide a bolt-on ground connector to inside of enclosure.
3. Enclosure shall be flush mounted in finished areas and where indicated. Enclosure shall be surface mount elsewhere.
4. Gutter Extension and Barrier: Same gauge and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.

E. Front

1. Doors shall be provided on all lighting and power panels. On switch and fuse panelboards doors over overcurrent devices shall not be provided unless rated for same.
2. Doors shall be heavy code gauge steel as required to maintain panel face flat.
3. Front shall be held closed with trim clamps.
4. Front door frame shall be hinged with captive screws. Circuit breaker section door shall be hinged.
5. Provide typewritten directory for total number of poles. Install behind plastic transparent protective cover on the panel frame.
6. Provide approved lock. All panels shall be keyed alike. Furnish four (4) sets of matching keys to the Owner.
7. Provided welded angle rest at the bottom of the door to facilitate cover installation.
8. Doors over 48" in height shall have auxiliary fasteners at top and bottom of door in addition to lock and catch.
9. Enclosure shall be factory finished in ANSI 61 gray enamel or two coats of air-drying lacquer over a rust inhibiting primer.

F. Multiple Section Panelboards

1. Each section of multiple section panelboards shall be the same height.
2. Multiple sections shall each contain the same number of poles (e.g., 72 poles equals 2-36 pole panels).
3. When a multi-panel is served from a transformer, the main circuit breaker shall be provided in the first section to adequately protect the transformer secondary.

G. Terminal Lugs

1. Terminal lugs shall be bolted type, labeled for either copper or aluminum conductors.
2. Main lugs shall be located properly at top or bottom, depending where main feeder enters.
3. Lugs shall be rated for 75°C terminations.

H. Electrical Ratings

1. Panelboards shall be rated 208Y/120 volts or 480Y/277 volts, 3 phase, 4 wire, full neutral with ampacities as indicated on the Contract Drawings (unless otherwise noted).
2. Panelboards shall be fully rated for the available short circuit current indicated on the Contract Drawings. Each panelboard as a complete and finished product shall receive a single U.L. approved integrated equipment rating by the manufacturer. The integrated equipment short-circuit rating shall certify that all equipment is capable of withstanding the thermal and magnetic stress of a fault equal to the value specified on the Contract Drawings. Such rating shall be established by actual tests by the manufacturer on similar equipment. This certification shall be permanently affixed to each panelboard.
3. Where indicated, provide panelboards having a "service entrance" Type U.L. label with neutrals factory bonded to frame or enclosure.
4. Provide surge protective devices as indicated on the Contract Documents.

I. Circuit Breaker Devices

1. Circuit breakers shall be plastic molded case bolt on type with completely sealed enclosure and toggle type operating handle. Trip ampere rating and "ON/OFF" indication shall be clearly visible. Plug-in type circuit breakers shall not be permitted.
2. Circuit breakers shall be thermal-magnetic trip-free, trip-indicating, quick-make/quick-break, with inverse time delay characteristics. Single-handle and common tripping multi-pole breakers shall be provided.
3. Provide with silver alloy contacts with auxiliary arc-quenching devices.
4. Panelboard shall be of the type which will accept the field installation of shunt trip devices of 60 amperes or less on the branch devices.
5. Interrupting capacities shall be as indicated on the Contract Drawings. As a minimum, 208Y/120 volt devices shall be not less than 10,000 AIC; 480Y/277 volt devices shall not be less than 14,000 AIC; and 42,000 AIC interrupting capacity for distribution style panels.
6. For lighting circuits provide devices labeled "SWD" for switching purposes.
7. Provide with bolted type terminals U.L. listed for either aluminum or copper 75°C conductors.
8. Provide main breakers in panels served from transformers unless separate transformer secondary protection is provided. Main circuit breakers shall be provided in the first section only when multi-section panelboards are provided.
9. Each breaker or space unit shall be provided with an individual number.
10. Circuit breakers serving computer equipment and those serving kitchen equipment beneath cooking hoods shall include a shunt trip coil, when a remote breakglass station or EPO is provided.
11. Shunt trip breakers shall be supplied with 120 volt coils. Provide 120 volt circuit from nearest 120 volt panel to coil. Where shunt trip breakers are in emergency panels provide emergency 120 volt source for same from nearest 120 volt emergency panel.
12. Provide handle padlocking device for designated breakers.
13. For HVAC equipment provide U.L. listed "HACR" type devices.
14. Provide tie-bars on all single pole circuit breakers serving multi-wire branch circuits in compliance with NEC Article 210.4(B). The disconnecting means shall simultaneously disconnect all ungrounded conductors at the point where the branch circuit originates.
15. Should fixed in-feeds require more than one (1) branch circuit, all circuit breakers shall be equipped with tie-bars to allow all circuits to be disconnected during maintenance events.

J. Ground Fault Circuit Interrupters (GFCI)

1. Ground fault circuit interrupter branch circuit breakers shall be provided as indicated on the Contract Drawings. Circuit breakers shall be circuit interrupting which will operate manually for normal switching functions and automatically under overload, short circuit, and 0.005 amp line-to-ground fault conditions. The operating mechanism shall be entirely trip-free so that contact cannot be held closed against an abnormal overcurrent, short circuit, or ground fault condition. The device shall be bolt-on type with insulated case

construction and shall be interchangeable with standard single pole breakers utilized in the panelboard.

K. Switch and Fuse Devices

1. Provide a quick-make/quick-break, horsepower rated, dead-front type. Each switch shall be a self-contained unit, externally operable from the front. Provision for padlocking handle in "OFF" position shall be provided.
2. Fuse and switch compartment shall be interlocked to prevent access to the fuse compartment until switch is thrown to "OFF" position. Interlock shall be intentionally releasable by externally applied tool to permit investigating switch and fuses under load.
3. Switch units shall be interchangeable for replacement, without disturbing balance of distribution panelboard's operation.
4. Switches shall be equipped with rejection type clips for U.L. Class R fuses up to 600A, suitable for U.L. Class L fuses above 600A.
5. Switches shall reject fuses other than those specified.
6. Provide spare fuses as specified in the fuse specification section.

2.2 ACCEPTABLE MANUFACTURERS

- A. Electrotech
- B. All City Switchboard
- C. Lincoln Electric.
- D. General Electric
- E. Square 'D'
- F. Eaton/Cutler Hammer
- G. Siemens

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All panels shall be mounted at a maximum height of six feet six inches to top unless otherwise noted.
- B. Surface type panels shall be mounted a minimum one inch off the wall on channels.
- C. Feed-through panels shall be connected to a main feeder by insulated parallel gutter taps. Full-size tap shall be provided for two (2) or more panels on a common feeder.
- D. Where flush mounted, the fire integrity of the wall in which it is installed shall be maintained.
- E. Branch circuit wires shall be neatly arranged and shall be tied together in each gutter with nylon pre-manufactured cable ties at four inch intervals.
- F. All knockouts removed and not utilized shall be plugged.
- G. Provide nameplate and fill out as-built typewritten panel directory.

- H. Provide grounding and bonding jumpers per the grounding specification section herein and as indicated on the Contract Drawings.
- I. All branch circuit conductors, within panelboards, shall be labeled with respective circuit number.
- J. Stub 3-1" empty conduits from each panelboard into the ceiling cavity above for future use.
- K. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

3.2 TOUCH UP AND CLEANING

- A. All backboxes shall be vacuumed clean of debris after installation and prior to final payment.
- B. Scratch marks, etc., shall be touched up with matching paint.

3.3 OBSERVATIONS

- A. Panel fronts shall be removed when directed by the Engineer/Architect for observation (either by floor, or by group of floors, or all panels on the project as required by the Engineer) and reinstalled immediately thereafter the observations.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Retain a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

3.5 FIELD QUALITY TESTING

- A. Perform the following field quality tests and visual inspections, in accordance with NETA Acceptance Testing Specifications.
 - 1. Exterior of the equipment.
 - 2. Interior of the cubicle.
 - 3. Interior bus/cable systems.
 - 4. Bus support insulators and spacing.
 - 5. Doors/panels/brackets.
 - 6. Door handles/locking bars/mechanisms.
 - 7. Instruments/relay covers.
 - 8. Control/metering transformers/instruments.
 - 9. Grounding/neutral bar installation correct per application.
 - 10. Wiring/terminal connections.
 - 11. Proper electrical clearances maintained.
 - 12. Complete circuit directories properly installed.
 - 13. Surge protection devices installed properly.
 - 14. Load current readings balanced per Code.
- B. Verify circuit breaker identification, sizing and operation in building distribution panelboards.
 - 1. Compile a comprehensive listing of building distribution panelboards, as well as, their respective directories, feeder sizes and designation from where panels are served from.
 - 2. Compare equipment nameplate data with the Contract Drawings and specifications.
 - 3. Inspect circuit breaker for correct mounting.
 - 4. Inspect case for cracks or other defects.

- C. Verify that wire size is appropriate for breaker size.
 - 1. De-energize each panelboard breaker while observing respective building loads served by the breaker.
 - 2. Re-energize each panelboard breaker verifying equipment is re-energized.
 - 3. Each tested breaker, when placed in the "OFF" position, breaks electrical power to the respective (labeled) building load.
 - 4. Each tested breaker, when placed in the "ON" position, supplies electrical power to the respective (labeled) building load.
 - 5. No visible and/or audible arcing present.
 - 6. There shall be no short circuits.
 - 7. Lugs shall all be pulled tight.
 - 8. Panelboards shall be clean and neat. Panelboard covers shall be reinstalled.
- D. Verify Circuit Loads on Main Distribution Panels.
 - 1. Ensure main distribution panels have the proper breaker feeding each load.
 - 2. Compile a comprehensive listing of building distribution panelboards, as well as, their respective directories.
 - 3. Verify breaker matches breaker load.
 - 4. Check breaker balance phase-to-phase.
 - 5. Check line to ground resistance.
 - 6. Check setting on the breaker for trip to motor loads.
 - 7. Verify settings and trip on larger breakers to match the calculated reports.
 - 8. Load shall not be higher than 80% of the breaker.
 - 9. Phases are properly balanced.
 - 10. No more than 0.005 ohm to ground.
- E. Submit all field quality test results.
- F. Perform the following infrared scan tests and inspections and prepare reports:
 - 1. Initial Infrared Scanning: After substantial completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - 2. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of substantial completion.
 - a. Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3.6 SPARE MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two (2) spares for each type of panelboard cabinet lock.
 - 2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two (2) spares for each panelboard.
 - 3. Fuses for Fused Switches: Equal to 10 percent of the quantity installed for each size and type, but no fewer than three (3) of each size and type.
 - 4. Fuses for Fused Power-Circuit Devices: equal to ten (10) percent of the quantity installed for each size and type, but no fewer than three (3) of each size and type.

3.7 WARRANTY

- A. Provide a one (1) year warranty from the date of substantial completion.

END OF SECTION

SECTION 262726

WIRING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide wiring devices in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Switches and Dimmers.
- B. Receptacles.
- C. Wall Plates.
- D. Poke Through Assemblies
- E. Multi-Outlet Assemblies
- F. Special Receptacles.

1.3 SUBMITTALS

- A. Submit manufacturer's catalog cuts and specifications for all types for each product indicated. Highlight exact model being proposed in the submittal.
- B. Submit samples for finish, color and texture as requested by the Architect.

1.4 QUALITY ASSURANCE

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
 - 1. Switches.
 - a. NEMA Standards WD-1 and WD-6.
 - b. Federal Specification Standard WS-896E.
 - c. U.L. 20.
 - 2. Receptacles:
 - a. NEMA Standards WD-1 and WD-6
 - b. U.L. Standard 498
 - c. Federal Specification WC596-D.
 - d. U.L. 943 (GFCI receptacles).
 - e. U.L. 514 (Poke Through Assemblies)
- B. Obtain each type of wiring device through a single manufacturer, where available.

1.5 WARRANTY

- A. Provide a five (5) year manufacturer's warranty for all components.

PART 2 - PRODUCTS

2.1 SWITCHES

- A. Switches shall be commercial specification grade, flush mounting, quiet-operating AC type, decora rocker type, heat-resistant plastic housing and self-grounding metal strap. Provide silver alloy contacts. Switches shall be rated 20A at 120-277V and capable of full capacity on all lamp loads. Switches shall be designed for side or back wiring with up to No. 10 AWG wire. Switches shall be rectangular (decorator) style in all areas.
- B. Provide single-pole, double-pole, 3-way, 4-way, pilot or keyed type switches, as indicated on the Contract Drawings or required.
- C. Switch with Pilot Light: Switches indicated with an illuminated rocker switch in the "OFF" position for visual load monitoring shall be provided as indicated on the Contract Drawings.
- D. Provide 3-position, momentary contact, center "OFF" type switches, which control lighting by way of a low voltage lighting control relays as indicated on the Contract Drawings.
- E. Provide illuminated type switches controlling lighting connected to emergency power – illuminated when switches are in the "OFF" position.
- F. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet "ON/OFF" slide switches and audible frequency and EMI/RFI filters.
 - 1. Control: Continuously adjustable; with single-pole or three-way switching to suit connections.
 - 2. Fluorescent/LED Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.
 - 3. Conference and meeting room dimmers shall be capable of dimmings 0-10 volt (fluorescent or LED drivers).
- G. The color of all devices shall be selected by the Architect.
- H. Acceptable Manufacturers
 - 1. Switches
 - a. Leviton
 - b. Hubbell
 - c. Bryant
 - d. Pass & Seymour/Legrand
 - e. Lutron
 - 2. Dimmers
 - a. Lutron
 - b. Leviton
 - c. Pass & Seymour/Legrand

2.2 RECEPTACLES

- A. Receptacles shall be two-pole, three-wire, grounding, simplex or duplex NEMA 5-20R, rated for 20 amperes at 125 volt electrical alternating current as indicated on the Contract Documents and ANSI standard type, commercial specification grade, with brass contacts that accepts a plug with two (2) parallel blades and one (1) grounding blade. Receptacles shall be equipped with terminals to accept up to No. 10 AWG conductors. Enclosures shall be heat-resistant plastic

with nylon face and two (2) grounding screws. Provide break-off terminals for 2-circuit wiring. Provide rectangular decora style.

- B. Ground fault circuit interrupter (GFCI) receptacles shall interrupt ground leakage currents between 4-6 mA having a maximum circuit current of 20 amperes. Employ feed through or non-feed through devices as indicated, or required. Configuration shall be straight blade type NEMA 5-20R. Utilize 2 3/4" deep outlet boxes without any adaptors. Long life LED light shall be provided, within the receptacle. Device shall have a minimum nominal tripping time of 0.025 seconds.
- C. Provide tamper-resistant receptacles in all dwelling units, hotel guest rooms, and child care facilities. All such receptacles shall be listed as tamper-resistant type.
- D. Provide RED receptacles when circuited to emergency power, unless otherwise noted.
- E. Provide commercial specification grade twist lock type receptacles as indicated on the Contract Documents.
- F. USB Charger Receptacle: Shall be equipped with two (2) USB style 'A' charging outlets with a 20A simplex tamper resistant receptacle.
- G. Switched duplex receptacles shall be wired so that only the top receptacle is switched. The lower receptacle shall be unswitched.
- H. Surge Protective Device (SPD) Receptacles shall have integral surge suppression in line to ground, line to neutral, and neutral to ground modes.
 - 1. SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 Volts and minimum single transient pulse energy dissipation of 210 Joules.
 - 2. Active SPD Indication: LED, visible in the face of the device to indicate device is active or no longer in service.
- I. Cable Reel Receptacles
 - 1. Reel shall have a heavy-duty spring motor, with self-contained rewind power and non-sparking ratchet assembly, a 4-way roller and adjustable cable stop, and a safety chain. Reel shall lock when desired cable has been pulled out, and unlock and retract when cable is pulled to release lock.
 - 2. Reel shall be provided with a minimum 20 foot cable rated for 30A with required phase conductors, neutral, and equipment grounding conductors. Provide device with NEMA configuration as shown on the Contract Documents.
 - 3. Cable reels shall be securely fastened to the structure per the manufacturer's requirements.
- J. The color of all normal devices shall be selected by the Architect.
- K. Acceptable Manufacturers
 - 1. Receptacles:
 - a. Leviton
 - b. Hubbell
 - c. Thomas & Betts
 - d. Pass & Seymour/Legrand

2.3 WALL PLATES

- A. Provide wall plates for all receptacles, outlets, and switches of 430 stainless steel with satin finish, unless otherwise noted. When two (2) or more switches or devices are shown in one (1) location, provide a common wall plate.
- B. Provide cast aluminum metal plate with stainless steel spring loaded, gasketed, double flap lift cover to provide protection for the receptacle and plug when "IN USE" for all exterior receptacles, those in mechanical rooms, those in garages, and where indicated on the Contract Documents. These covers shall be labeled and listed as "extra duty" type.
- C. Provide lockable type covers where indicated on the Contract Documents.
- D. Provide RED wall plates for all receptacles circuited to emergency power.
- E. Acceptable Manufacturers
 - 1. By same manufacturer as device utilized.

2.4 POKE THROUGH ASSEMBLIES

- A. A minimum fire rating of two (2) hours for all through-floor power and communication wiring devices shall be provided.
- B. Dedicated power poke through assemblies shall be factory prewired units with 120V, 20 amp rated grounded receptacles, with one (1) through floor conduit, junction box, and a self-supporting fitting without attachment of above floor fitting.
- C. Combination power & communication poke through assemblies shall be factory prewired with two (2) 120V, 20 amp rated grounded simplex receptacles, and internal barrier such that power will occupy one-half of the outlet box and telecommunication the remaining half of outlet box (space for two (2) category 6 RJ-45 jacks minimum). Furniture fed type service assembly shall be provided as indicated on the Contract Documents.
- D. Provide an integral fire barrier to incorporate cold smoke barrier to prevent passage of smoke when heat is not present.
- E. Poke through assemblies shall be for use with slab floors as well as corrugated metal decks. Metal boxes with corrosion protection suitable for installation in concrete shall be provided. Aluminum alloy boxes are not considered acceptable for installation in concrete or cinder fill unless protected by asphalt paint or equivalent. Selected to fit in nominally 4" cored holes.
- F. Provide each outlet with a heavy gauge steel work plate that is clearly marked - power-communication. Do not install service fittings until floor finishing is completed.
- G. Contoured, flush mounted, die-cast cover shall be provided for all types of assemblies. Finish shall be as selected by the Architect.
- H. Contractor shall verify thickness of the floor and select through floor components that fit the floor thickness.
- I. Acceptable Manufacturers
 - 1. Thomas & Betts – Steel City
 - 2. Hubbell
 - 3. Legrand/Wiremold

2.5 MULTI-OUTLET ASSEMBLIES

- A. Provide multi-outlet assemblies consisting of surface mounted multi-compartment metal raceways, lengths as indicated on the Contract Documents.
- B. The raceways shall be utilized for power branch circuits, data network voice, and other low voltage wiring. Each wiring system shall be installed in the respective dedicated channel of the raceway.
- C. Raceways shall be one- or two-piece design with base and snap-on cover, or three-piece design with base and two snap-on covers which snap side by side on a common base. Base shall be dividable with a fixed barrier for up to 4 compartments. Raceway shall be in widths of $\frac{3}{4}$ " to 10" and depths of $17/32$ " to 5" as indicated on the Contract Documents.
- D. Provide the required fittings, device brackets, and plates to accommodate a complete code compliant system.
- E. The raceway shall be aluminum with a finish color as selected by the Architect.
- F. Provide receptacle types, quantities, and spacing as indicated on the Contract Documents. Provide device cover plates (power & communication) in a satin finish with circuiting identification tags. Colors of power and communication devices shall be by the Architect.
- G. Pre-wired Raceways
 - 1. Raceways shall be single or multi-channel as indicated in the Contract Documents.
 - 2. Fittings: Multi-outlet system consisting of factory assembled components with a full complement of fittings including, but not limited to, elbows (90 degree, internal and external) slide couplings for joining raceway sections, blank end caps for closing open ends of the raceway, and flat tees. No field cutting of raceways will be permitted.
 - 3. Devices: Wiring devices and other connectors shall be factory installed, electrically wired, and covers labeled as identified on the Contract Documents. Each receptacle shall be identified noting the panel number and circuit number from which it is fed. Receptacles rated higher than NEMA 5-20R shall also be provided with voltage, phase and amperage identified in the same manner. Raceway sections shall be provided with 12" pigtails at feed locations for ease of installation. Grounding shall be maintained by means of factory installed NEC sized grounding conductors and utilize insulation displacement connectors as required.
 - 4. Raceway Covers and Device Plates: Raceway covers shall have either hole-cut provision for communications outlets or the voice and data/LAN outlets shall be factory mounted to the cover plates as indicated on the Contract Documents. Raceway shall be capable of containing, but not limited to, snap-in modular jacks (3-pair, 4-pair, 4-pair keyed and fiber optic, coaxial and F-connectors and communication grommets. Wiring connections of these devices shall be completed during installation.
 - 5. Finish shall be as selected by the Architect.
 - 6. Shop drawing submittal must clearly identify all devices being installed at the factory.
- H. Tele-Power Poles
 - 1. Provide multi-channel vertical raceways as indicated on the Contract Documents.
 - a. The multi-outlet system shall consist of a full complement of fittings including feed fittings, ceiling trim plates, T-bar mounting hardware, and carpet-floor grippers.
 - b. Provide receptacle types, quantities and spacing as indicated on the Contract Documents. Provide device cover plates (power and communication) in a finish as selected by the Architect. Color of devices shall be as selected by the Architect.
 - c. Acceptable Manufacturers

- 1) Legrand/Wiremold
- 2) Hubbell
- 3) Approved Equal

PART 3 - EXECUTION

3.1 SWITCHES

- A. Install all switches vertically with the "ON" position on top, unless noted or specified otherwise.
- B. Where switches are indicated near doors, corner walls, etc., install not less than two (2) inches and not more than twelve (12) inches from the trim.
- C. Carefully coordinate locations of switches to insure locations are at the strike side of doors.
- D. Furnish and install an engraved legend for each switch that controls motors, equipment systems, etc., not located within the sight of the controlling switch.
- E. Install wall dimmers to achieve indicated rating after derating for ganging according to the manufacturer's written instructions.
- F. Install unshared neutral conductors on the line and load sides of the dimmers according to the manufacturers' written instructions.

3.2 RECEPTACLES

- A. Unless otherwise noted, mount receptacles vertically with U-shaped ground position at the top.
- B. Coordinate device layouts and installation with all other adjacent devices and any wall obstruction prior to any work.

3.3 GROUND FAULT CIRCUIT INTERRUPTERS (G.F.C.I.)

- A. Swab all conduits and outlet boxes clear of moisture.
- B. Do not combine G.F.C.I. protected circuits with other circuits in the same raceway; only one (1) G.F.C.I. circuit per raceway.
- C. Do not substitute G.F.C.I. circuit breakers for G.F.C.I. receptacles.
- D. All G.F.C.I. receptacles shall be installed in a readily accessible location per the NEC.

3.4 DEVICE GROUNDING

- A. Provide a No. 12 AWG grounding conductor from the device grounding terminal to the panelboard ground bus.
- B. Provide a No. 12 AWG grounding conductor from the device grounding terminal to the outlet box.

3.5 INSTALLATION

- A. All devices shall be flush-mounted except as otherwise noted on the Contract Documents.

- B. Locations
 - 1. Comply with layout drawings for general location.
 - 2. Relocate outlets obviously placed in a location or manner not suitable to the room finish.
 - 3. Avoid placing outlets behind open doors.
- C. Mounting heights and positions are specified in the Special Conditions specification section and as indicated on the Contract Documents. Architectural drawings take precedence over heights and positions specified in the electrical specifications.
- D. Ganging of Switches: Provide steel barriers between ganged 277 volt switches of different phases between all ganged dimmers; and between normal and emergency sources.
- E. Fastening: Securely fasten the devices into the outlet boxes and attach appropriate wall plates.
- F. Testing
 - 1. After installing wiring devices and after circuiting has been energized, test for proper polarity, ground continuity, and other requirements indicated on the Contract Documents.
 - 2. Test GFCI operation with local fault simulation according to the manufacturer's instructions.
 - 3. Replace all malfunctioning devices with new and retest as specified above.
- G. All devices shall be provided with identification as indicated in the identification specification section.

3.6 CLEANING

- A. Clean equipment and devices internally and externally using methods and materials recommended by the manufacturer, and repair any damaged finishes.

3.7 SPARE PARTS

- A. Provide five (5) spare devices for each type used on the project.

3.8 SERVICE AND SUPPORT

- A. Startup and Programming
 - 1. Provide a factory-certified field service engineer to visit the site to ensure proper system installation and operation under the following parameters:
 - a. Qualifications for factory-certified field service engineer:
 - 1) Minimum experience of 2 years training in the electrical/electronic field.
 - 2) Certified by the equipment manufacturers on the systems installed.
 - b. Perform site visits upon completion of the wiring device systems, installation, and;
 - 1) Verify connections and locations of all control devices.
 - 2) Verify systems operation control, zone by zone.
 - 3) Verify proper integration of the manufacturers' interfacing equipment.
 - 4) Obtain sign-off on all system functions.

END OF SECTION

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SECTION 262816
DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide disconnect switches in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Safety Switches (Fused and Non-Fused Types).
- B. Manual Control Switches.

1.3 SUBMITTALS

- A. Product Data
 - 1. Submit manufacturers' data for all disconnect switches, including dimensional data, ratings, fuse ratings and types, and cable terminal sizes.
 - 2. Identify motor or equipment served by each switch; indicate nameplate inscription.

1.4 QUALITY ASSURANCE

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest applicable recommendations of the following:
 - 1. U.L. Standards #98.
 - 2. NEMA Standard KS1.
 - 3. U.L. 20 and Federal Specification Test Standards for Toggle Switches.

PART 2 - PRODUCTS

2.1 SAFETY SWITCHES

- A. Provide heavy-duty, horsepower rated, single-throw knife switch with quick-make/quick-break mechanism, capable of full load operations. Switches shall meet NEMA and U.S. Government specifications for Class A switches.
- B. Provide with contact arc-quenching devices, such as magnetic blowouts or snuffing plates. Provide self-aligning switchblades with silver alloy contact areas, designed so that arcing upon making and breaking does not occur on final contact surfaces. Provide with high-pressure, spring-loaded contact. Switch parts shall be mounted on high-grade insulating base.
- C. Enclosure: Shall be NEMA 1 with hinged door, and defeatable interlock when switch is in "ON" position, able to be padlocked in "ON" and "OFF" positions. Provide NEMA 3R (rain-tight) enclosure for exterior installations and NEMA 12 in warehouse and mechanical rooms.
- D. Size, fusing and number of poles shall be provided as shown on the Contract Documents or as required. Where fused, the switch shall be provided with U.L. listed rejection feature to reject all but Class R fuses. Provide horsepower rated switch to match motor load if size is not shown.

Provide 3 pole plus solid neutral switches on four wire circuits and 3 pole switches on all other circuits, unless otherwise noted.

- E. Lugs shall be U.L. listed for copper conductors and be front removable.
- F. Provide six (6) pole switches for connection to motors with the following starter types:
 - 1. Non-reversing - two step - part winding - star connected.
 - 2. Non-reversing - full voltage - two speed separate winding.
 - 3. Non-reversing - full voltage - two speed single winding.
 - 4. Where otherwise required.
- G. Provide auxiliary contacts for switches where required or where indicated on the Contract Documents.
- H. Viewing Windows – Provide viewing windows for all safety switches to provide blade visibility when the switch door is closed.

2.2 TOGGLE TYPE MANUAL CONTROL SWITCHES

- A. Provide switches which operate at their full rating with fluorescent, tungsten, and resistance loads and at 80% of their rated capacity with motor loads.
- B. Switches shall be heavy duty type and shall have:
 - 1. Arc-resisting bodies.
 - 2. Slow make-and-break mechanisms.
 - 3. Silver alloy contact buttons.
 - 4. Side or back wiring with up to No. 10 AWG solid conductors.

2.3 ACCEPTABLE MANUFACTURERS

- A. Safety Switches
 - 1. Square 'D'
 - 2. Eaton/Cutler Hammer
 - 3. General Electric
 - 4. Siemens
- B. Toggle Type Manual Control Switches
 - 1. Square D
 - 2. Eaton/Cutler-Hammer
 - 3. General Electric
 - 4. Siemens

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Provide each motor over ½ HP with a horsepower rated safety-type disconnect switch.
- B. Provide each piece of equipment utilizing multi-phase power with a safety-type disconnect switch.
- C. Provide each piece of equipment utilizing single-phase power but protected at over 30 amperes with a safety-type disconnect switch.

- D. Equipment other than that mentioned above shall utilize toggle type manual control switch properly sized and rated for equipment it disconnects.
- E. Factory installed disconnect switches may be used to satisfy the above requirements.
- F. Disconnect switches serving the fire alarm system shall be painted RED.

3.2 MOUNTING

- A. Provide connections and wiring to and from each disconnect switch.
- B. Disconnect switches shall be mounted on adjacent wall or from the floor with independent supports. Switches shall not be mounted on the equipment housings.
- C. Switch enclosure shall be rigidly mounted and with proper alignment on building structure or steel supports with centerline of operating handle not more than 6 feet above finished floor unless otherwise required. Steel supports fabricated from standard rolled structural steel shapes or framing channel shall be used to provide one-inch separation between enclosure and building wall for vertical flow of air.
- D. Fuses shall be used as specified in this Division.
- E. Completed installation shall contain no extraneous openings.
- F. All viewing windows shall be cleaned.

3.3 IDENTIFICATION

- A. Provide nameplate identification of all disconnect switches in accordance with these specifications.

3.4 FIELD TESTING

- A. The following field acceptance tests shall be performed and test report submitted:
 - 1. Compile a comprehensive listing of building motor loads, including voltage, phase, HP, FLA, and location.
 - 2. Compare equipment nameplate data with the Contract Drawings and specifications.
 - 3. Command inductive motor loads to start through respective manual or computer controls.
 - 4. With individual motor loads running break power to the load with respective disconnect switch and/or safety stop.
 - 5. Wait until motor loads come to a complete stop.
 - 6. Re-connect power to the motor load with the respective disconnect switch and/or safety stop.
 - 7. Compare fuse size with motor full-load current rating to verify correct sizing.
 - 8. Verify that no visible or audible arcing is present.

END OF SECTION

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SECTION 262913

480/277V SWITCHBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide 480/277V Life-Safety switchboard rated 600V or less in accordance with the Contract Documents (3-phase, 4-wire).

1.2 WORK INCLUDED

- A. Switchboard
- B. Circuit Breakers
- C. Surge Protection Devices (SPD)
- D. Mimic Bus
- E. Short Circuit Analysis and Arc Flash Study
- F. Instrumentation and Control Power

1.3 SUBMITTALS

A. Shop Drawings

1. Include fully detailed and dimensioned plans, sections and elevations of each section of the switchboards. Include information on type and size of structural supports, metal thicknesses, surface finishes, bus cross sections, and provisions for lifting. Drawings shall be a minimum of 1/4" scale.
2. All concrete housekeeping pads must be sized and illustrated.
3. Detail utility company's metering and C.T. cabinet provisions with indication of approval by the utility company.
4. Include all required code and maintenance clearance space around each piece of equipment.
5. Detail descriptive documentation of any barriers specified for electrical insulation and/or isolation.
6. Conduit entrance locations and requirements must be identified.
7. Indicate shipping splits coordinated with the project delivery path to assure all equipment can be moved into place.
8. Shop drawing shall be submitted to utility company for approval.

B. Product Data

1. Single line diagram of circuit breakers, bus arrangements, ground fault alarm, surge protective devices, metering arrangements, etc.
2. Furnish complete schematic wiring diagrams and a full set of equipment wiring diagrams for protective equipment relays, over current protection devices, pilot lights, alarms, controls, etc. Provide narratives for all wiring diagrams submitted.
3. Include full load heat rejection in BTU per hour for total components by switchboard.
4. All circuit breaker sizes and types must be indicated.
5. All nameplate information must be complete.

6. All mimic bus arrangements must be illustrated.
7. Short circuit and coordination study must be provided at the time of the switchboard submission. The switchboard submission must be coordinated with the study results.
8. All diagrams shall include system voltage, phase, frequency, bus current ratings and withstanding ratings.
9. Detail features, characteristics, ratings, and factory settings of the individual overcurrent protection devices and auxiliary components.
10. Detail enclosure types for each type other than NEMA 250, Type 1.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in the switchboard.
12. Submit testing procedures which will be used for field quality testing.

C. Test Reports

1. Submit test data verification of fault current withstand rating.
2. Submit certified reports of field quality testing.
3. Seismic restraint calculations and certificate of compliance.

1.4 QUALITY ASSURANCE

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
1. Ground Fault Alarm UL 1053.
 2. QMQB Operators UL E1818.
 3. Switchboards NEMA Standards PB-2, PB-2.1, PB-2.2; UL 891 and UL Service Entrance Label.
 4. Meters ANSI Specification C 39.1.
 5. ANSI C37.13.
 6. ANSI C37.51.
 7. NETA
 8. Molded Case Circuit Breakers UL 489 and NEMA AB1.
- B. Switchboard shall receive a single integrated equipment rating by the manufacturer. The integrated equipment short-circuit rating shall certify that all equipment is capable of withstanding the thermal and magnetic stress of a fault equal to the value calculated by the Contractor/manufacturer's coordination study. Such rating shall be established by actual tests by the manufacturer on similar equipment. This certification shall be permanently affixed on the switchboard. Test data shall be submitted to the Engineer at the time of submission of Submittal Drawings.
- C. Only qualified staff shall be allowed to work on the installation of this equipment and all terminations, as defined in NEMA PB2.1 and NFPA 70E.
- D. Obtain all switchboards, overcurrent protection devices, components, and accessories from a single manufacturer.

1.5 SHORT CIRCUIT AND COORDINATION STUDY

- A. Refer to the Overcurrent Protective Device Coordination Study specification section for all requirements.

1.6 ARC-FLASH HAZARD ANALYSIS

- A. Refer to the Overcurrent Protective Device Coordination Study specification section for all requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide switchboard of the free standing, totally enclosed dead-front safety type, consisting of an assembly of thermal magnetic molded case chassis-mounted insulated case feeder circuit breakers of the number, size and arrangement shown on the Contract Documents.
- B. Switchboard shall be of front accessible type where all connections are accessible from the front.
- C. Overcurrent devices shall be provided as individually mounted devices in switchboards of 1,200 amperes or more. Provide group mounted in switchboards rated below 1,200 amperes.
- D. Carefully check the physical space limitations for the switchboard and furnish switchboards to match those conditions. Nothing in these specifications shall preclude the use of a custom designed switchboard (as reviewed by the Engineer) to meet those limitations.
- E. Switchboard enclosures shall be steel, NEMA 250, Type 1 and fully gasketed.
- F. Provide service entrance label where required.
- G. Provide dedicated switchboard cubicle for circuit breaker taps serving fire pump. This cubicle shall be provided with steel barriers and painted red. The fire pump take-off shall be tapped ahead of the main service switch and after the main utility meter. Fire pump switches or shall be in stand-alone sections, independent of the switchboard tap and any other overcurrent device or metering.
- H. Switchboard shall be rated 100,000 AIC bracing, UON.

2.2 CONSTRUCTION

- A. The enclosure shall be formed structural steel, forming a rigid structure. Turned down peripheral edge on front and rear panels.
- B. Completely enclosed on the back, front, and sides with removable panels. All closure plates shall be small enough for easy handling by the operator.
- C. All sections shall be the same height, 90 inches, except as otherwise required due to physical space limitations. All sections shall be the same depth.
- D. The switchboard enclosure shall be painted on all exterior surfaces. The paint finish shall be a medium gray, ANSI 49, applied by the electro-deposition process over an iron phosphate pre-treatment.
- E. Provide steel barriers between each section of the switchboard.
- F. Compartments indicated as "SPACE" or "FUTURE" shall be equipped with mounting brackets, supports, bus connections, and appurtenances at full rating of the overcurrent device compartment.

2.3 PULLBOX OVER SWITCHBOARD

- A. Where required for conduit terminations, provide a pullbox of the same type of construction and finish as the switchboard. Adequate ventilation to maintain temperature in the pullbox within the same limits as the switchboard.
- B. Provide cable supports for horizontal support of cables. Construct supports of 3/4 inch conduit loosely enclosed by strong fiber tubes. Space supports no more than 24 inches horizontally and 6 inches vertically.
- C. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into the switchboard.
- D. Removable covers shall form top, front and sides. Top covers at rear shall be easily removable.

2.4 BUSES

- A. Bus bars shall be arranged throughout A-B-C left to right, top to bottom, and front to rear.
- B. Conductor material shall be copper of 98% conductivity silver plated.
- C. Bus shall be sized at 1,000 amperes per square inch, but in no case less than of sufficient cross section to limit temperature rise to 55°C above an ambient temperature of 40°C.
- D. Horizontal bus shall be full size, tapered bus is not permitted. Provide bolt holes drilled and tapped for future extension at the end of the bus bars including the neutral and ground buses. The provisions shall include bus bars installed and extended to the extreme side of the section and shall be fabricated in such a fashion that the addition of a future section would require only the installation of standard bolted splice plates.
- E. All bus bars shall be rigidly braced to comply with the integrated equipment rating of the switchboard.
- F. Neutral bus shall be rated 100 percent of the ampacity of the phase buses.
- G. Bus bars shall be extended vertically to the fullest extent to allow the installation of future devices, space permitting.

2.5 FEEDER INSTALLATION AND TERMINATION

- A. Bolted and accessible from the rear for rear access type. Bolted and accessible from the front for front access type.
- B. Where bus ducts terminate at the switchboard, these conductors (including neutral and grounds) shall be extended to the switchboard bus. The use of cable is unacceptable.

2.6 CIRCUIT BREAKERS

- A. Main Protective Devices
 - 1. Molded Case Circuit Breaker – (1200A or less)
Insulate Case – (Greater than 1200A)

Molded case circuit breaker shall be of the quick-make, quick-break, trip-free, solid state type. The continuous current rating shall be adjustable from 20 to 100% without the need for a rating plug. Circuit breakers shall be a 3-pole 600-volt with a trip current ratings as

specified on the Contract drawings and or schedules with interrupting capacities of not less than 100,000 amperes RMS symmetrical at the system voltage. Breaker shall be G.E. "Spectra" series or Siemens "Sentron" design or equivalent.

2. The trip unit shall provide the following protective functions:
Long Time Delay
Short Time Pickup and Delay
Instantaneous Pickup
 3. The breakers shall have the ability to provide shunt trips, bell alarms, auxiliary switches, electric motor operator, undervoltage release, remote close solenoids, as shown on the contract drawings.
 4. Mains shall be manually operated, stationary.
 5. Furnish non-automatic mains where indented on the drawings.
- B. Feeder Protective Devices
1. Molded Case Circuit Breakers – Under 1201 A
Insulated Case – More than 1200A

2.7 GROUNDING

- A. Provide ground bus of at least 33 percent of capacity of the switchboard extending along the full length of the switchboard.

2.8 METERING

- A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
1. Potential Transformers: IEEE C57.13; 120 V, 60 Hz, secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
 2. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
 3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
 4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.
- B. Ammeters, Voltmeters, and Power-Factor Meters: ANSI C39.1.
1. Meters: 4-inch diameter or 6 inches square, flush or semiflush, with antiparallax 250 degree scales and external zero adjustment.
 2. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.
- C. Instrument Switches: Rotary type with "OFF" position.
1. Voltmeter Switches: Permit reading of all phase-to-phase voltages and, where a neutral is indicated, phase-to-neutral voltages.
 2. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in a closed-circuit condition at all times.

2.9 MIMIC BUS

- A. Provide a factory installed mimic bus on the switchboard, accurately depicting phase bus work, take-offs, connections, meters and disconnecting means per the factory record as-built drawings.
- B. Mimic bus shall be ¼ inch thick, heat and impact resistant, beveled bakelite, ½ inch wide, secured to the switchboard enclosure with cadmium plated screws.
- C. Mimic bus on the normal switchboards shall be ivory colored and red colored on the emergency switchboards.
- D. Mimic bus shall be installed prior to energizing the equipment.

2.10 EMERGENCY SWITCHES

- A. Devices or enclosures serving the normal side of fire alarm systems or fire pumps shall have the cover of that device enclosure painted high gloss red and suitably labeled and be provided with the generator section.

2.11 ACCEPTABLE MANUFACTURERS

- A. Switchboard
 - 1. Electrotech
 - 2. All City Switchboard
 - 3. Lincoln Electric
 - 4. General Electric
 - 5. Square D
 - 6. Siemens.
 - 7. Eaton/Cutler Hammer

2.12 GROUND FAULT PROTECTION

- A. Ground fault protection (GFP) shall be provided where indicated on the Contract Documents and on all disconnect switches rated 1000 amperes or more as required by the National Electrical Code. For 2-zone ground fault protecting the main and all the feeders shall contain ground fault protection.
- B. The ground fault protection shall consist of the following:
 - 1. Current Sensors: Provide zero sequence current sensors for feeder and branch devices and ground return sensors for main service device; inputs compatible to relay. Construct sensor frame so it can be opened to permit removal or installation around conductors without disturbing conductors. Provide test winding in sensor for testing operation of GFP unit, including sensor pick-up, relay, and circuit protection device operation.
 - 2. Ground-Fault Relay: Provide solid-state ground-fault relay, which requires no external source of electrical power, drawing energy to operate GFP system directly from output of current sensor. Construct with adjustable pick-up current sensitivity for GF currents from 200 to 1200 amperes, with calibrated dial to show pick-up point settings. Provide factory-set time delay of 0.5 seconds and which precludes tampering with setting after installation.
 - 3. Monitor Panel: Provide monitor panel capable of indicating relay operation, and provide means for testing system with or without interruption of service. Construct so GFP system cannot be left in an inactive or "OFF" state. Provide indicator lamps and TEST and RETEST control switches. The panel shall be installed in the front of the switchboard adjacent to the device being protected.

4. Shunt-Trip: Each device, switch, or circuit breaker, with ground fault protection, shall be provided with a shunt-trip mechanism which shall automatically "OPEN" the device when signaled by the ground-fault sensor.
 5. Provide 2-zone ground fault protection to main service switchboard.
 6. Provide ground fault indication (GFI) for all breakers serving fire pumps.
 7. Provide ground fault indication (GFI) for all breakers of Life-Safety Switchboard.
- C. Provide a fuse protected control power transformer from the switchboard line side for the ground fault systems. Ground fault and shunt-trip device shall be capable of operation at 55% of the rated voltage.
1. Settings
 - a. The electrical trade shall set each ground fault sensor pick up setting at 25% of the rating of the over-current device with a 6-cycle time delay unless specifically indicated otherwise in the short circuit and coordination study.
 2. Where switchboard contains power breaker, electrically operated, control power should be obtained from the above control transformer.

PART 3 - EXECUTION

- 3.1 Install switchboard when the area is free and clear of dust and debris. Protect switchboards continuously from dust and moisture. Do not utilize switchboards for temporary lighting and power services except where authorized in writing by the owner.
- 3.2 Install switchboard on 4 inch high concrete housekeeping pads which shall follow the contour of the switchboards with 4 inch clear all around, per the factory record drawing.
- 3.3 Provide steel channel sills below each switchboard where the switchboard frame is not suitable for use as a floor sill.
- 3.4 FEEDER INSTALLATION AND TERMINATION
 - A. Group cables paralleling one another and arranged so as to permit easy insertion of a clamp-on ammeter on each cable.
 - B. All line and load side conductors emanating from the top or bottom of the switchboards shall be lashed to cable braces provided in the switchboard. Lashing shall be performed as per the manufacturer's recommendations to maintain the integrated equipment rating. Lashing material shall be nonmetallic fire and heat resistant with a tensile strength of 2,000 pounds. In general on service entrance cable, run and bend the cable in a manner so as to rest directly against the cable braces. Make six (6) revolutions around the "A" and "B" phase and the six (6) revolutions around the "B" and "C" phase cables. With the remaining lashing material make four (4) to five (5) revolutions between each of the phase cables tying a knot to the cable braces as the last revolution is complete. All revolutions must be as tight as possible to prevent magnetic stress during short circuits. Load cables in general should be lashed with four (4) revolutions around the cable and the brace, then tied in a knot after the last revolution.
- 3.5 At the completion of the work, each switchboard shall be field tested by a manufacturer's representative as described below. A report recording each item of the testing shall be certified by the manufacturer and submitted to the Engineer.
 - A. Operation of each disconnecting means under load.
 - B. Operation of all metering equipment.

- C. Operation of all alarm devices.
- D. Observation of cable bracing, both incoming and outgoing, certifying that it is in accordance with the manufacturer's recommendations.
- E. Verification of setting of all ground fault protection (GFP) systems. Test each system by checking coordination between ground fault and phase to ground fault of a single pole lighting branch circuit.
- F. Verification of torque for all nuts and bolts on buswork. Tighten connections in accordance with the manufacturer's specifications.
- G. Measure, using a megger, the insulation of each bus section phase-to-phase; and phase-to-ground for one (1) minute each, at a minimum test voltage of 1000 VDC for 480 volt and 500 VDC for 208 volt systems. Minimum acceptable value for insulation resistance is 1 megaohms. Coordinate testing with the equipment manufacturer prior to any testing.

3.6 OPERATING AND MAINTENANCE MANUAL

- A. Provide the manufacturer's operating and maintenance manuals for all switchboards. Manuals shall include spare parts data listing, source of replacement parts and supplies and as-built drawings.
- B. Provide the manufacturer's installation and maintenance instructions. Instructions shall be affixed to the cover of the incoming section of each equipment.
- C. Demonstration: Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.
- D. Include time current coordination curves for each type and rating of overcurrent protective device.

3.7 AS-BUILT RISER DIAGRAM

- A. Provide an as-built riser diagram of each distribution system mounted in a glass covered-frame. Media shall be high quality presentation type paper. Diagrams shall be located in the respective electrical room. A digital electronic version shall be submitted to the Engineer and building Owner.

3.8 FIELD QUALITY TESTING

- A. Perform field testing in accordance with NETA Acceptance Testing Standards and to include, but not limited to, the following:
 - 1. Perform resistance tests through all bus joints with a low-resistance ohmmeter. Any joints that cannot be directly measured due to permanently installed insulation wrap shall be indirectly measured from closest accessible connection.
 - 2. Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground.
 - 3. Bolt-torque levels shall be in accordance with the manufacturer specifications.
 - 4. Compare bus connection resistances to values of similar connections.
 - 5. Insulation-resistance values for bus, control wiring, and control power transformers shall be in accordance with the manufacturer's published data. Overpotential tests should not proceed until insulation-resistance levels are raised above minimum values.

6. Apply overpotential test voltages in accordance with the manufacturer's recommendations. The insulation shall withstand the overpotential test voltage applied.
- B. Perform the following infrared scan tests and inspections and prepare reports:
 1. Initial Infrared Scanning: After substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front and rear panels so joints and connections are accessible to portable scanner.
 - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
 2. Instruments and Equipment
 - a. Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- C. Switchboard will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports; including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.9 FIELD SETTINGS

- A. The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the final short-circuit study, ground fault protective device evaluation study, and protective device coordination study.
- B. Necessary field settings of devices and adjustments and minor modifications to equipment to accomplish conformance with the final short-circuit and protective device coordination study shall be carried out by the Contractor at no additional cost to the Owner.

3.10 SPARE PARTS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Potential Transformer Fuses: Equal to ten (10) percent of the quantity installed for each size and type, but no fewer than two (2) of each size and type.
 2. Control-Power Fuses: Equal to ten (10) percent of the quantity installed for each size and type, but no fewer than two (2) of each size and type.
 3. Fuses and Fusible Devices: Equal to ten (10) percent of the quantity installed for each size and type, but no fewer than three (3) of each size and type.
 4. Fuses for Fused Switches: Equal to ten (10) percent of the quantity installed for each size and type, but no fewer than three (3) of each size and type.
 5. Fuses for Fused Power-Circuit Devices: Equal to ten (10) percent of the quantity installed for each size and type, but no fewer than three (3) of each size and type.
 6. Indicating Lights: Equal to ten (10) percent of the quantity installed for each size and type, but no fewer than one (1) of each size and type.

3.11 WARRANTY

- A. Provide a five (5)-year warranty from the date of substantial completion for all defects in materials and workmanship.

3.12 INSULATION MAT

- A. Provide a 36 inch wide x $\frac{1}{4}$ " thick insulation mat in the front and rear of the entire switchboard, rated for a dielectric test voltage of 30,000 volts.

END OF SECTION

SECTION 263212
RADIATOR MOUNTED RESISTIVE
LOAD BANK (1000 KW)

PART 1 - GENERAL

1.1 SCOPE

- A. This specification contains the minimum requirements for the design, manufacture and testing of a UL listed, radiator style resistive load bank.
- B. The load bank is required for periodic exercising and testing of the (standby) emergency power source. The load bank shall use the air discharge from the generator radiator for cooling.
- C. This specification shall apply if the load bank is supplied to the purchaser, or as a part of other equipment.
- D. Should the vendor take exception to any part of this specification, it shall be stated in the bid, and referenced to the specification line number.

1.2 RELATED SECTION

- A. Section 263213 – 480/277 Volt Life-Safety Diesel Engine Generator.

1.3 SUBMITTALS

- A. The manufacturer shall submit for review technical data including features, performance, electrical characteristics, physical characteristics, ratings, accessories, and finishes.
- B. Shop drawings shall include dimensional plans and mounting details sufficient to properly install the load bank. Load bus configuration and load connections termination area shall be clearly identified.
- C. Electrical schematic drawings shall be provided to detail the operation of the load bank and the provided safety circuits. Over-current protection and control devices shall be identified and their ratings marked. An interconnection drawing shall be included for control wiring related to the load bank.

1.4 STANDARDS

- A. The equipment covered by this specification shall be designed with the latest applicable NEMA,
- B. NEC, and ANSI standards.
- C. The load bank shall be listed to UL Standard 508A.

PART 2 - PRODUCTS

2.1 RATINGS

- A. The total capacity of the load bank shall be rated (1000) KW at (480) Volts, 3-Phase, 3-Wire, 60 Hertz, (1200) Amps per Phase at unity Power Factor.
- B. The load step resolution shall be a nominal 20% of the load bank rating.
- C. The load bank shall be designed for continuous duty cycle operation with no limitations.
- D. Radiator/Duct mounted load banks are designed as a supplemental load to the generator set, and shall be sized at 50-60% of generator nameplate KW rating (not 100%).
- E. A 1600/1500A circuit breaker with shunt trip should be installed adjacent to generator main 3000 ampere circuit breaker for serving the load bank with four (4) sets of 3-500MCH cables, plus/#4/0 ground-in 3½" conduit.

2.2 MATERIAL AND CONSTRUCTION

- A. The load bank shall be suitable for installation on the generator radiator core, or within the radiator exhaust ductwork.
- B. Due to the high radiator exhaust from the generator, the load bank shall be constructed of heavy gauge aluminized steel per ASTM A463. Aluminized steel provides superior corrosion protection and extended service life, with a better tolerance to high heat exposure compared to the more common Galvanized steel.
- C. The main input load bus, load step relays, fuses and control relays shall be located within the load bank enclosure.
- D. The load bank shall have a core size to match the generator radiator with a self-contained 2" flange on the top and bottom edges for mounting.
- E. E. The load bank shall be designed for installation and operation indoors. All exterior fasteners shall be stainless steel.

2.3 RESISTIVE LOAD ELEMENTS

- A. Load elements shall be Avtron Helidyne™, helically wound chromium alloy rated to operate at approximately ½ of maximum continuous rating of wire. Elements must be fully supported across the entire length within the air stream by segmented ceramic insulators on stainless steel rods. Element supports shall be designed to prevent a short circuit to adjacent elements or to ground.
- B. The change in resistance due to temperature shall be minimized by maintaining conservative watt densities.
- C. The overall tolerance of the load bank shall be –0% to +5% KW at rated voltage. A –5%, +5% rating allows the load bank to deliver less than rated KW and shall not be used. The load bank must deliver full rated KW at rated voltage.

- D. Sealed wire type elements (which have the internal resistance wire totally enclosed) prevent internal cooling of the element wire and shall not be used.

2.4 PROTECTIVE DEVICES

- A. An over-temperature switch shall be provided to sense the load bank exhaust. The switch shall be electrically interlocked with the load application controls to prevent load from being applied in the event of an over temperature condition.
- B. To provide for major fault protection, branch fuses shall be provided on all three phases of switched load steps above 50KW. Branch fuses shall be current limiting type with an interrupting rating of 200K A.I.C.
- C. The exterior of the load bank shall have appropriate warning/caution statements on access panels.

2.5 CONTROL PANEL

- A. The control panel shall be a local panel mounted on the load bank. The control panel shall contain the following manual controls:
 - 1. Power ON/OFF switch
 - 2. Master load ON/OFF switch.
 - 3. Load step switches for ON/OFF application of individual load steps.
- B. Control panel visual indicators shall be as follows:
 - 1. Power ON indication light.
 - 2. OVER-TEMPERATURE light.
- C. A standard remote load dump circuit shall be provided as part of the load bank control circuit. Provisions shall be provided to remove the load bank off-line from the operation of a remote normally closed set of auxiliary contacts from a transfer switch or other device. In the event of the remote contact opening, all load is removed.

2.6 DOCUMENTATION

- A. Installation and operation manuals shall be provided with the equipment and shall include complete details for the installation, commissioning, operation, and maintenance of the load bank.
- B. The manuals shall include the electrical schematic and interconnect drawings for the power and control wiring for the load bank and all control devices.
- C. A complete parts list with part numbers, device identification; rating shall be included in the manuals. The original manufacturers name and part number shall be included in the parts listing.
- D. Two (2) sets of manuals shall be provided with the load bank.

PART 3 - QUALITY ASSURANCE

3.1 QUALITY CONTROL

- A. The load bank shall be fully tested using a test specification written by the supplier. Tests shall include electrical functional testing, verifying conformance to assembly drawings and specifications. Each load step shall be cold resistance checked to verify proper calibration of resistive load steps and proper ohmic value.
- B. The manufacturer shall maintain this data on file for inspection purposes by the purchaser. Tests using high potential equipment shall be performed to ensure isolation of the load circuits from the control circuits and to determine isolation of the load circuits from the load bank frame. Tests of all safety circuits shall be performed to verify conformance to the specification
- C. All electrical circuits shall have a high potential insulation resistance test performed at twice rated voltage plus 1000 VAC to assure insulation integrity.
- D. All quality control test equipment shall be regularly maintained and calibrated to traceable national standards.
- E. The Company's Quality System shall be ISO9001 Certified.

3.2 QUALIFICATIONS OF MANUFACTURER

- A. The load bank shall be manufactured by a firm regularly engaged in the manufacture of load banks and who can demonstrate at least twenty five (25) years' experience with at least twenty five (25) installations of load banks similar or equal to the ones specified herein.
- B. The manufacturer shall have a written Quality Control procedure available for review by the purchaser, which will document all phases of operations, engineering, and manufacturing.
- C. Manufacturer must have a field service organization with service personnel having a minimum of an Associate Degree in Electrical Engineering.
- D. The load bank shall be as manufactured by:

Avtron Loadbank Inc, 6255 Halle Drive, Cleveland, Ohio 44125.
Phone 216-573-7600, Fax 216-573-5953.
Email: LBsales@avtron.com
Website: www.load-bank.com

END OF SECTION

SECTION 263213

480-277V VOLT LIFE-SAFETY DIESEL ENGINE GENERATOR

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide standby engine generator and accessories in accordance with the Contract Documents.
- B. Generator shall be provided with radiator mounted resistive load bank, as specified by Section 263212.

1.2 RELATED SECTIONS

- A. Section 260573 – Power System Studies
- B. Section 263212 – Radiator Mounted Resistive Load Bank
- C. Section 263600 – 277/480V Automatic Transfer Switches

1.3 WORK INCLUDED

- A. Engine/Generator.
- B. Exhaust Silencer.
- C. Batteries.
- D. Battery Charger.
- E. Vibration Isolation and Seismic Restraints (refer to Section 26 05 48).
- F. Base Mounted Double Lined Fuel Day Tank.
- G. Remote Annunciators.
- H. Warranty.
- I. Testing (Field and Factory).

1.4 SUBMITTALS

- A. Shop Drawings
 - 1. A complete $\frac{1}{2}$ " = 1'-0" scaled elevation and plan drawings showing the exact generator system layout including all components and accessories being provided or required for operation as specified herein.
 - 2. All seismically restraint concrete housekeeping pads must be sized and illustrated. This must be signed and sealed by a professional engineer.
 - 3. Indicate any shipping splits and weights.
- B. Product Data

1. Engine manufacturer's catalog cut sheets, performance data, detailed drawings, power output curves, and fuel consumption curves which relate to the design criteria specified.
2. Generator manufacturer's catalog cut sheets, detailed drawings and performance data.
3. Complete list of materials and catalog cuts of all components being provided.
4. Complete detailed wiring diagram of the system.
5. Starting battery sizing calculations showing compliance with specifications at ambient conditions.
6. After the engine generator system is accepted, submit a completed permit application for the local Air Quality Management District, ready for submission by the Owner.
7. Name and location of certified testing agency.
8. Weights of all equipment.
9. Engine mechanical data at varying loads up to full load, including heat rejection, exhaust gas flows, combustion air and ventilation air flows, noise data, fuel consumption, etc.
10. General electrical data including temperature and insulation data, cooling requirements, excitation ratings, voltage regulation, efficiencies, waveform distortion, and telephone influence factor.
11. Generator resistances, reactances, and time constraints.
12. Generator current decrement curve.
13. Generator motor starting capability.
14. Generator thermal damage curve.
15. Jacket water heater connection diagram.
16. Control panel schematics.
17. Manufacturer's dealer warranty.
18. Emissions data, complying with all applicable regulations.
19. All warranty data.
20. Sound data for mechanical and engine exhaust in octave band frequencies between 31.5 Hz to 8,000 Hz and sound data for manufacturer engine exhaust silencer options, complying with all applicable regulations.
21. Vibration Isolation Base Detail must be signed and sealed by a professional engineer. This includes detail fabrication, anchorage and attachments to the structure and to supported equipment.

C. Test Reports

1. Certified factory test report.
2. Certified field test reports.

D. Permits

1. Provide all necessary documents required to obtain State and Local approvals for installing a generator and a petroleum bulk storage tank which includes, but is not limited to:
 - a. As-built drawings, signed and sealed by a Professional Engineer, passing tightness testing for the new fuel oil storage tank with a list of materials used in the installation.
 - b. Site plan on 8-1/2x11 paper which includes property lines, buildings, adjacent streets with names, tanks identified by ID number, storm drains, and non-stationary tank storage areas.

1.5 QUALITY ASSURANCE

- A. Except as modified by governing codes and the Contract Documents, comply with the latest applicable provisions and the latest recommendations of the following:

1. Alternator:

- a. NEMA MG-1-22
 - b. ASTM D396
 - 2. Battery Charger:
 - a. U.L. 1236
 - 3. Engine Generator:
 - a. Local Air Quality Management District.
 - b. U.L. 2200
 - 4. Control and Status Panels:
 - a. NFPA 110
 - 5. Testing:
 - a. NETA
- B. Equipment suppliers shall have local representation and shall have been actively engaged in the assembly, installation and service of this equipment for emergency power purposes for a period of not less than 10 years in the Job Site area. The engine-generator supplier shall have service facilities within 50 miles of the project site.
- C. Equipment suppliers shall have full parts backup and a 24 hour per day service availability for this equipment.
- D. The emergency generator shall be adaptable to the emerging technologies that may be required with new regulations. At a minimum, the generator shall comply with EPA off-road diesel engine Tier standards.

1.6 LOCATION CRITERIA

- A. Altitude: Below 1000 feet above sea level.
- B. Seismic: IBC Ss (Short Period Spectral Response Acceleration).
- C. Wind Loading: IBC Force: 150 mph.

PART 2 - PRODUCTS

2.1 CRITERIA

- A. The engine generator system and accessories described herein shall be fully capable of operation as specified in the following environmental conditions:
 - 1. Maximum outdoor ambient temperature: 110°F
 - 2. Minimum outdoor ambient temperature: -15°F
 - 3. Altitude: 1000 feet above sea level
- B. The diesel engine-generator sets shall be capable of single step load pick up of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.

2.2 ENGINE

- A. The engine shall be diesel fueled with number 2 diesel oil, 1800 rpm, compression ignition type, four stroke-cycle, water cooled, solid injection, V configuration.
- B. One (1) of the generators shall be installed indoors as shown on the drawings and it shall be
 - 1. 2000 kW/2500 KVA, 480/277V, 60 cycles.
- C. The engine shall be EPA Tier Certified and in compliance with the State Emission regulations at the time of installation/commissioning. Actual engine emissions values must be in compliance with EPA Tier emissions standards per ISO 8178 – D2 Emissions Cycle at specified kW/bHP rating. Utilization of the “Transition Program for Equipment Manufacturers” also known as “Flex Credits” to achieve Tier certification is not acceptable. Unit shall be Tier rated as required for an Emergency standby system given the generator set HP rating as defined by EPA and/or local regulations.
- D. Fuel consumption of the engine generator shall be substantiated by means of manufacturer's published curves.
- E. The engine shall be equipped with an electronic governor to maintain engine speed within limits specified herein. Governor shall be adjustable from isochronous to five (5) percent droop. Provision shall be made to run the engine at idle speed for test and startup purposes.
- F. Engine safety devices, including high water temperature switch, overspeed sensing switch, low oil pressure switch, and low water temperature switch, shall be mounted on the engine and connected to the engine/generator control panel instruments and alarms as specified herein.
- G. Engine wiring shall be high quality, heat resistant, insulated, stranded copper conductor. Wiring shall be protected with suitable woven loom protection and shall be isolated from high temperature engine parts. Wiring for alternating current power circuits shall be protected by rigid or flexible metallic conduit.
- H. Engine shall be equipped with integral radiator mounted fuel oil coolers. It shall be mounted on the radiator in the cooling air stream before it enters the radiator core. It shall be capable of reducing the return fuel temperature to a level acceptable to the manufacturer's requirement, given the project ambient requirements.
- I. The complete engine block shall be machined from one casting. Designs incorporating multiple blocks bolted together are not acceptable.
- J. The engine shall utilize a gear type positive displacement, full pressure lubricating oil pump and water-cooled lube oil cooler. Pistons shall be spray cooled. Provide oil filters, oil pressure gauge, dipstick, and oil drain.
- K. Fuel filters and serviceable fuel system components shall be located to prevent fuel from spilling onto generator set batteries.
- L. The engine governor shall be Electronic Load Sharing and Speed Control type. Speed droop shall be externally adjustable from 0 (isochronous) to 10% from no load to full rated load. Steady state frequency regulation shall be +/-0.25 percent. It shall be capable of sharing load with 5% when paralleled with similarly equipped engines. Speed shall be sensed by a magnetic pickup off the engine flywheel ring gear. A provision for remote speed adjustment shall be included. The governor shall incorporate provisions for limiting fuel during start-up, and include

capability for actuator compensation adjustment. Protection from voltage spikes and reverse polarity shall be included. In the event of a DC power loss, the forward acting actuator will move to the minimum fuel position.

2.3 ELECTRIC STARTING SYSTEM

- A. Dual starting motor with solenoid and either Bendix or overrunning clutch drive shall be furnished on the engine. The starting motor shall be of the required voltage and ampere rating.
- B. Provide a system of sealed lead acid batteries sized such that the set may complete four (4) sixty-second complete cranking cycles at firing speed and specified room temperature. Provide a matching metal frame rack and cables of sufficient ampacities. Floor mounted batteries will not be acceptable.
- C. Provide a wall mounted 120 volt AC battery charger to recharge the batteries to full capacity within 8 hours. Battery charger shall have both a high rate and low rate charging system. The battery charger shall be current limiting and shall not require cranking cutout contacts for charger protection when cranking. Accessories shall include: D.C. ammeter, fused input, D.C. voltmeter, high/low DC output voltage relay and input voltage failure relay. Battery charger output shall be rated ten (10) amperes at required voltage.
- D. The entire electric starting system shall be rated for 24 VDC operation.

2.4 ENGINE HEATING SYSTEM

- A. Jacket water heaters, rated for operation on 208 VAC, single phase power shall be provided and shall be sized to insure that the generator set will start within the specified time period and ambient conditions. Heaters shall include thermostats, oil pressure disconnecting device and required connection boxes.
- B. Provide isolation valves that allow for change out of the heater without draining the entire cooling system.
- C. The capacity of the jacket heaters shall be sized by the engine manufacturer to maintain criteria listed above

2.5 ENGINE COOLING SYSTEM

- A. The engine shall be liquid cooled by means of an engine mounted vertical core radiator. The radiator shall be adequately sized to cool the engine on a continuous basis at the maximum ambient temperature (110°F) and altitude specified. Ambient temperature stated shall be for actual ambient capability, and the manufacturer shall allow for a minimum of seven (7) degree rise across the engine as measured at the fan. Suitable expansion space, either by means of surge tanks or radiator top tank shall be provided. The cooling system shall allow proper deaeration for the engine. An engine driven propeller type fan shall be provided with 1 inch water (H₂O) column static pressure external to the radiator and radiator assembly to allow for proper air-flow. Engine coolant shall be a mixture of fifty (50) percent ethylene glycol based antifreeze and fifty (50) percent water. A duct adaptor flange shall be included for flex connection provided by another trade.
- B. The engine shall be liquid cooled by means of a remote fan radiator. The radiator shall be adequately sized to cool the engine on a continuous basis at the maximum ambient temperature and altitude specified. Radiator shall be suitable for outdoor application and include fan, fan guard, core guard, steel supporting legs, cooling coils, steel frame, filler neck and pressure cap. Fan motor shall be single speed, totally enclosed fan cooled (TEFC) for 3 phase, 60 Hertz, 480

volt (208 volt) operation. Radiators without integral surge space must be supplied with a 20 gallon minimum expansion tank, complete with mounting angles, sight glass, fittings and filler neck with pressure cap. Engine coolant shall be a mixture of sixty (60) percent ethylene glycol based antifreeze and forty (40) percent water. Coolant solution shall be provided by the installing contractor.

- C. The engine cooling system shall include one or more spin-on type engine water filters which will treat the coolant and prevent corrosion and scale deposits inside the cooling system.

2.6 AIR INTAKE AND EXHAUST SYSTEM

- A. An air cleaner/silencer shall be furnished as recommended by the engine manufacturer. Air cleaners shall be dry heavy duty type with built-in restriction gauge to monitor.
- B. Engine exhaust outlets shall be coupled to the exhaust silencer(s) by means of an adequately sized section of stainless steel corrugated flexible tubing. Flexible tubing connector(s) shall be flanged at both ends for mating to the engine and exhaust system.
- C. A critical grade exhaust silencer(s) shall be provided. Sound levels shall be rated no more than 80 dBA average sound level when measured five (5) feet from the exhaust outlet and 60 dBA at 5 feet. Exhaust silencer(s) shall be sized to limit exhaust back pressure to acceptable values. The exhaust silencer(s) shall be suitable for horizontal mounting and shall be equipped with flanged bottom inlet and flanged end outlet. The exhaust silencer(s) shall be double wall construction and shall have a high temperature anti-corrosion coating applied uniformly on the outside surface.
- D. Silencer configuration shall be pancake type, unless otherwise noted.
- E. The generator shall meet most stringent of the applicable EPA Tier off-road diesel engine standards without the use of pipe exhaust treatments.

2.7 FUEL SYSTEM

- A. Provide a 300-gallon, "ready supply", package base mounted double-lined (200% rupture basin) fuel day tank to provide an immediate fuel supply to the engine fuel pump upon engine start-up. Tank shall comply with NYS Uniform Code requirements. Fuel shall be supplied to the tank by means of 120 volt electric fuel transfer pump mounted on the day tank. Also provide a hand pump for priming. Equip tank with an automatic float to control the day tank level with a low level contact (set at 25% capacity) for remote alarm indication and a high level contact set at 95% of the tank capacity for remote alarm indications. Provide independent fuel pumps control floats/contacts set at pump on 35% capacity and pump off at 90% capacity. Supply and return connects shall be brought to the outside of each generator enclosure for contractor connection. A drain cock and valve shall be provided in the tank and rupture basin. Rupture basin shall contain a leak detection system for remote indication to the alarm panel. Engine fuel oil pump shall have suction 8" mercury.
- B. The fuel tank shall be rated to comply with UL 142. (Pressure test of 3 psi shall be performed and a leak test shall then be performed.)
- C. Fuel lines between injection pumps and valves shall be of heavy seamless tubing and to eliminate irregularity of fuel injections shall be of the same length for all cylinders.
- D. Provide fusible link type safety shutoff valves to fail close.

- E. The fuel system shall be equipped with a fuel filter having replaceable elements which may be easily removed from their housing for replacing without breaking any fuel line connections or disturbing the fuel pumps or any other parts of the engine. All fuel filters shall be conveniently located in one accessible housing, ahead of the injection pumps, so that the fuel will have been thoroughly filtered before it reaches the pumps. No screens or filters requiring cleaning or replacement shall be used in the injection pump or injection assemblies. Filters shall be duplex type and have a valve arrangement so filters can be changed during operation.
- F. Provide crankcase fumes reclamation system. System shall collect engine crankcase emissions, filter out airborne lube oil, and reintroduce the emissions back into the engine combustion air system.
- G. Provide an integral fuel oil cooler designed to return fuel below the maximum allowable fuel oil supply temperature.

2.8 ALTERNATOR

- A. Generator shall be rated 480Y/277, three phase, four wire, 60 hertz, 0.8 power factor of a kilowatt capacity as indicated on the Contract Documents.
- B. The alternator shall be a four (4) pole, synchronous brushless type. The alternator shall be dual bearing type coupled directly to the engine flywheel by means of a flexible disc coupling.
- C. The alternator voltage regulator shall be solid state type, three phase true RMS sensing and shall incorporate an under-frequency protective circuit to limit generator excitation at lower than normal operating speeds. The voltage regulator shall be equipped with a voltage adjusting rheostat capable of plus or minus five (5) percent rated voltage adjustment. The voltage regulator shall maintain the voltage within the limits specified.
- D. The alternator insulation system shall be NEMA Class H and shall be a combination of epoxy coating and varnish. The alternator shall be sized and properly derated according to NEMA MG1-22 to yield a maximum temperature rise of 130°C by resistance above an ambient temperature of 40°C at rated altitude.
- E. Excitation shall be provided by a direct connected brushless permanent magnetic rotating exciter. The armature shall be of the three phase design and connected to a full wave three phase rotating bridge. Diodes used shall be of the silicon type mounted on proper heat sinks with surge protector to prevent voltage spikes during parallel operation.
- F. Exciter field power shall be provided by a separate permanent magnet generator directly connected to the brushless exciter. The PMG shall provide sufficient power to the excitations system to produce 300% short circuit from the main generator armature during a three phase fault with sufficient duration for protective devices to operate.
- G. The sub transient reactions shall be 15% or less.

2.9 MAIN LINE CIRCUIT BREAKER/OUTPUT SWITCHBOARD

- A. Main line circuit breaker which shall operate both manually as an isolation switch and automatically during overload and short circuit conditions. The trip unit for each pole shall have elements providing inverse time delay features during overload conditions and instantaneous magnetic tripping for short circuit protection. Circuit breaker shall be suitable for 100% load. The circuit breaker shall be provided with an auxiliary contact to provide a trouble indication should

the breaker be in the "OFF" or tripped position. (Main circuit breaker 3000 ampere plus 1600/1500 ampere breaker for serving the radiator mounted load bank (see Section 263212)).

- B. The circuit breakers shall be mounted in a NEMA 1 generator mounted cabinet. The cabinet shall be formed frame design to support the weight of the installed devices. Cabinet shall be welded construction, no bolt together structures will be allowed. Box material shall be minimum 12 gauge construction. Cabinet will be provided with a bolt-on front access door. Cabinet shall be finish painted to match the generator. Circuit breaker shall be equipped with load side, full rated bus to accommodate 2-hole, long barrel copper compression lugs. Bus hole centers shall be NEMA standard 1.75" hole centers. A neutral disconnect link shall be provided for the neutral connection. Bus shall accept fully rated feeders for neutral and ground connections. Neutral and ground connections shall be isolated from the box frame. Circuit breaker shall be equipped with a minimum 1a/1b auxiliary contacts and 24 VDC-shunt trip. An external zero sequence ground fault protection system will be installed for the circuit breaker for trip activation upon ground fault sensing. A light shall be provided for local annunciation. The mainline circuit breaker shall be cabled from the line side to the generator. The circuit breaker shall be provided with an identification labeling. Position of this mainline cabinet must be at the rear side of generator with the face of the breaker facing the enclosure access door.
- C. The generator output switchboard to contain main line circuit breaker and additional circuit breakers for the fire pump, as per Electrical Riser Diagram. In addition, provide bus tapping lugs for fire alarm and fuel oil pump power, as per the risers.

2.10 CONTROL PANEL

- A. A generator mounted control panel shall be provided with lockable hinged front door for complete control and monitoring of the respective generator set functions. Panel shall be environmentally sealed in a NEMA 1 enclosure.
- B. The following shall be included in the control panel:
 - 1. Automatic start/stop operation.
 - 2. Adjustable cycle cranking.
 - 3. Digital engine monitoring.
 - 4. Shutdown sensors and alarms with horns and reset.
 - 5. Adjustable cool down timer.
 - 6. Emergency stop button.
 - 7. Self-diagnostic capabilities and fault logging.
 - 8. AC digital ammeter, .5% true RMS accuracy, with phase selector.
 - 9. AC digital voltmeter.
 - 10. Frequency digital meter.
 - 11. Elapse time digital meter.
 - 12. Engine water temperature digital readout.
 - 13. Engine oil temperature digital readout.
 - 14. Engine oil pressure digital readout.
 - 15. Voltage adjusting rheostat.
 - 16. All items specified under remote status panels.
 - 17. Provide a fixed nameplate consisting of red bakelite with white, 1-inch lettering, identifying the generator controlled.
 - 18. Engine speed digital readout.
 - 19. Modbus interface to BMCS.

2.11 AUTOMATIC ELECTRIC-SET PROTECTION

- A. Protection System: Provide power for sensors, trips, indicator lights, and alarm by engine cranking batteries. Provide fault sensors to cause emergency engine shutdown when any of the following faults occur:
1. High water temperature sensors set to trip at 205°F $\pm 3^\circ\text{F}$, 96°C $\pm 2^\circ\text{C}$.
 2. Approach to high water temperature sensors set to pre-alarm at 190°F.
 3. Low water temperature sensors set to trip at 80°F.
 4. Overspeed sensors set to trip at 2050 revolutions per minute.
 5. Low lube oil pressure sensors set to trip at the engine manufacturer's recommendation for lowest permissible oil pressure.
 6. Overcrank sensors set to trip after four (4) 15-second attempts to start.
 7. Low water level shut down.

2.12 REMOTE STATUS PANELS

- A. Provide three (3) panels per generator set. One (1) in the engineering office, another in the Fire Command Center, and the remaining shall be furnished as part of the generator control panel. Provide alarm indicators per NFPA No. 110 and as specified herein. When actuated, these alarms shall sound audible alarms and indicate, by means of individual lights at the annunciator panels, which particular malfunction is initiating the alarm. Provide 3/16 inch high (minimum) labeling to identify the alarm.
- B. Provide a horn at each panel with silencing (override) switch to silence alarm. Override switch shall have flashing pilot lamp labeled "Override" to indicate that alarm is silenced. Provide power for alarm system from generator battery system. Alarm annunciators shall indicate the following malfunctions:

	Item	Lens Cap Color
1.	High water temperature**	Red
2.	Low water temperature*	Red
3.	Approach to high water temperature*	Yellow
4.	Approach to low oil pressure*	Yellow
5.	Overspeed*	Red
6.	Cranking failure (after 60 seconds)*	Red
7.	Generator in operation*	Green
8.	High and low battery charge**	Red
9.	Battery charger input failure**	Red
10.	Automatic transfer switch position lights for each automatic transfer switch. Two (2) lamps for each switch.*	Red & Green
11.	Pilot light denoting engine selector switch in "OFF" position*	Red

	Item	Lens Cap Color
12.	Start/stop switch (Fire Command Center Only)	--
13.	Test switch (Fire Command Center only)	--
14.	Main circuit breaker tripped open*	Red
15.	Running pilot lights for each fuel oil pump (Fire Command Center only)	Red
16.	Hand/off/automatic switch for each fuel oil pump*	--
17.	Low and high fuel oil (day tank)*	Red
18.	Low fuel oil (main tank)*	Red
19.	Load bank cooling failure*	Red
20.	Remote shutdown activation (via break glass station at the generator)	Red
21.	Spare	--

* Provide one (1) set of normally closed = normal dry contacts for BMCS interface.

**Provide one (1) set of normally closed = normally dry contacts summary alarm for BMCS interface. If Modbus is available, all alarms shall be monitored through such system.

1. Connection to Data Link: A separate terminal block, factory wired to Form C contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals for "Electrical Power Monitoring and Control."
 2. Provide serial port (RS 232, RS 422, or RS 485) to communicate with the power monitoring system.
- C. Fire Alarm Monitoring – Remote monitoring by Fire Alarm System
1. Running indication.
 2. Fail to start indication.
- D. Provide conduit and wire from new transformer building generator to existing fire command center and engineers office in Southwest part of existing Javits Convention Center building as required for operation of remote status panels.

2.13 GENERATOR SET PERFORMANCE

- A. The completed generator set shall meet or exceed the following performance criteria:
1. Voltage regulation shall be ± 1 percent rated voltage.
 2. Steady state voltage stability ± 0.5 percent rated voltage.
 3. Balanced telephone interference factor (TIF) shall not exceed 50.
 4. Frequency regulation from no load to full load shall be adjustable from isochronous to 5 percent.
 5. Steady state frequency stability shall be ± 0.5 percent.

6. Maximum recovery time to return to frequency stability, bandwidth shall not exceed 6-8 seconds.
7. Generator set shall be capable of start-up and accepting rated load within 10 seconds.

2.14 VIBRATION ISOLATION AND SEISMIC RESTRAINTS

- A. Installation shall be in accordance with the reviewed vibration isolation and seismic restraint submittal.
- B. Fuel oil and coolant line shall be flexible braided bronze hoses.
- C. Raceway connections to the generator shall be in liquid tight flexible metal conduits.

2.15 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: Insulated-case or power breaker, electronic-trip type; 100 percent rated; complying with UL 489.
 1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
 2. Trip Settings: Selected to coordinate with generator thermal damage curve.
 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
 4. Mounting: Adjacent to or integrated with control and monitoring panel.
- B. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:
 1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
 2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
 3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
 4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.
- C. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

- 2.16 Provide remote emergency shut-off buttons (breakglass stations) to each generator. Locate in the field and provide all required wiring and conduit.

2.17 ACCEPTABLE MANUFACTURERS

- A. The documents are based upon engine generator physical sizing criteria of one (1) particular manufacturer. The Contractor shall be responsible for modifications necessary in the use of a proposed manufacturer. These modifications are to include all mechanical and electrical work, architectural work and structural work.
- B. The following manufacturers are acceptable:

1. Prime Mover and Generator:
 - a. Caterpillar
 - b. Cummins/Onan
 - c. MTU
 - d. Kohler
2. Radiator:
 - a. IEA
 - b. Young
 - c. Modine
3. Exhaust Silencer:
 - a. Harco
 - b. GT Exhaust
 - c. Terrance & Pembro
4. Day Tank:
 - a. Simplex
 - b. Pryco
 - c. Tramont
5. Vibration Isolators:
 - a. Mason Industries, Inc.
 - b. Kinetic Noise Control
 - c. Amber Booth Company
 - d. Ace Mountings
6. Governor:
 - a. Woodward
 - b. Basler
 - c. Approved Equal.
7. Batteries:
 - a. Nife
 - b. Exide
 - c. C&D
 - d. Interstate
8. Battery Charger:
 - a. Lamarche
 - b. Sens
 - c. Charles
9. Voltage Regulations:
 - a. Basler
 - b. Approved Equal.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install the emergency generator system as shown on the Contract Documents, as indicated in the manufacturer's instructions and as required for a neat workmanlike and fully operational system. Insure that the manufacturer's recommended clearances are maintained.
- B. Provide an empty raceway system capable of supporting the elevator supply wiring. The raceway system shall meet the requirements of the elevator supplier. As a minimum, provide one (1) two-inch empty conduit with pull cord from each elevator shaft to the Fire Command Center.
- C. Provide a minimum of two (2) remote emergency shut off buttons for the generator. Locate in the field and provide all control wiring and conduit.
- D. Provide equipment grounding connections for the generator. Tighten connections to comply with tightening torque levels specified in UL Std 486A.

3.2 VIBRATION ISOLATION

- A. Isolate the generator set at the base by means of combination spring type isolators and neoprene pads. Provide isolators of not less than 98% efficiency of a sufficient quantity such that each is loaded to not more than 75% of its rated value. Provide a minimum static deflection of 3".
- B. All fuel oil and coolant lines shall be isolated by means of flexible light tight braided hoses.
- C. All raceway connections to the generator set shall be in flexible metal conduit.
- D. Entire run of engine exhaust piping shall be supported on spring hangers or mounts such as Mason 30N or Mason Type SLF respectively or approved equal. Isolators shall be sized for 1" minimum static deflection. These isolators should be installed between generator and isolated floor or dunnage. For more information follow this link www.mason_ind.com
- E. Mount the entire generator on restrained spring vibration isolators, such as Mason SLR, with 1" of static deflection.

3.3 SEQUENCE OF OPERATION

- A. Engine start contacts shall signal generator to start when the voltage of the normal source drops below 80% on any phase, after a time delay of 1 second to allow for momentary dips. The voltage sensing relay shall be field adjustable while energized.
- B. The automatic transfer switch shall transfer to emergency when 90% of rated voltage and frequency of the emergency source have been reached.
- C. After restoration of normal power of all phases to 90% of rated voltage, an adjustable time delay period shall delay retransfer to allow stabilization of normal power. If the emergency power source should fail during this time delay period, the automatic transfer switch shall bypass the timing relay and transfer to the normal source.

- D. After retransfer to normal, the engine generator shall be allowed to operate at no load for five minutes.
- E. A test on the automatic transfer switch shall simulate normal power failure.
- F. When the generator begins to start (and is cranking) the following shall occur:
 - 1. Fuel oil solenoids shall open.
 - 2. Air intake motorized dampers shall open.
 - 3. Air exhaust motorized dampers shall open.
 - 4. The fuel oil transfer pumps shall be on.
- G. When the generator is OFF, the following shall occur:
 - 1. Fuel oil solenoid valves shall close.
 - 2. Air intake motorized dampers shall close.
 - 3. Air exhaust motorized dampers shall close.
 - 4. The fuel oil transfer pumps shall be off.

3.4 FUEL OIL

- A. Upon acceptance of field testing and prior to final payment, the main fuel oil tank and the day tank shall be topped off by the installing contractor.

3.5 TESTING

- A. Factory Testing
 - 1. Prior to shipment of the engine-generator set from the factory, a certified load test shall be performed and the results shall be submitted to the Architect/Engineer for review before shipment of the unit. The tests shall verify the proper operation of all alarms and shut down circuits.
 - 2. The tests shall also demonstrate compliance with the generator performance criteria as specified herein.
 - 3. Testing shall be performed as follows:
 - a. Verify operation of all shut down and alarm points specified.
 - b. Perform transient response testing to verify performance as specified. Load steps shall be performed as follows:
 - 1) 0% - 25% - 0%
 - 2) 0% - 50% - 0%
 - 3) 0% - 75% - 0%
 - 4) 0% - 100% - 0%
 - 5) 0% - 25% - 75% - 25% - 0%
 - 6) 0% - 50% - 100% - 50% - 0%
 - c. All load steps shall be recorded on a chart recorder or light beam oscilloscope.
 - d. In a period of four (4) hours with a loading 25, 50, 75 and 100 percent of rated load. Step loading procedure shall be utilized (i.e., 25 percent first hour, 50 percent second hour, etc.).
 - e. Maintain 100% load for 1 hour.
 - f. Factory testing shall be accomplished using resistive and reactive load banks to match kW and kVA requirements set forth in the Contract Documents.
 - g. The factory testing shall include the "Generator Set Performance" criteria, listed in Section 2 above.

B. Field Testing

1. After completion of the installation, the Contractor shall perform a certified load test, in accordance with NFPA 110, of the engine generator and related automatic transfer switches. The generator shall be required to start-up and accept full load within 10 seconds. The unit shall continue to operate for not less than four (4) hours at 100 percent rated load. The test shall also include demonstrating that all alarms, signals, shut down devices, elevator recall, etc., are functioning properly. The Contractor shall be responsible for securing all temporary load-banks, temporary cables, etc., required for the tests.
2. The full load test shall utilize all required temporary load banks sufficient to provide a load equal to 100 percent of the generator nameplate rating. Electrical Contractor shall secure all such load banks, cabling, hoisting, and terminations needed to perform the full load test.
3. This Contractor shall supply all fuel for the testing. Upon acceptance by the Architect/Engineer, the day tank and main fuel oil tank shall be filled to capacity after each testing.

C. Certified Test Reports

1. Field testing shall be performed by the manufacturer's certified factory field service technicians.
2. Test procedures shall be in accordance with NFPA 110.
3. Verify that the installation is in accordance with the manufacturer's instructions.
4. Verify that the equipment has been fully tested and is operational.
5. Perform reactive testing and compile detailed test reports for each piece of equipment and system tested.
6. Perform pull-the-plug test to demonstrate proper operation of the entire emergency electrical system.

D. Miscellaneous – Provide the following:

1. Location of a factory authorized service center. Number of full time factory trained personnel at each service center and the experience of personnel.
2. The response time for service calls. There should be a maximum response time of two hours on-site.
3. Recommended preventive maintenance procedures and recommended intervals with one included within the first year. Also contract prices for the 2nd and 3rd years.
4. Recommended spare parts to minimize downtime for repairs with pricing.

3.6 CLASSROOM INSTRUCTION

- A. The generator set supplier shall provide a minimum of four (4) hours of classroom instruction on maintenance and operation of the emergency power system. Classes shall be held at the supplier's facility, shall be administered by a full time instructor and shall be open to up to three (3) representatives of the Owner's maintenance staff.
- B. Training shall be videotaped and turned over to the Owner.

3.7 HOUSEKEEPING PAD

- A. Provide a six-inch high concrete housekeeping pad beneath the generator.
- B. Provide a concrete curb around the fuel oil day tank to contain the full capacity of fuel plus 50% in the event of a day tank leak.

- C. Provide a concrete curb under each door of the generator room to prevent migration of spilled liquids out of the room.
- D. Provide a leak detection system for fuel containment and connect to the Building Management System for monitoring. Provide a 120 volt power supply from nearest emergency panel location.

3.8 WARRANTY

- A. The manufacturer's standard warranty shall in no event be for a period of less than five (5) years from date of initial start-up of the system and shall include repair parts, labor, reasonable travel expense necessary for repairs at the job site, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Include a temporary generator set at no cost to the Owner should a warrantable repair take an extended period of time. Submittals received without written warranties as specified will be rejected in their entirety.

3.9 FIELD REPRESENTATION

- A. Provide services of manufacturer's field representative (factory trained) for a period of 5 working days to supervise start-up, testing and two (2) training sessions for operating personnel.
- B. The generator set dealer shall be responsible for coordination between all related generator control wiring, regulator and governor equipment, testing and start-up and all associated systems that affect the coordination of the switchgear with the generator sets. All submittal packages relating to the two systems shall be supplied as a one source package for review by the engineer. The one source of responsibility criteria would rest upon the generator supplier to ensure a smooth transition in every step of the installation process, as well as being available for coordination meetings with his associated sub-vendor.
- C. Owner reserves the right along with his authorized representatives to visit the factory during the course of fabrication of equipment to observe progress, quality control, schedule of completion, etc. All costs shall be paid by this Contractor.

3.10 SPARE PARTS

- A. Deliver one (1) set of filter elements (air, fuel and oil) and one (1) belt for every belt drive to the Owner at final acceptance.
- B. Deliver one (1) complete set of fuses and one (1) injector.
- C. Deliver two (2) for every six (6) of each indicator lamp type used, but no fewer than two (2).
- D. Deliver two (2) quarts of touch paint – each color on generator and accessories.

3.11 TECHNICAL LITERATURE

- A. Provide the Owner with three (3) copies of technical literature on all system components consisting of a manual of sequential operations, recommended preventive maintenance, parts list with recommended spares, and all pertinent control manuals and wiring diagrams.

3.12 LOAD BANK FIELD TESTING

- A. Prior to energizing the load bank, the insulation resistance on the bus shall be measured from phase-to-phase and phase-to-ground.

- B. After installation is completed, all switches shall be functionally tested.
- C. All protective functions shall be tested and all remote functions simulated to determine if the units have been wired properly.
- D. All testing of the completed installations shall be performed in the presence of and as directed by the Engineer. The Contractor shall notify the Engineer when the equipment is installed and ready for testing.
- E. Testing shall be performed in the following manner.
 - 1. All control and power cable connections shall pass inspection for workmanship, tightness, and continuity.
 - 2. All load banks shall be tested for equipment grounds. Maximum acceptable resistance shall be 1 ohm.
 - 3. The unit shall be given a phase-to-phase and phase-to-ground megger test and all feeder load terminals grounded.
 - 4. Megger tests shall be applied between each phase and ground with phases not under test also grounded.
 - 5. All alarm devices shall be adjusted and set.
 - 6. All control circuits shall be given operational tests from the supply source for which they were designated. This shall include normal operation three (3) times from each control point, and activation of alarm devices.
 - 7. All test results shall be in accordance with the manufacturer's recommendations.
- F. **Provide load bank for onsite test.**

3.13 TEST ONSITE WITH ACTUAL BUILDING LOADS

- A. **Similar test shall be executed by utilizing building loads.**

3.14 PULL THE PLUG TEST

- A. **Test the life-safety generator by deenergizing Con Edison power and standby power.**

3.15 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by trained employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
- B. The generator set manufacturer and its distributor shall maintain a 24-hour parts and service organization. This organization shall regularly engage in maintenance contract programs to perform preventive maintenance and service on equipment similar to that specified. A service agreement shall be available and shall include system operation under simulated operating conditions; adjustment to the generator set, transfer switch, and switchgear controls as required, and certification in the Owner's maintenance log of repairs made and function tests performed on all systems.

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SECTION 263214

13.2 KV STANDBY DIESEL ENGINE GENERATORS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide three (3) 3500 KW, 4375 KVA, 13.2 kV, 0.8 pf Wye connected, 60 cycles engine generators and accessories in accordance with the Contract Documents.
- B. The installation of the power generation system shall include the following:
 - 1. Engine-driven generator set.
 - 2. Control system.
 - 3. Cooling system.
 - 4. Fuel supply and storage system.
 - 5. Generator set accessories.
 - 6. Mounting system.
 - 7. System control
- C. The work includes supplying and installing a complete integrated generator system. The system consists of three (3) diesel generator sets with related component accessories, paralleling switchgear, and automatic transfer switches.

1.2 RELATED SECTIONS

- A. Section 26 05 73: Power System Studies.
- B. Section 26 23 13: 13.2 kV Automatic Paralleling/Synchronizing Switchgear.
- C. Section 26 36 25: 13.2 kV Automatic Transfer Switches.
- D. Section 26 36 28: 13.2 kV Outdoor Resistive Load Bank.

1.3 WORK INCLUDED

- A. Engine/Generator and related items such as voltage regulator, governor, etc., shall be provided and mounted at the engines.
- B. Exhaust Silencer plus insulation blankets (muffler plus blankets).
- C. Batteries.
- D. Battery Charger.

1.4 WORK UNDER HVAC SECTION

- A. Installation of exhaust silencer plus insulation blankets (muffler plus blankets).
- B. 300 gallon common day tank.
- C. Fuel oil piping & transfer pump system.

- D. Exhaust System piping.
- E. Insulation of exhaust piping.
- F. Ducting between radiator & exhaust, outlet.

1.5 REFERENCES AND STANDARDS

- A. The generator set covered by these specifications shall be designed, tested, rated, assembled and installed in strict accordance with all applicable standards below:
 - 1. CSA C22.2 No14
 - 2. CSA 282
 - 3. CSA 100
 - 4. EN61000-6
 - 5. EN55011
 - 6. FCC Part 15 Subpart B
 - 7. ISO8528
 - 8. IEC61000
 - 9. NEMA MG-1-22
 - 10. UL508
 - 11. UL142
 - 12. Designed to allow for installed compliance to NFPA 70, NFPA99 and NFPA 110
 - 13. NYC Advisory Board

1.6 REQUIREMENTS, CODES AND REGULATIONS

The equipment supplied and installed shall meet the requirements of the NEC and all applicable local codes and regulations. All equipment shall be of new and current production by a MANUFACTURER who has 25 years of experience building this type of equipment. Manufacturer shall be ISO9001 certified.

1.7 SUBSTITUTION

Proposed deviations from the specifications shall be treated as follows:

A. Substitution Time Requirement

Requests for substitutions shall be made a minimum of ten (10) days prior to bid date. Manufacturers catalog data shall accompany each request and authorized acceptance shall be addenda only.

B. Substitution Responsibility

The power system has been designed to the specified manufacturer's electrical and physical characteristics. The equipment sizing, spacing, amounts, electrical wiring, ventilation equipment, fuel, and exhaust components have all been sized and designed around Caterpillar supplied equipment. Should any substitutions be made, the CONTRACTOR shall bear responsibility for the installation, coordination and operation of the system as well as any engineering and redesign costs, which may result from such substitutions.

1.8 SUBMITTALS

Engine-generator submittals shall include the following information:

A. Generator Set:

1. Technical Data - Manufacturer produced generator set specification or data sheet identifying make and model of engine and generator, and including relevant component design and performance data.
2. Engine:
 - a. Type, aspiration, compression ratio, and combustion cycle
 - b. Bore, stroke, displacement, and number of cylinders
 - c. Engine lubricating oil capacity
 - d. Engine coolant capacity without radiator
 - e. Engine coolant capacity with radiator
 - f. Coolant pump external resistance (maximum)
 - g. Coolant pump flow at maximum resistance
3. Alternator:
 - a. Model
 - b. Frame
 - c. Insulation class
 - d. Number of leads
 - e. Weight, total
 - f. Weight, rotor
 - g. Air flow
 - h. Conduit entrance locations
4. At rated voltage:
 - a. Efficiency at 0.8 power factor for:
 - 1) 50% load
 - 2) 75% load
 - 3) 100% load
 - b. Time constants; short circuit transient (T'D)
 - c. Time constants, armature short circuit (TA)
 - d. Reactance, subtransient - direct axis (X"D),
 - e. Reactance, transient - saturated (X'D)
 - f. Reactance, synchronous - direct axis (XD)
 - g. Reactance, negative sequence (X2)
 - h. Reactance, zero sequence (X0)
 - i. Fault current, 3 phase symmetrical
 - j. Decrement curve
5. Radiator:
 - a. Model
 - b. Type
 - c. Fan drive ratio
 - d. Coolant capacity, radiator
 - e. Coolant capacity, radiator and engine
 - f. Weight, dry
 - g. Weight, wet
 - h. Airflow
 - i. Static pressure

6. Generator set characteristics:
 - a. Power rating at 0.8 power factor
 - b. kVA rating
 - c. Fuel consumption at standard conditions for:
 - 1) 50 % load
 - 2) 75 % load
 - 3) 100% load
 - d. Combustion air inlet flow rate
 - e. Exhaust gas, flow rate
 - f. Stack temperature
 - g. Exhaust system backpressure (maximum)
 - h. Heat rejection to:
 - 1) Coolant
 - 2) Aftercooler
 - 3) Exhaust
 - 4) Atmosphere from engine
 - 5) Atmosphere from generator
 - i. Overall dimensions:
 - 1) Length
 - 2) Width
 - 3) Height
 - j. Weight, dry
 - k. Weight, wet
 7. All warranty data.
 8. Battery performance curves proving the output to start the generator
 9. Vibration isolators and neoprene pads.
- B. Test Reports engine, radiators, pumps, jacket water heaters, batteries, battery chargers etc.
1. Certified factory test report.
 2. Certified field test reports.

1.9 QUALITY ASSURANCE

- A. Except as modified by governing codes and the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
1. Alternator:
 - a. NEMA MG-1-22
 - b. ASTM D396
 2. Battery Charger:
 - a. U.L. 1236
 3. Engine Generator:
 - a. Local Air Quality Management District.
 4. Control and Status Panels:
 - a. NFPA 110

- 5. Testing:
 - a. NETA
- B. Equipment suppliers shall have local representation and shall have been actively engaged in the assembly, installation and service of this equipment for emergency power purposes for a period of not less than 10 years in the Job Site area.
- C. Equipment suppliers shall have full parts backup and a 24 hour per day service availability for this equipment.
- D. The manufacturer's and dealer's extended warranty shall in no event be for a period of less than five (5) years from date of initial start-up of the system and shall include repair parts, labor, reasonable travel expense necessary for repairs at the jobsite, and expendables (lubricating oil, filters, antifreeze, and other service items made usable by the defect) used during the course of repair. Applicable deductible costs shall be specified in the manufacturer's warranty. Include a temporary generator set in the event the repair time will be for an extended period. Submittals received without written warranties as specified will be rejected in their entirety.

1.10 LOCATION CRITERIA

- A. Altitude: 1000 feet above sea level.
- B. Seismic: UBC Zone II.
- C. Ambient temperature min. - 20°F.
max. 110°F

1.11 RADIATED EMISSION REQUIREMENTS

- A. Emission requirements shall comply with the latest NYC requirements for standby generator.

1.12 SYSTEM RESPONSIBILITY

- A. Generator Set Distributor

The completed engine generator set shall be supplied by the **Manufacturer's** authorized distributor only.

- B. Requirements, Codes and Regulations

The equipment supplied and installed shall meet the requirements of NEC and all-applicable local NYC codes and regulations. All equipment shall be new, of current production. There shall be one source responsibility for warranty; parts and service through a local representative with factory trained service personnel.

1.13 WARRANTY

- A. Five Year Standby (ISO 8528-1: ESP) Generator Set Warranty

The manufacturer's standard warranty shall in no event be for a period of less than five (5) years from date of initial start-up of the system and shall include repair parts, labor, reasonable travel expense necessary for repairs at the job site, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the

course of repair. Running hours shall be limited to 500 hours annually for the system warranty by both the manufacturer and servicing distributor. Submittals received without written warranties as specified will be rejected in their entirety.

B. Service Facility

The engine-generator supplier shall maintain 24-hour parts and service capability within 50 miles of the project site. The distributor shall stock parts as needed to support the generator set package for this specific project. The supplier must carry sufficient inventory to cover no less than 80% parts service within 24hrs and 95% within 48 hours.

C. Service Personnel

The dealer shall maintain qualified factory trained service personnel.

1.14 PRODUCT SUPPORT

A. Preventive Maintenance Agreement

The authorized Caterpillar dealer shall provide a preventive maintenance agreement using qualified factory trained service personnel, for a period of 1-year minimum. The dealer shall provide genuine Caterpillar parts and filters, shall provide all recommended fluids, dealer labor, travel labor and travel mileage to complete the suggested preventive maintenance as defined in the manufacturer's Operation and Maintenance Manual.

B. Standby Generator Set Extended Service Coverage

Extended Service Coverage shall be provided for a period of 5 or 10 years, and shall include no deductible. Extended Service Coverage provides for 100 percent of usual and customary parts and labor costs for failures due to defects in materials and workmanship to the "as shipped consist" from the factory, excluding filters, fluids, vee belts, hoses, power take-offs, paint, batteries and clutches. Platinum Extended Service Coverage provides for a rental power unit due to unscheduled failures causing unexpected downtime to the customer in excess of 48 hours from the time of diagnoses. All repairs will be performed by factory trained dealer service personnel, and allows for repairer travel and mileage for all repairs up to 8 hours and 320 miles per incident.

PART 2 - PRODUCTS

2.1 CRITERIA

- A. The engine generator system and accessories described herein shall be fully capable of operation as specified in the following environmental conditions:

Maximum ambient temperature: 110°F

Minimum ambient temperature: -20°F

Altitude: 1174 feet above sea level

Radiator shall be suitable for 110°F operation and allow for 6° rise above 110°F, manufacturer to verify if oversized radiator is required.

2.2 ENGINE

- A. The engine shall be diesel fueled, four (4) cycle, water-cooled, while operating with nominal speed not exceeding 1800 RPM. The engine will utilize in-cylinder combustion technology, as

required, to meet applicable EPA non-road mobile regulations and/or the EPA NSPS rule for stationary reciprocating compression ignition engines. Actual engine emissions values must be in compliance with applicable EPA emissions standards per ISO 8178 – D2 Emissions Cycle at specified kW / bHP rating. Emissions requirements / certifications of this package: EPA T2. The prime mover shall be designed, tested and built by the manufacturer. Generator sets that are built using an engine other than the manufacturer's standard tested product will not be considered. The engine make and model must be provided as part of the bill of materials list on the proposal. Proposals will not be considered without this information listed.

2.3 ENGINE GOVERNING (SPEED CONTROL)

- A. The engine governor shall be an electronic Engine Control Module (ECM) with 24-volt DC Electric Actuator. The ECM shall be enclosed in an environmentally sealed, die-cast aluminum housing which isolates and protects electronic components from moisture and dirt contamination. Speed droop shall be adjustable from 0 (isochronous) to 10%, from no load to full rated load. Steady state frequency regulation shall be +/- 6 RPM. Speed shall be sensed by a magnetic pickup off the engine flywheel ring gear. A provision for remote speed adjustment shall be included. The ECM shall adjust fuel delivery according to exhaust smoke, altitude and cold mode limits. In the event of a DC power loss, the forward acting actuator will move to the minimum fuel position.

2.4 GENERATOR

- A. Generator Specifications
 - 1. The generator shall be a synchronous, three phase, four pole, 2/3 pitch, form wound, double bearing, and IP23 drip proof. Bearing(s) shall be double shielded and maintenance free. The insulation system shall meet NEMA MG 1 and UL1446 standards for Class H insulation. Generator temperature rise shall be limited to NEMA MG1 temperature limit of 105C, at a 40C ambient. Subtransient reactance shall not exceed 15%. . The excitation system shall enable the generator to sustain 300% of rated current for ten seconds at prime rating during a fault condition and shall improve the immunity of the voltage regulator to non-linear distorting loads.

2.5 VOLTAGE REGULATOR

- A. Digital Voltage Regulator
 - 1. The digital voltage regulator shall be microprocessor based with fully programmable operating and protection characteristics. The regulator shall maintain generator output voltage within +/- 0.25% for any constant load between no load and full load. The regulator shall be capable of sensing true RMS in three phases of alternator output voltage, or operating in single phase sensing mode. The voltage regulator shall include a VAR/Pf control feature as standard. The regulator shall provide an adjustable dual slope regulation characteristic in order to optimize voltage and frequency response for site conditions. The voltage regulator shall include standard the capability to provide generator paralleling with reactive droop compensation and reactive differential compensation.
 - 2. The voltage regulator shall communicate with the Generator Control Panel via a J1939 communication network with generator voltage adjustments made via the controller keypad. Additionally, the controller shall allow system parameter setup and monitoring, and provide fault alarm and shutdown information through the controller. A PC-based user interface shall be available to allow viewing and modifying operating parameters in a windows compatible environment.

B. Motor Starting

1. Provide locked rotor motor starting capability of 11,168 skVA at 30% instantaneous voltage dip as defined per NEMA MG 1. Sustained voltage dip values/calculations is not acceptable.

2.6 CIRCUIT BREAKER

- A. Use free-standing vacuum breaker to match paralleling switchgear

2.7 CONTROLS – GENERATOR SET MOUNTED

Provide a fully solid-state, microprocessor based, generator set control. The control panel shall be designed and built by the engine manufacturer. The control shall provide all operating, monitoring, and control functions for the generator set. The control panel shall provide real time digital communications to all engine and regulator controls via SAE J1939.

A. Environmental

The generator set control shall be tested and certified to the following environmental conditions:

1. -40°C to +70°C Operating Range
2. 100% condensing humidity, 30°C to 60°C
3. IP22 protection for rear of controller; IP55 when installed in control panel
4. 5% salt spray, 48 hours, +38°C, 36.8V system voltage
5. Sinusoidal vibration 4.3G's RMS, 24-1000Hz
6. Electromagnetic Capability (89/336/EEC, 91/368/EEC, 93/44/EEC, 93/68/EEC, BS EN 50081-2, 50082-2)
7. Shock: withstand 15G

B. Functional Requirements

The following functionality shall be integral to the control panel.

1. The control shall include a minimum 33 x 132 pixel, 24mm x 95mm, positive image, transfective LCD display with text based alarm/event descriptions.
2. The control shall include a minimum of 3-line data display
3. Audible horn for alarm and shutdown with horn silence switch
4. Standard ISO labeling
5. Multiple language capability
6. Remote start/stop control
7. Local run/off/auto control integral to system microprocessor
8. Cooldown timer
9. Speed adjust
10. Lamp test
11. Emergency stop push button
12. Voltage adjust
13. Voltage regulator V/Hz slope - adjustable
14. Password protected system programming

C. Digital Monitoring Capability

The controls shall provide the following digital readouts for the engine and generator. All readings shall be indicated in either metric or English units

1. Engine
 - a. Engine oil pressure
 - b. Engine oil temperature
 - c. Engine coolant temperature
 - d. Engine RPM
 - e. Battery volts
 - f. Engine hours
 - g. Engine crank attempt counter
 - h. Engine successful start counter
 - i. Service maintenance interval
 - j. Real time clock
 - k. Engine exhaust stack temperature
 - l. Engine main bearing temperature
2. Generator
 - a. Generator AC volts (Line to Line, Line to Neutral and Average)
 - b. Generator AC current (Avg and Per Phase)
 - c. Generator AC Frequency
 - d. Generator kW (Total and Per Phase)
 - e. Generator kVA (Total and Per Phase)
 - f. Generator kVAR (Total and Per Phase)
 - g. Power Factor (Avg and Per Phase)
 - h. Total kW-hr
 - i. Total kVAR-hr
 - j. % kW
 - k. % kVA
 - l. % kVAR
 - m. Generator bearing temperature
 - n. Generator stator winding temperature
3. Voltage Regulation
 - a. Excitation voltage
 - b. Excitation current

D. Alarms and Shutdowns

The control shall monitor and provide alarm indication and subsequent shutdown for the following conditions. All alarms and shutdowns are accompanied by a time, date, and engine hour stamp that are stored by the control panel for first and last occurrence:

1. Engine Alarm/Shutdown
 - a. Low oil pressure alarm/shutdown
 - b. High coolant temperature alarm/shutdown
 - c. Loss of coolant shutdown
 - d. Overspeed shutdown
 - e. Overcrank shutdown
 - f. Emergency stop shutdown
 - g. Low coolant temperature alarm
 - h. Low battery voltage alarm

- i. High battery voltage alarm
 - j. Control switch not in auto position alarm
 - k. Battery charger failure alarm
- 2. Generator Alarm/Shutdown
 - a. Generator phase sequence
 - b. Generator over voltage
 - c. Generator under voltage
 - d. Generator over frequency
 - e. Generator under frequency
 - f. Generator reverse power (real and reactive)
 - g. Generator overcurrent
- 3. Voltage Regulator Alarm/Shutdown
 - a. Loss of excitation alarm/shutdown
 - b. Instantaneous over excitation alarm/shutdown
 - c. Time over excitation alarm/shutdown
 - d. Rotating diode failure
 - e. Loss of sensing
 - f. Loss of PMG
- E. Inputs and Outputs
 - 1. Programmable Digital Inputs

The Controller shall include the ability to accept programmable digital input signals. The signals may be programmed for either high or low activation using programmable Normally Open or Normally Closed contacts.
- F. Programmable Relay Outputs

The control shall include the ability to operate programmable relay output signals, integral to the controller. The output relays shall be rated for 2A @ 30VDC and consist of six (6) Form A (Normally Open) contacts and two (2) Form C (Normally Open & Normally Closed) contacts.
- G. Programmable Discrete Outputs

The control shall include the ability to operate two (2) discrete outputs, integral to the controller, which are capable of sinking up to 300mA.
- H. Maintenance

All engine, voltage regulator, control panel and accessory units shall be accessible through a single electronic service tool. The following maintenance functionality shall be integral to the generator set control

 - 1. Engine running hours display
 - 2. Service maintenance interval (running hours or calendar days)
 - 3. Engine crank attempt counter
 - 4. Engine successful starts counter
 - 5. 40 events are stored in control panel memory
 - 6. Programmable cycle timer that starts and runs the generator for a predetermined time. The timer shall use 7 user-programmable sequences that are repeated in a 7-day cycle. Each sequence shall have the following programmable set points:

- a. Day of week
- b. Time of day to start
- c. Duration of cycle

I. Remote Communications

1. Remote Communications

The control shall include Modbus RTU communications as standard via RS-485 half duplex with configurable baud rates from 2.4k to 57.6k. Option: Upgraded control panel has Modbus output as TCP (10BT Ethernet)

2. Optional: Remote Monitoring Software

- a. The control shall provide Monitoring Software with the following functionality:
 - 1) Monitor up to eight (8) generator sets, plus ATS and UPS.
 - 2) Provide access to all data and events on generator set communications network
 - 3) Provide remote control capability for the generator set(s)
 - 4) Ability to communicate via Modbus RTU or remote modem

J. Local and Remote Annunciation

1. Local Annunciator (NFPA 99/110, CSA 282)

- a. Provide a local, control panel mounted, annunciator to meet the requirements of NFPA 110, Level 1.
 - 1) Annunciators shall be networked directly to the generator set control
 - 2) Local Annunciator shall include a lamp test pushbutton, alarm horn and alarm acknowledge pushbutton
 - 3) Provide the following individual light indications for protection and diagnostics:
 - a) Overcrank
 - b) Low coolant temperature
 - c) High coolant temperature warning
 - d) High coolant temperature shutdown
 - e) Low oil pressure warning
 - f) Low oil pressure shutdown
 - g) Overspeed
 - h) Low coolant level
 - i) EPS supplying load
 - j) Control switch not in auto
 - k) High battery voltage
 - l) Low battery voltage
 - m) Battery charger AC failure
 - n) Emergency stop
 - o) Damper operation
 - p) Generator room high and low temperature

K. Remote Annunciator (NFPA 99/110, CSA 282)

1. Provide a remote annunciator to meet the requirements of NFPA 110, Level 1.

- a. The annunciator shall provide remote annunciation of all points stated above and shall incorporate ring-back capability so that after silencing the initial alarm, any subsequent alarms will sound the horn.
- b. Ability to be located up to 4000 ft from the generator set

2.8 COOLING SYSTEM

The generator set shall be equipped with a rail-mounted, engine-driven radiator with blower fan and all accessories. The cooling system shall be sized to operate at full load conditions and 110 F ambient air temperature. The blower type fan shall allow for 1" H₂O of external static pressure. Allow for a 7 degree F air temperature rise across the engine.

2.9 FUEL SYSTEM

Note: The Contractor shall provide a full tank of diesel fuel for the completion of all site testing.

A. Fuel System

The fuel system shall be integral with the engine. In addition to the standard fuel filters provided by the engine manufacturer, there shall also be installed a primary fuel filter/water separator in the fuel inlet line to the engine. All fuel piping shall be black iron or flexible fuel hose rated for this service. No galvanized piping will be permitted. Flexible fuel lines shall be minimally rated for 300 degrees F and 100 psi.

- B. Provide a twin set of filters with a Krassil valve between them to allow for complete isolation of one filter assembly from the other
- C. Provide firematic type valve on the fuel inlet line to the generator set. Valve shall be the spring loaded automatic close type when the design temperature has been reached.
- D. Provide a 300-gallon, "ready supply", package double-lined (200% rupture basin) fuel day tank to provide an immediate fuel supply to the engine fuel pump upon engine start-up. Tank shall comply with NYCCode requirements. Fuel shall be supplied to the tank by means of 120 volt electric fuel transfer pump mounted on the day tank. Also provide a hand pump for priming. Equip tank with an automatic float to control the day tank level with a low level contact (set at 25% capacity) for remote alarm indication and a high level contact set at 95% of the tank capacity for remote alarm indications. Provide independent fuel pumps control floats/contacts set at pump on 35% capacity and pump off at 90% capacity. Supply and return connects shall be brought to the outside of each generator enclosure for contractor connection. A drain cock and valve shall be provided in the tank and rupture basin. Rupture basin shall contain a leak detection system for remote indication to the alarm panel. Engine fuel oil pump shall have suction 8" mercury.
- E. The fuel tank shall be rated to comply with UL 142. (Pressure test of 3 psi shall be performed and a leak test shall then be performed.)
- F. Fuel lines between injection pumps and valves shall be of heavy seamless tubing and to eliminate irregularity of fuel injections shall be of the same length for all cylinders.
- G. Provide fusible link type safety shutoff valves to fail close.
- H. The fuel system shall be equipped with a fuel filter having replaceable elements which may be easily removed from their housing for replacing without breaking any fuel line connections or disturbing the fuel pumps or any other parts of the engine. All fuel filters shall be conveniently located in one accessible housing, ahead of the injection pumps, so that the fuel will have been thoroughly filtered before it reaches the pumps. No screens or filters requiring cleaning or replacement shall be used in the injection pump or injection assemblies. Filters shall be duplex type and have a valve arrangement so filters can be changed during operation.

- I. Provide crankcase fumes reclamation system. System shall collect engine crankcase emissions, filter out airborne lube oil, and reintroduce the emissions back into the engine combustion air system.
- J. Provide an integral fuel oil cooler designed to return fuel below the maximum allowable fuel oil supply temperature.

Option: Provide remote fuel system supply and overflow ports. Include extra sensor ports for pump on, pump off, critical high and critical low fuel sensor ports that will tie in to the main tank transfer pump control system. Coordinate pump control supplier sensor requirements with the day tank.

2.10 EXHAUST SYSTEM

A. Silencer

A silencer rated 85 dba @ 5 feet shall be provided. Include, companion flanges, nut bolt gasket kits for all flanges and flexible stainless steel exhaust fitting properly sized according to the manufacturer's recommendation. Mounting shall be provided by the contractor as shown on the drawings. The silencer shall be mounted so that its weight is not supported by the engine nor will exhaust system growth due to thermal expansion be imposed on the engine. Exhaust pipe size shall be sufficient to ensure that exhaust backpressure does not exceed the maximum limitations specified by the engine manufacturer. Silencer shall be the torpedo style.

2.11 STARTING SYSTEM

A. Starting Motor

A DC electric starting system with positive engagement shall be furnished. The motor voltage shall be as recommended by the engine manufacturer. Provide dual redundant electric starting motors. Each individual set of starting motors shall be able to start the engine in the event the other starter motor is inoperable.

B. Jacket Water Heater

Jacket water heater shall be provided and shall be sized to insure that genset will start within the specified time period and ambient conditions. Heaters shall be mounted on the engine and piped according to the engine MFG recommendations. Include isolation valves at each end to allow for replacement of the JW heater without having to drain the entire cooling system. Provide circulation pump as part of the JW heater assembly. JW heater shall be sized and designed in accordance with meeting NFPA 110 Level 1 Type 10 requirements

C. Batteries

Batteries - A lead-acid storage battery set of the heavy-duty diesel starting type shall be provided. Battery voltage shall be compatible with the starting system. Include a battery stand and interconnecting cables.

D. Battery Charger

A UL listed/CSA certified 35 amp voltage regulated battery charger shall be provided for each engine-generator set. Input AC voltage and DC output voltage shall be as required. Chargers shall be equipped with float and equalize charge settings, with provisions to

automatically switch between the two modes. It shall maintain its rated output voltage within $\pm 0.2\%$ with AC input variation of $\pm 10\%$. Operational monitors shall provide with individual form C contacts rated at 4 amps, 120 VAC, 30VDC for remote indication of battery charger malfunction, low battery voltage, high battery voltage, and battery charger malfunction. Charger shall include an Analog DC voltmeter and ammeter and fused AC input and DC output, and shall be wall mount type in a NEMA 1 enclosure. Provide alarms as well as remote alarm contacts in accordance with NFPA 110 Level 1 Type 10 requirements.

2.12 CRANKCASE EMISSIONS

- A. Provide a crankcase fumes reclamation system on the engine. System shall collect crankcase emissions, filter out airborne lube oil, and return the crankcase fumes back to the engine air intake. Crankcase fumes shall not be allowed to vent directly in to the atmosphere. Fumes collection system shall be as MFG by Racor or approved equal

2.13 VIBRATION ISOLATION

- A. Provide spring type vibration isolators for mounting between the generator set base rails and the mounting surface. Isolators shall be seismic zone rated in accordance with the seismic zone activity for the zip code in which the generator set will be installed. Isolators shall allow for 1" deflection. Isolators are to include vertical leveling stops. Provide neoprene type pad for the isolator base mounting pad.

2.14 AUTOMATIC ELECTRIC-SET PROTECTION

- A. Protection System: Provide power for sensors, trips, indicator lights, and alarm by engine cranking batteries. Provide fault sensors to cause emergency engine shutdown when any of the following faults occur:
 - 1. High water temperature sensors set to trip at $205^{\circ}\text{F} \pm 3^{\circ}\text{F}$, $96^{\circ}\text{C} \pm 2^{\circ}\text{C}$.
 - 2. Approach to high water temperature sensors set to pre-alarm at 190°F .
 - 3. Low water temperature sensors set to trip at 80°F .
 - 4. Overspeed sensors set to trip at 2050 revolutions per minute.
 - 5. Low lube oil pressure sensors set to trip at the engine manufacturer's recommendation for lowest permissible oil pressure.
 - 6. Overcrank sensors set to trip after four (4) 15-second attempts to start.

2.15 ACCEPTABLE MANUFACTURERS

- A. The documents are based upon engine generator physical sizing criteria of one particular manufacturer. The Contractor shall be responsible for modifications necessary in the use of a proposed manufacturer. These modifications are to include all mechanical and electrical work, architectural work and structural work.
- B. The following manufacturers are acceptable:
 - 1. Prime Mover and Generator:
 - a. Caterpillar
 - b. MTU
 - c. Cummins
 - 2. Generator
 - a. Marathon
 - b. Kato
 - c. Newage

3. Exhaust Silencer:
 - a. Harco
 - b. GT
 - c. Silex
4. Vibration Isolators:
 - a. Ace Manufacturing
 - b. Vibration Eliminator Co.
 - c. Korfund, Mason
5. Governor:
 - a. Woodward
 - b. Basler
 - c. Caterpillar ADEM
 - d. MTU DDEC
6. Batteries:
 - a. Nife
 - b. Alcad/Chloride
 - c. C&D
7. Battery Chargers:
 - a. Lamarche
 - b. Lorain
 - c. Nife
 - d. Caterpillar
8. Voltage Regulations:
 - a. Marathon
 - b. Basler
 - c. Caterpillar
9. Circuit Breakers (match paralleling switchgear breaker except not drawout):
 - a. General Electric
 - b. Eaton
 - c. Siemens

PART 3 - EXECUTION

3.1 GENERAL

- A. Install the emergency generator system as shown on the drawings, as indicated in the manufacturer's instructions and as required for a neat workmanlike and fully operational system. Insure that the manufacturer's recommended clearances are maintained.

3.2 SPARE PARTS

- A. Deliver 1 set of filter elements (air, fuel, oil) and one belt for every belt drive to Owner at final acceptance.
- B. Manufacturer to submit recommended spare parts list.

3.3 INSTALLATION

- A. Verify installation of work by other trades including: flexible fuel connections and piping, exhaust system and ductwork.

3.4 SEQUENCE OF OPERATION

- A. For complete sequence of operation refer to section 26 23 13 "Automatic Paralleling/Synchronizing Switchgear," paragraph 2.5.
- B. Each engine start contacts shall signal generator to start when the voltage of the normal source drops below 80% on any phase, after a time delay of 1 second to allow for momentary dips. The voltage sensing relay shall be field adjustable while energized. The first generator to achieve 90% of the rated voltage and frequency shall be connected to the standby bus. The second incoming generator shall automatically synchronize and parallel with the first unit.
- C. The transfer switches shall transfer to emergency when 90% of rated voltage and frequency of the emergency source have been reached, in a sequential manner.
- D. After restoration of normal power of all phases to 90% of rated voltage, an adjustable time delay period shall delay retransfer to allow stabilization of normal power. If the emergency power source should fail during this time delay period, the switch shall bypass the timing relay and transfer to the normal source.
- E. After all ATSS retransfer to normal, the engine generators shall be allowed to operate at no load for 0-30 minutes adjustable.
- F. A test on the transfer switch shall simulate normal power failure.
- G. When generator begins to start (and is cranking) the following should occur:
 - 1. Air intake motorized damper shall open.
 - 2. Air exhaust motorized damper shall open.
 - 3. The bulk fuel oil transfer pumps shall be on.
- H. When the generator is off, the following should occur:
 - 1. Air intake motorized damper shall close.
 - 2. Air exhaust motorized damper shall close.
 - 3. The bulk fuel oil transfer pumps shall be off.

Note: A one way check valve could be used via the return line.

3.5 FUEL OIL

- A. Upon acceptance of field testing and prior to final payment the fuel oil tank shall be provided with predetermined amount of oil by the Electrical Contractor.

3.6 TESTING

Note: Contractor to coordinate with customer's rep in case that customer decides to witness the factory testing.

A. Factory Testing

1. Prior to shipment of the engine-generator set from the factory, a certified load test shall be performed and the results submitted to the Architect/Engineer for approval before shipment of the unit. The test shall verify the proper operation of all alarms and shut down circuits. Do not ship units until factory test is submitted and approved by the engineer.
2. The test shall also demonstrate compliance with the generator performance criteria as specified herein.
3. Testing shall be performed as follows:
 - a. Verify operation of shut down and alarm points including all monitoring and control functions specified.
 - b. Perform transient response testing to verify performance as specified. Load steps shall be performed as follows:
 - 1) 0% - 25% - 0%
 - 2) 0% - 50% - 0%
 - 3) 0% - 75% - 0%
 - 4) 0% - 100% - 0%
 - 5) 0% - 25% - 50% - 75% - 100% - 75%, 50%, - 25% - 0%
 - c. All load steps shall be recorded on a chart recorder or light beam oscilloscope.
 - d. In a period of five (5) hours with a loading 100 percent of rated load. Step loading procedure shall be utilized (i.e., 25 percent first hour, 50 percent second hour, etc.).
 - e. Additional testing:
 - 1) Fuel consumption at $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, and full load
 - 2) Mechanical and exhaust noise data.
 - 3) Governor speed regulation at $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, and full load; during transients.
 - 4) Harmonic analysis, voltage waveform deviation and telephone influence factor.
 - 5) Cooling system performance.

B. Field Testing (Full Load Test Onsite, Provide Load Banks for Onsite Test)

Note: ATS start up by paralleling switchgear/ATS manufacturer technicians to establish set parameters and functions: Refer to electrical commissioning section 26 08 00 for additional testing requirements.

1. After completion of the installation, the Contractor shall perform a certified load test of the engine generator and related automatic transfer switches. The generator shall be required to start-up and accept full load within 10 seconds. The unit shall continue to operate for not less than four (4) hours at 100 percent rated load. The test shall also include demonstrating that all alarms, signals, shut down devices, elevator recall, etc., are functioning properly. The Contractor shall be responsible for securing all temporary load-banks, temporary cables, etc., required for the tests.
2. This Contractor shall supply all fuel for the testing. Upon acceptance by the Architect/Engineer, the day tank and main fuel oil tank shall be filled to capacity after each testing.

- C. Test onsite with actual building load similar to load bank test utilizing the available building load.
- D. Pull the Plug Test
 - 1. Test the Standby Generators deenergizing the Con Edison service.
- E. Certified Test Reports
 - 1. Field testing shall be performed by a NETA certified, independent third-party testing agency.
 - 2. Test procedures shall be in accordance with NFPA 110.
 - 3. Verify that the installation is in accordance with the manufacturer's instructions.
 - 4. Verify that the equipment has been fully tested and is operational.
 - 5. Perform reactive testing and compile detailed test reports for each piece of equipment and system tested.
 - 6. Perform an arm-plate system resistive load bank test after all equipment is installed.
- F. Miscellaneous – Provide the following:
 - 1. Location of a factory authorized service center. Number of full time factory trained personnel at each service center and the experience of personnel.
 - 2. The response time for service calls. There should be a maximum response time of four hours on-site.
 - 3. Recommended preventive maintenance procedures and recommended intervals with one included within the first year. Also contract prices for the 2nd and 3rd year.
 - 4. Recommended spare parts to minimize downtime for repairs with pricing.

3.7 CLASSROOM INSTRUCTION

- A. The generator set supplier shall provide a minimum of six hours of classroom instruction on maintenance and operation of the emergency power system. Classes shall be held at the supplier's facility, shall be administered by a full time instructor and shall be open to up to three (3) representatives of the Owner's maintenance staff.

3.8 Provide all necessary wiring and conduit to each remote alarm panel.

3.9 HOUSEKEEPING PADS

- A. Refer to structural and architectural drawings. Electrical contractor to coordinate.
- B. Provide a six-inch high concrete housekeeping pad beneath each generator.
- C. Provide a concrete curb under each door of the generator room to prevent migration of spilled liquids out of the room.
- D. Provide a leak detection system for fuel containment and connect to the Building Management System. Provide a 120 volt power supply from nearest emergency panel location.

3.10 FIELD REPRESENTATION

- A. Provide services of manufacturer's field representative (factory trained) for a period of 5 working days to supervise start-up, testing and two (2) training sessions for operating personnel.

- B. The generator set dealer shall be responsible for coordination between all related generator control wiring, regulator and governor equipment, testing and start-up and all associated systems that affect the coordination of the switchgear with the generator sets. All submittal packages relating to the two systems shall be supplied as a one source package for review by the engineer. The one source of responsibility criteria would rest upon the generator supplier to ensure a smooth transition in every step of the installation process, as well as being available for coordination meetings with his associated sub-vendor.
- C. Owner reserves the right along with his authorized representatives to visit the factory during the course of fabrication of equipment to observe progress, quality control, schedule of completion, etc. All costs shall be paid by this Contractor.

3.11 OPERATION & MAINTENANCE MANUAL

- A. Submit O&M manual illustrated parts, breakdown, troubleshooting guide, etc. All information shall be specific to the project installation. Generic manuals not acceptable.
- B. Include full product submittal full engineering performance data.

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SECTION 263623

480/277 VOLT AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide automatic transfer switches in accordance with the Contract Documents.

1.2 RELATED SECTIONS

- A. 260573 – Power Systems Study
- B. 260913 – Electrical Power Monitoring
- C. 262913 – 480/277V Life-Safety Diesel Engine Generator

1.3 WORK INCLUDED

- A. Automatic Transfer Switches.
- B. Manually-Operated Non-Automatic Transfer Switches.
- C. Interconnecting control wiring, conduit, and programming for the complete requirements of the standby power generation system.

1.4 SUBMITTALS

- A. Shop Drawings
 - 1. Detailed drawings which relate to the design criteria specified, including single line diagram.
 - 2. Submission shall be coordinated with the short circuit study submitted with the project switchboard shop drawings for the entire electrical system. Equipment submissions made without this study shall be returned unreviewed.
 - 3. All concrete housekeeping pads shall be sized and illustrated on the submittal.
- B. Product Data
 - 1. Manufacturer's catalog cut sheets and performance data.
 - 2. Complete detailed wiring diagram of the system including all remote connections.
 - 3. All nameplate information.
 - 4. All warranty data.
 - 5. Certified factory test report.
 - 6. Complete list of materials and components being furnished, including capacities, weights, operating ratings, and all accessories.

1.5 QUALITY ASSURANCE

- A. Except as modified by governing codes and the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
 - 1. U.L. 1008 – Standard for Transfer Switch Equipment
 - 2. NFPA 110 – Emergency and Standby Systems

3. U.L. 508 – Industrial Control Equipment
 4. U.L. 1008 – Transfer Switch Equipment
 5. NFPA 70 – National Electrical Code
 6. IEEE Standard 446 – IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Application
 7. NEMA Standard ICS10-1993 – AC Automatic Transfer Switches
- B. Equipment suppliers shall have local representation and shall have been actively engaged in the assembly, installation and service of this equipment for emergency power purposes for a period of not less than 10 years in the job site area.
- C. Equipment suppliers shall have full parts backup and a 24 hour per day service availability for this equipment.
- D. Equipment supplier shall have factory direct service employees specifically trained for work on automatic transfer switches and all related devices.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Rating: The automatic transfer switches shall be furnished as shown on the Contract Documents and shall be listed under UL-1008. All three phase, four wire transfer switches shall be the four-pole switched neutral type with overlapping neutral contacts to eliminate transients and optimize the integrity of the neutral path. The automatic transfer switches shall be capable of switching all classes of load and shall be rated for continuous duty when installed in a non-ventilated enclosure constructed in accordance with Underwriters' Laboratories, Inc. Standard UL-1008. Rating and configuration of the switches shall be as indicated on the Contract Documents.
- B. Construction and Performance: The automatic transfer switch shall be double throw, actuated by a single or dual electrical operator momentarily energized and connected to the transfer mechanism by a simple over-center type linkage with a total transfer time not to exceed one-sixth of a second. The automatic transfer switch shall be capable of transferring successfully in either direction with 80 percent of rated voltage applied to the switch terminals.
- C. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically locked in position in both the normal and emergency positions without the use of hooks, latches, magnets, or springs and shall be silver-tungsten alloy protected by arcing contacts, with arc grids on each pole. Interlocked molded case circuit breakers or contactors are not acceptable.
- D. The transfer switch shall be equipped with a maintenance operator that is designed to operate with switch de-energized. The switch shall operate with a slow movement to allow for inspection of the contact travel. The transfer switch shall be equipped with a safe external manual operator designed to prevent injury to operating personnel. The manual operator shall provide the same contact to contact transfer speed as the electrical operator to prevent a flashover from switching the main contacts slowly. The external manual operator shall be safely operated from outside of the transfer switch enclosure while the enclosure door is closed.
- E. Transfer switches shall be mounted in NEMA 250, Type 1 enclosures as indicated on the Contract Documents.

- F. When conducting temperature rise tests to paragraph 17 of UL-1008, the manufacturer shall include post-endurance temperature rise tests to verify the ability of the transfer switch to carry full rated current after completing the overload and endurance tests.
- G. The automatic transfer switches shall have the short circuit withstand and close-in ratings consistent with the available short circuit current as indicated on the Contract Documents and a result of the Contractor's short circuit analysis.
- H. Nameplate: Provide a nameplate of red bakelite with white lettering containing the following information:

ATS # _____ (1/2" lettering)
Serves Panel _____ (1/4" lettering)
Normal Power from Panel _____ CKT _____ (1/4" lettering)
Emergency Power from Panel _____ CKT _____ (1/4" lettering)

2.2 OPERATION

A. Microprocessor Control Module

- 1. A microprocessor control module shall be provided to direct the operation of the transfer switch. The control module shall be connected to the transfer switch by an interconnecting wiring harness which shall include a keyed disconnect plug to enable disconnecting for routine maintenance.
- 2. A full duplex RS422 interface shall be built-in to the control module to enable digital communications with remotely-located annunciators and/or network supervisors.
- 3. Provide serial port (RS232; RS422; or RS485) to communicate with the power monitoring system.

B. Relays, Contacts and Controls

- 1. Close differential voltage sensing on all phases of normal system.
 - a. Drop out field adjustable from 75 to 98%. Factory set at 80%.
 - b. Pick up field adjustable from 85 to 100%. Factory set at 90%.
- 2. Voltage sensing on at least one phase of emergency system.
 - a. Pick up field adjustable from 85% to 100%. Factory set at 90%.
- 3. Frequency sensing of emergency system.
 - a. Pick up field adjustable from 90 to 100%. Factory set at 95%.
- 4. Time delay of momentary normal source outages.
 - a. Field adjustable from 0 to 6 seconds. Factory set at 1 second.
- 5. Time delay on transfer back to normal.
 - a. Field adjustable from 0 to 30 minutes. Factory set at 10 minutes.
 - b. Immediate bypass and transfer to normal source if emergency service fails.
 - c. Shall cause a normally open set of contacts to close 10-15 seconds prior to transfer back to normal for switches serving elevator loads. This signal shall be adjustable from 0-60 seconds and shall be set as required by the elevator vendor.
- 6. Time delay of transfer to emergency.
 - a. Field adjustable from 0 to 5 minutes. Factory set at 0 minutes.

- b. Where multiple transfer switches are employed, set the time delay at 5 seconds apart between each switch (i.e. 4 switches total transfer of last switch 20 seconds). Switch priority assignments shall be assigned by the Engineer.
- 7. Unloaded engine run cool down time delay.
 - a. Field adjustable from 0 to 60 minutes. Factory set at 5 minutes.
- 8. Engine start contacts.
 - a. Two sets, one set to close the other set to open upon failure of normal source.
 - b. Signal to start respective generator after time out of transfer to emergency relay as specified in article 6 above.
- 9. Test switch.
 - a. Momentary type mounted through the enclosure.
 - b. Simulates failure of normal source.
 - c. System to remain in test position until delay on transfer back to normal has timed out.
 - d. A test reset switch shall be included and shall bypass the delay on transfer back to normal. It shall not bypass the unloaded engine run cool down delay or the presignal specified in 5c above.
 - e. During test conditions (operation of test switch) a normally open set of contacts shall be caused to close 10-15 seconds prior to transfer to emergency. The signal shall be adjustable from 0-60 seconds and shall be set as required by the elevator vendor.
- 10. Spare contacts.
 - a. Four (4) spare auxiliary contacts, two (2) closed with switch in emergency position, the other closed with switch in normal position.
- 11. Switch indicating lights.
 - a. Mounted on enclosure door.
 - b. Red when the switch is in the emergency position.
 - c. Green when the switch is in the normal position.
 - d. Green to indicate normal source is available.
 - e. Red to indicate emergency source is available.
 - f. Lights shall be paralleled at the remote annunciator panels.
 - g. Amber when the switch is in the bypass-isolation switch position.
- 12. In phase monitor.
- 13. Service manual shall be supplied inside of the enclosure when shipped.

2.3 ACCEPTABLE MANUFACTURERS

- A. Automatic Switch Co.
- B. Russelectric Co.
- C. Or Approved Equal.

PART 3 - EXECUTION

3.1 GENERAL

- A. The automatic transfer switches shall be installed as shown on the Contract Documents, in conjunction with the engine generator system as indicated in the manufacturer's instructions and as required for a neat workmanlike and fully operational system.

3.2 Provide the following in conjunction with each and every automatic transfer switch:

- A. 2#12-3/4"C. from the auxiliary contact (closed when switch is in the emergency position) on each automatic transfer switch to each elevator machine room which is served via an emergency generator. Terminate where required by the elevator vendor.
- B. 2#12-3/4"C. from the auxiliary contact (closed before the switch returns to normal power) on each automatic transfer switch serving elevators to each elevator machine room which is served via that transfer switch. Terminate where required by the elevator vendor.
- C. 2#12-3/4"C from the auxiliary contact (closed before the switch moves to the emergency position) on each automatic transfer switch serving elevators to each elevator machine room which is served via that transfer switch. Terminate as and where required by the elevator vendor.
- D. 2#12-3/4"C. from the engine start contact on each automatic transfer switch to the respective emergency generator control panel.
- E. Wiring as necessary from each automatic transfer switch to the remote annunciator panels and the engine control panel for each automatic transfer switch position indicator lights.

3.3 Provide all necessary wiring and conduit to each remote alarm panel.

3.4 Provide 4" high concrete housekeeping pads for all floor mounted equipment.

3.5 Provide a 24 inch wide isolation mat in the front and rear of all automatic transfer switches.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing, start-up and commissioning.
 - 2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.

- c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
- a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
 - f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
 - g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
- a. Verify grounding connections and locations and ratings of sensors.
- B. Testing Agency's Tests and Inspections:
- 1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
- a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
 - f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
 - g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
 - a. Verify grounding connections and locations and ratings of sensors.
- C. Coordinate tests with tests of generator and run them concurrently.
- D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- E. Remove and replace malfunctioning units and retest as specified above.
- F. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.
- B. Coordinate this training with that for generator equipment.

3.8 WARRANTY

- A. Provide a manufacturer's standard warranty for a period of two (2) years from final acceptance by the Owner.

END OF SECTION

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SECTION 263625

13.2 KV AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SCOPE

- A. Provide 13.2 kV automatic transfer switches (MV.ATS); three (3) poles, 1200 amperage. Each automatic transfer switch shall consist of one (1) section with Medium voltage (15 kV) freestanding metal-clad switchgear with vacuum circuit breakers and a second section with controls and microprocessor controller to provide automatic operation. A third section with metal-clad switchgear with two (2) vacuum circuit breakers shall be provided and connected to ATS with 1200 amp bus for serving two (2) substation zones. All transfer switches and controllers shall be the products of the same manufacturer.

1.2 RELATED SECTIONS

- A. 260573 – Power Systems Study
- B. 260913 – Electrical Power Monitoring System
- C. 261313 – 13.2 kV Service Switchgear
- D. 262313 – 13.2 kV Automatic Paralleling/Synchronizing Switchgear
- E. 263214 – 13.2 kV Standby Diesel Engine Generators

1.3 CODES AND STANDARDS

The automatic transfer switches and controls shall conform to the requirements of:

- A. UL 1008A – Standard for Medium Voltage Transfer Switches, 1st Edition, for transfer switches rated greater than 750 volts up to 46 kV.
- B. ANSI/IEEE C37.20.2 – Standard for Metal-Clad Switchgear.
- C. ANSI/IEEE C37.04 – Standard Rating Structure for AC High-Voltage Circuit Breakers.
- D. ANSI/IEEE C37.06 – Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis – Preferred Ratings and Related Required Capabilities for Voltages Above 1000V.
- E. ANSI/IEEE C37.11 – Standard Requirements for electrical control for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis or a total current basis.
- F. ANSI/IEEE C37.09 – Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
- G. ANSI Z55.1 – Gray Finishes for Industrial Apparatus and Equipment.
- H. ANSI/IEEE C57.13 – Standard Requirements for Instrument Transformers.

- I. NEMA SG4 – Alternating Current High Voltage Circuit Breakers.
- J. NEMA SG5 – Power Switchgear Assemblies.

1.4 ACCEPTABLE MANUFACTURERS

- A. Automatic transfer switches shall be ASCO 7000 Series.
- B. Russelectric
- C. The metal-clad switchgear and circuit breaker shall be manufactured by Square D, Siemens, Eaton, GE, or an approved equal.

1.5 WARRANTY

Manufacturer shall be warranted to be free of defects in material and workmanship for a period of eighteen (18) months.

1.6 EXTRA MATERIALS/ACCESSORIES

- A. Submit one (1) racking handle per Medium Voltage ATS line-up. Charging handle to be furnished on each breaker mechanism.
- B. Provide one (1) circuit breaker lifting device.

PART 2 - PRODUCTS

2.1 METAL-CLAD SWITCHGEAR ASSEMBLY

- A. The metal-clad switchgear shall consist of a Type 1 Indoor enclosure containing circuit breakers and the necessary accessory components all factory assembled. The assembly shall be a self-supporting and floor mounted on a level concrete pad. The integrated switchgear assembly shall withstand the effects of closing, carrying and interrupting currents up to the assigned maximum short circuit rating.
- B. System Voltage: 13.2 kV nominal, three-phase solidly grounded 60 Hz.
- C. Maximum Design Voltage: 15.0 kV.
- D. Impulse Withstand (Basic Impulse Level): 95 kV.
- E. Power Frequency Withstand: 19 kV, 1 minute test.
- F. Main Bus Ampacity: 1200 amps, continuous.
- G. Momentary Current Ratings: Equal to the circuit breaker close and latch rating, 40 kAIC @ 15 kV.

2.2 COMPONENTS

- A. Stationary Structure

1. The switchgear shall comprise a minimum of three (3) sections. Section #1 compartment with two (2) 1200A Emergency breakers and Section #2 auxiliary compartment with controls for Normal and Emergency sources and Section #3 compartment with two (2) 1200A normal breakers, to form a rigid self-supporting completely enclosed structures providing steel barriers between sections.
- B. Circuit Breaker Compartment
1. Each circuit breaker compartment shall be designed to house a horizontal drawout metal-clad vacuum circuit breaker. The stationary primary disconnecting contacts are to be silver-plated copper and mounted within glass polyester support bushings. The movable contacts and springs shall be mounted on the circuit breaker element for ease of inspection/maintenance.
 2. Entrance to the stationary primary disconnecting contacts shall be automatically covered by metal shutters when the circuit breaker is withdrawn from the connected position to the test or disconnected position or removed from the circuit breaker compartment. Extend a ground bus into the circuit breaker compartment to automatically ground the breaker frame with high-current spring type grounding contacts located on the breaker chassis when in the test and connected positions. Guide rails for positioning the circuit breaker and all other necessary hardware are to be an integral part of the circuit breaker compartment. Blocking devices shall interlock breaker frame sizes to prevent installation of a lower ampere rating or interrupting capacity element into a compartment designed for one of a higher rating. It shall be possible with indoor switchgear to install a circuit breaker into a bottom compartment without use of a transport truck or lift device.
- C. Ground Bus
1. A ¼ inch x 2 inch copper ground bus shall extend through the entire length of the transfer switch.
- D. Main Bus Compartment
1. The main bus is to be rated 1200 amps and be fully insulated for its entire length with an epoxy coating by the fluidized bed process. The conductors are to be silver-plated copper and be of a bolted design. Access to this compartment is gained from the front or rear of the structure by removing a steel barrier. Provide standard provisions for future extension, as applicable.
- E. Doors and Panels
1. Relays, control switches, etc., shall be mounted on a formed front-hinged panel for each circuit breaker compartment. Front doors shall include features to facilitate quick and complete removal or reinstallation of entire front door assembly. Door hinges shall have removable pins. Where allowable, all control circuits (except, for example, current transformers and grounding) shall be wired via plugs/receptacles prior to termination.
- F. Circuit Breakers
1. The circuit breakers shall be rated 15 kV nominal volts, maximum volts, 60 Hz, with a continuous current rating of 1200 amps and a maximum symmetrical interrupting rating of 40kA/1000MVA - 15 kV system. Furnish vacuum circuit breakers with one vacuum interrupter per phase. Breakers of same type and rating shall be completely interchangeable. The circuit breaker shall be operated by means of a stored energy mechanism which is normally charged by a universal motor but can also be charged by the manual handle supplied on each breaker for manual emergency closing or testing.

The closing speed of the moving contacts is to be independent of both the control voltage and the operator. Provide a full front shield on the breaker. Secondary control circuits shall be connected automatically with a self-aligning, self-engaging plug and receptacle arrangement when the circuit breaker is racked into the connected position. Provision shall be made for secondary control plug to be manually connected in test position. A minimum of 4 auxiliary contacts (2a 2b), shall be provided for external use. The racking mechanism to move the breaker between positions shall be operable with the front door closed and position indication shall be visible with door closed.

2. An interlocking system shall be provided to prevent racking a closed circuit breaker to or from any position. An additional interlock shall automatically discharge the stored-energy operating mechanism springs upon removal of the breaker out of the compartment.
3. The circuit breaker control voltage shall be: 125 volts DC.

G. Instrument Transformers

1. Voltage transformers are drawout mounted with primary current-limiting fuses and shall have ratio as indicated. The transformers shall have mechanical rating equal to the momentary rating of the circuit breakers and shall have metering accuracy per ANSI Standards.
2. Current transformers: The current transformer assembly shall be insulated for the full voltage rating of the switchgear. The current transformers wiring shall be Type SIS #14 AWG minimum.
Relaying and metering accuracy shall conform to ANSI Standards.

H. Control Wiring

1. The switchgear shall be wired with Type SIS #14 AWG minimum. The control wiring shall be UL listed and have VW-1 flame retardant rating. Wires shall terminate on terminal blocks with marker strips numbered in agreement with detailed connection diagrams.

2.3 FABRICATION

- A. Construction: Each equipment bay shall be a separately constructed cubicle assembled to form a rigid freestanding unit with sufficient bracing to minimize distortion. Minimum sheet metal thickness shall be 11 gauge steel on all exterior surfaces. Adjacent bays shall be securely bolted together to form an integrated rigid structure. The rear covers shall be removable to assist installation and maintenance of bus and cables.
- B. The metal-clad switchgear shall be fully assembled, inspected and tested at the factory prior to shipment. Large line-ups shall be split to permit normal shipping and handling as well as for ease of rejoining at the job site.
- C. Switchgear sections shall be furnished with four (4) lifting lugs.

2.4 FACTORY FINISHING

- A. All steel parts, shall be cleaned and an iron phosphate pre-treatment applied prior to paint application.
- B. Paint color shall be ANSI-61 [light grey].

2.5 MICROPROCESSOR CONTROLLER

- A. The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module.
- B. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator's manuals.
- C. All customer connections shall be wired to a common terminal block to simplify field-wiring connections.

2.6 ENCLOSURE

- A. All standard and optional door-mounted switches and pilot lights shall be 16-mm industrial grade type or equivalent for easy viewing & replacement.

2.7 MODES OF OPERATION

The modes of operation for the MV.ATS, described below, shall include controls discussed in subsequent sections.

- A. Automatic Mode
 - 1. In automatic mode, all 4 breakers should be racked in; the designated transfer switch breaker pair must be racked in. As the bypass breakers are not utilized for this mode, the operator should have the option of temporarily racking out one or both designated bypass breakers for service or maintenance while remaining in automatic mode.
- B. Each breaker includes individual electrical controls (open/close). Interlocks should prevent electrical controls from inappropriate closure. However, operators can open the front door, manually charge the breaker and possibly close on a live bus. Additionally, operators can remove rear covers (or open the rear door) and possibly access a live bus. This equipment contains no protective means to prevent these actions.

2.8 CONTROLLER DISPLAY AND KEYPAD

- A. A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the serial communications input port. The following parameters shall only be adjustable via DIP switches on the controller:
 - 1. Nominal line voltage and frequency
 - 2. Single or three phase sensing
 - 3. Operating parameter protection
 - 4. Transfer operating mode configuration (Open transition)

2.9 VOLTAGE, FREQUENCY AND PHASE ROTATION SENSING

- A. Voltage and frequency on both the normal and emergency sources shall be continuously monitored, with the following pickup, dropout, and trip setting capabilities (values shown as % of nominal unless otherwise specified):

<u>Parameter</u>	<u>Sources</u>	<u>Dropout / Trip</u>	<u>Pickup / Reset</u>
Undervoltage	N&E, 3 ϕ	70 to 98%	85 to 100%
Overvoltage	N&E, 3 ϕ	102 to 115%	2% below trip
Underfrequency	N&E	85 to 98%	90 to 100%
Overfrequency	N&E	102 to 110%	2% below trip
Voltage unbalance	N&E	5 to 20%	1% below dropout

- B. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.
- C. The controller shall be capable (when activated by the keypad or through the serial port) of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).
- D. Source status screens shall be provided for both normal & emergency to provide digital readout of voltage on all 3 phases, frequency, and phase rotation.

2.10 AUTOMATIC AND USER SUPERVISED NON-AUTOMATIC CONTROL

- A. Open, Closed, and Delayed Transition Switching Solutions shall provide complete automatic control of the transfer switch. Transfer Switches shall be constructed as Metal-Clad Switchgear, they shall also include full function Non-Automatic Control to permit safe, electrically interlocked user supervised operation.
- B. A Transfer Switch Automatic-Manual selector switch shall allow the user to place the transfer switch in a fully manual mode of operation. The Normal and Emergency Source Circuit Breakers shall then be operated using the circuit breaker control switches on the front of each circuit breaker compartment. This shall provide electrically interlocked operation to ensure that both circuit breakers cannot be closed simultaneously. Additionally, the Normal or Emergency Source Circuit Breakers may be tripped open by the circuit breaker control switches at any time during Automatic or Manual operation.

2.11 TIME DELAYS

- A. An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals.
- B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.
- C. Two time delay modes (which are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 10 hours. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.

- D. A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.
- E. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:
 - 1. Prior to transfer only.
 - 2. Prior to and after transfer.
 - 3. Normal to emergency only.
 - 4. Emergency to normal only.
 - 5. Normal to emergency and emergency to normal.
 - 6. All transfer conditions or only when both sources are available.
- F. All time delays shall be adjustable in 1 second increments, except the extended parallel time, which shall be adjustable in .01 second increments.
- G. All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the serial communications port.

2.12 ADDITIONAL FEATURES

- A. A three position momentary-type test switch shall be provided for the test / automatic / reset modes. The test position will simulate a normal source failure. The reset position shall bypass the time delays on either transfer to emergency or retransfer to normal.
- B. A SPDT contact, rated 5 amps at 30 VDC, shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.
- C. Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact closed, when the ATS is connected to the emergency source.
- D. LED indicating lights (16 mm industrial grade, type 12) shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).
- E. LED indicating lights (16 mm industrial grade, type 12) shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and emergency sources, as determined by the voltage sensing trip and reset settings for each source.
- F. System Status - The controller LCD display shall include a "System Status" screen which shall be readily accessible from any point in the menu by depressing the "ESC" key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position. For example,
 - 1. Normal Failed
 - 2. Load on Normal
 - 3. TD Normal to Emerg
 - 4. 2min15s

- G. Communications Interface – The controller shall be capable of interfacing, through an optional serial communication module, with a network of transfer switches, locally (up to 4000 ft.) or remotely through modem serial communications. Standard software specific for transfer switch applications shall be available by the transfer switch manufacturer. This software shall allow for the monitoring, control and setup of parameters.
- H. Communications Module - A full duplex RS485 interface shall be installed in the ATS controller to enable serial communications. The serial communications shall be capable of a direct connect or multi-drop configured network. This module shall allow for the seamless integration of existing or new communication transfer devices.

2.13 POWER MANAGER

- A. The MV.ATS shall be provided with power manager function to permit communication with the Electric Power Monitoring System.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install the automatic transfer switch as shown on the drawings and as per manufacturer's instructions and as required for a neat workmanlike and fully operational system.

3.2 Provide the following in conjunction with each and every automatic transfer switch:

- A. 2# 12-1/2"C form engine start contact on transfer switch to emergency generator control panel.
- B. Wiring as necessary from transfer switch to remote annunciator panels and engine control panel for transfer switch position indicator lights.
- C. Provide wiring for ATS status (on normal or on emergency) to power monitoring system.

3.3 FACTORY ACCEPTANCE TESTING

- A. The complete MV.ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.
- B. The MV.ATS manufacturer shall be certified to ISO 9001: 2008 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation, and servicing in accordance with ISO 9001.
- C. Manufacturer is to submit the factory test procedures to the CA for approval one month prior to performing any tests.
- D. All factory testing is to be witnessed by the CA

3.4 SITE ACCEPTANCE TESTING

- A. Startup and testing of the MV.ATS is to be performed by a factory certified representative and witnessed by the CA, as specified, and shall include, but no limited to, the following:

1. Verify MV/BP-ATS is clean of all debris and all connections have been torque
2. Perform and record the contact resistance measurements on the normal, normal bypass, emergency and emergency bypass contacts.
3. All time delay settings associated with the MV/BP-ATS as per manufacturer's startup sheet.
4. Manually operate MV.ATS through all modes, normal, normal bypass, emergency, emergency bypass, disconnected then reconnect. ATS's shall be infrared scanned in all positions with 100% of rated load applied.
5. During the load bank testing of the generator and or UPS systems perform infrared scanning on all power contacts and cable terminations of the transfer switch.
6. Manufacturer to submit their site start up procedures to CA for approval 1 month prior to startup.

3.5 TRAINING

- A. Provide customer with 12 hours of classroom and hands on training on the operation and maintenance of the transfer switches.
- B. Provide all training hand outs and O&M manuals to the customer prior to any training for review.

3.6 SPARE PARTS

- A. Provide customer with the recommended spare parts list with pricing as an option.
- B. Manufacturer's warranty period.

3.7 COMPLIANCE OF ANSI STANDARDS

- A. All tests shall comply with applicable ANSI standards.
 1. Dielectric Test: ANSI C37.20 Para. 5.3.1, latest revision.
 2. Mechanical Test: ANSI C37.20 Para. 5.3.2, latest revision.
 3. Grounding of Instrument Transformer Case Test: ANSI C37.20 Para. 5.3.3, latest revision.
 4. Electrical Operation & Control Wiring Test: ANSI C37.20 Para. 5.3.3, latest revision.
 5. Polarity Test: ANSI C37.20 Para. 5.3.4.3, latest revision.
 6. Sequence Test: ANSI C37.20 Para. 5.3.4.4, latest revision.

3.8 SERVICE REPRESENTATION

- A. The ATS manufacturer shall maintain a national service organization of company-employed personnel located throughout the contiguous United States. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.
- B. The manufacturer shall maintain records of each switch, by serial number, for a minimum of 20 years.

END OF SECTION

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SECTION 263628

13.2 KV OUTDOOR RESISTIVE LOAD BANK

PART 1 - GENERAL

1.1 SCOPE

- A. This specification contains the minimum requirements for the design, manufacture and testing of a direct connect, medium voltage, air-cooled, outdoor resistive load bank.
- B. The load bank is required for periodic exercising and testing of the (standby) emergency power source. The load bank shall be permanently mounted outdoors in a weather resistant enclosure. Unit shall be forced air cooled. The control panel will be remotely mounted.
- C. This specification shall apply if the load bank is supplied to the purchaser, or as a part of other equipment.
- D. Should the vendor take exception to any part of this specification, it shall be stated in the bid, and referenced to the specification line number.

1.2 SUBMITTALS

- A. The manufacturer shall submit for review technical data including features, performance, electrical characteristics, physical characteristics, ratings, accessories, and finishes.
- B. Shop drawings shall include dimensional plans, front and side elevations and mounting details sufficient to properly install the load bank. Load bus configuration and load connections termination area shall be clearly identified.
- C. Electrical schematic drawings shall be provided to detail the operation of the load bank and the provided safety circuits. Over-current protection and control devices shall be identified and their ratings marked. A system interconnection drawing shall be included for control wiring related to the load bank.

1.3 STANDARDS

- A. The equipment covered by this specification shall be designed with the latest applicable NEMA, NEC, and ANSI standards.
- B. The load bank shall be manufactured using UL Listed components as available.

PART 2 - PRODUCTS

2.1 RATINGS

- A. The total capacity of the load bank shall be rated 4000 KW at 13.2 kV, 3-Phase, 3-Wire, 60 Hertz, 175 Amps per Phase at unity Power Factor and 500 KW minimum load step resolution.
- B. The load bank shall be designed for continuous duty cycle operation with no limitations. The load bank shall operate in an ambient temperature of -28°C to 49°C (-20°F to 120°F).

- C. To avoid any transformation of voltage, load bank shall be designed as a true medium voltage direct connect unit. The use of a medium voltage step down power transformer and low voltage load bank shall not be permitted.

2.2 MATERIAL AND CONSTRUCTION

- A. The load bank shall be outdoor construction, suitable for installation on a concrete pad or structural base. All exterior fasteners shall be stainless steel.
- B. The load bank shall be provided with field installable frame extension legs. The extensions shall be required to allow unobstructed air intake.
- C. The load bank frame shall be fabricated from formed and welded steel, making a rigid, drip-proof structure. The frame shall be primed on the inside and out with catalyzed epoxy primer and catalyst. Finish shall be two coats of ANSI 61 Gray urethane, Polane S. Total dry film thickness to be 4.8-6.2 milage less spatter top coat if applied.
- D. The main medium voltage input load bus and medium voltage vacuum load contactors shall be located within a dedicated local load bank enclosure. Medium voltage load input bus shall be either external power bushings or internal bus bars (customer defined).
- E. An integral low voltage enclosure shall be provided to house control devices, fuses, blower starter/control relays and safety circuits. A thermostatically controlled heater shall be located within the control section to provide protection to the control devices from the effects of moisture and condensation.
- F. Airflow through the load bank resistor section shall be vertical. Ambient intake cooling air shall be drawn in at the base of the unit and heated air exhausted out the top. Intake openings shall be designed to prevent objects greater than 0.50" diameter from entering the unit.
- G. The load bank exhaust hood(s) shall be angled and include interior baffle plates to direct falling rain from the interior of the load bank. The exhaust hood(s) shall be constructed from corrosion resistant aluminum with stainless steel exhaust screens.
- H. Load elements shall be contained in multiple resistor cases or trays. Each can be removed in its entirety as a unit for inspection or service.

2.3 RESISTIVE LOAD ELEMENTS

- A. Load elements shall be Avtron Helidyne™, helically wound chromium alloy rated to operate at approximately ½ of maximum continuous rating of wire. Elements must be fully supported across the entire length within the air stream by segmented ceramic insulators on stainless steel rods. Element supports shall be designed to prevent a short circuit to adjacent elements or to ground.
- B. The change in resistance due to temperature shall be minimized by maintaining conservative watt densities.
- C. The overall tolerance of the load bank shall be -0% to +5% KW at rated voltage. A -5%, +5% rating allows the load bank to deliver less than rated KW and shall not be used. The load bank must deliver full rated KW at rated voltage.

2.4 COOLING

- A. The load bank shall be cooled by integral TEFC or TEAO motor(s) which are direct coupled to the cooling fan blade. The fan motor must be electrically protected against overload using a motor overload device and short circuit protected using three (3) current limiting fuses with an interrupting rating of 200K A.I.C.
- B. The fan blade is to be an airfoil design constructed from aluminum or non-corroding material.
- C. Provide external supply 480 volt, 3 phase or 208 volt, 3 phase (coordinate with manufacturer) to the load banks control and motor starter circuitry for load bank fan power.

2.5 PROTECTIVE DEVICES

- A. A differential pressure switch(s) shall be provided to detect air loss (one for each stack). The switch(s) shall be electrically interlocked with the load application controls to prevent load from being applied if cooling air is not present.
- B. An over-temperature switch shall be provided to sense the load bank exhaust in each vertical resistor case assembly. The switch shall be electrically interlocked with the load application controls to remove load from being applied in the event of an over temperature condition.
- C. The exterior of the load bank shall have appropriate warning/caution statements on access panels.

2.6 CONTROL PANEL

- A. The control panel shall be a remote 19" rack mounted panel housed in a NEMA 4 type wall mount enclosure. The control panel shall contain the following manual controls:
 - 1. Power ON/OFF switch
 - 2. Blower START/STOP pushbuttons.
 - 3. Master load ON/OFF switch.
 - 4. Load step switches for ON/OFF application of individual load steps.

Control panel visual indicators shall be as follows:

- 1. Power ON indication light.
 - 2. Blower ON light.
 - 3. Blower/Air FAILURE light.
 - 4. OVERTEMPERATURE light.
- B. A standard remote load dump circuit shall be provided as part of the load bank control circuit. Provisions shall be provided to remove the load bank off-line from the operation of a remote normally closed set of auxiliary contacts from a transfer switch or other device. In the event of the remote contact opening, all load is removed.

2.7 DOCUMENTATION

- A. Installation and operation manuals shall be provided with the equipment and shall include complete details for the installation, commissioning, operation, and maintenance of the load bank.
- B. The manuals shall include the electrical schematic and interconnect drawings for the power and control wiring for the load bank and all control devices.

- C. A complete parts list with part numbers, device identification, and rating shall be included in the manuals. The original manufacturers name and part number shall be included in the parts listing.
- D. Two (2) sets of manuals shall be provided with the load bank. 8/2011-Rev A (K922A)

PART 3 - EXECUTION

3.1 QUALITY CONTROL

- A. The load bank shall be fully tested using a test specification written by the supplier. Tests shall include electrical functional testing, verifying conformance to assembly drawings and specifications. Each load step shall be cold resistance checked to verify proper calibration of resistive load steps and proper ohmic value.
- B. The manufacturer shall maintain this data on file for inspection purposes by the purchaser. Tests using high potential equipment shall be performed to ensure isolation of the load circuits from the control circuits and to determine isolation of the load circuits from the load bank frame. Tests of all safety circuits shall be performed to verify conformance to the specification
- C. All electrical circuits shall have a high potential insulation resistance test performed at twice rated voltage plus 1000 VAC to assure insulation integrity.
- D. All quality control test equipment shall be regularly maintained and calibrated to traceable national standards.
- E. The Company's Quality System shall be ISO9001 Certified.

3.2 QUALIFICATIONS OF MANUFACTURER

- A. The load bank shall be manufactured by a firm regularly engaged in the manufacture of load banks and who can demonstrate at least twenty five (25) years' experience with at least twenty five (25) installations of load banks similar or equal to the ones specified herein.
- B. The manufacturer shall have a written Quality Control procedure available for review by the purchaser, which will document all phases of operations, engineering, and manufacturing.
- C. Manufacturer must have a field service organization with service personnel having a minimum of an Associate Degree in Electrical Engineering.
- D. The load bank shall be a model K922A as manufactured by:

Avtron Loadbank, Inc. 6255 Halle Drive © Cleveland, Ohio 44125
Phone 216-573-7600 © Fax 216-573-5953
Email: LBsales@Emerson.com © Website: www.avtronloadbank.com

END OF SECTION

SECTION 264000

FIRE ALARM LIFE-SAFETY SYSTEM

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Work under this Section shall be governed by the Contract Documents. Provide materials, labor, equipment and services necessary to furnish, deliver and install all work of this Section as shown on the Contract Drawings and as specified herein.
- B. A Fire Alarm System shall be provided for the Transformer Building with all required components, including a Smoke Control Panel and Data Gathering Panels (DGP), all located as shown on the Drawings.

The Control Panel and Data Gathering Panels shall be connected to the existing Javits Convention Center Fire Command Station, which it should be upgraded to include all required points and controls of the Transformer Building fire alarm components.

- C. All required upgrading work of the existing fire command station, including reprogramming, shall be part of this Contract.
- D. All components shall match the existing equipment with required upgrades.
- E. The Transformer building fire alarm system shall be a standalone system, including smoke control panel and also connected to the existing building Fire Command Station. The existing building Fire Command Station shall be modified to include monitoring and control, including smoke control of the entire transformer building devices. Provisions should be made to existing Building Fire Command Station to include monitoring and control of the new North Javits building to be built under a separate contract.

1.2 SUMMARY

- A. Section Includes:
 - 1. This specification describes an addressable Fire Detection and alarm signaling system. The control panel shall be intelligent device addressable, analog detecting, low voltage and modular, with digital communication techniques, in full compliance with all applicable codes and standards. The features and capacities described in this specification are required as a minimum for this project and shall be furnished by the successful contractor.
 - 2. The system shall be in full compliance with National and Local Codes.
 - 3. The system shall include all required hardware, raceways, interconnecting wiring and software to accomplish the requirements of this specification and the contract drawings, whether or not specifically itemized herein.
 - 4. All equipment furnished shall be new and the latest state-of-the-art products of a single manufacturer, engaged in the manufacturing and sale of analog fire detection devices for over 20 years.
 - 5. The system as specified shall be supplied, installed, tested and approved by the local Authority Having Jurisdiction, and turned over to the owner in an operational condition.
 - 6. In the interest of job coordination and responsibilities, the installing contractor shall contract with a single supplier for fire alarm equipment, engineering, programming, inspection and tests, and shall be capable of providing a "UL Listing Certificate" for the complete system.

7. The system specified shall be that of Siemens Fire Safety, or approved equal, which meets the project requirements. All systems approved shall meet the requirements spelled out in this specification.
8. Must integrate into the currently installed Siemens System.
9. Must integrate with an Auxiliary Radio Communication system.

1.3 STANDARDS AND CODES

- A. All equipment shall be U.L. listed and conform to the latest U.L. standards:
 1. Control equipment - U.L. std. 864, meeting the requirements of NFPA 72.
 2. Smoke detectors - U.L. std. 268.
 3. Heat detectors – U.L. std. 521.
 4. Audible alarm signals - U.L. std. 1480.
 5. Security Standard - U.L. std. 1076.
 6. All equipment shall be U.L. listed under UOJZ as an interrelated assembly by a single manufacturer.
 7. Two-Way Radio Emergency Communication Enhancement Systems.
- B. The installation shall comply with:
 1. The latest provisions of and amendments to Local Law No. 5, Local Law No. 16 and Local Law No. 58 of the City of New York.
 2. The requirements of the City of New York Building Department and the City of New York Fire Department.
 3. New York City Electrical Code, latest edition.

1.4 SUBMITTALS

- A. Contractor shall submit complete shop drawings for the Fire Alarm Life Safety System, including:
 1. Fire Alarm Equipment approved for the purpose by the Board of Standards and Appeals of the City of New York.
 2. Wiring diagrams prepared specifically for this project showing the location of all devices and equipment.
 3. Electrical connection diagrams for all devices and equipment including power requirements.
 4. Manufacturer's catalog sheets for all devices and equipment being furnished.
 5. Samples of peripheral devices as requested by the Architect/Engineer.
- B. Substitutions of products said to be of equal quality and performance to those specified herein will be considered only when the following requirements have been met:
 1. A complete list of such substituted products complete with supporting literature has been submitted to the Architect/Engineer for approval.
 2. The base bid must include an amount for the equipment as specified herein and must also include a separate add or deduct for substituted equipment.
 3. The contractor shall furnish satisfactory manufacturer's proof that the substituted products are, in fact, equal in quality and performance to those specified herein. Proof required shall include, but shall not be limited to, the City of New York Fire Alarm Equipment Approval number.
 4. The contractor shall furnish proof that the manufacturer of substituted equipment has been engaged in the manufacture of this type of equipment, has similar type systems installed and operating in New York City and maintains a fully stocked service facility employing factory trained technicians within fifty (50) miles of the installation.
 5. The contractor shall state specifically what, if any, specific points of operation differ from that herein specified and shall be responsible for remedying any deficiencies in system operation uncovered during final inspection.

6. Approval of any substitutions must be obtained from the Architect/Engineer prior to any commitments by the contractor to a vendor. However, approval of substitutions shall only be construed to mean that installation may proceed. The contractor shall remain liable for replacement of substituted equipment that does not comply, at the time of final acceptance test, with the operational specifications detailed herein or does not meet the requirements of the authority having jurisdiction.
- C. Within thirty (30) days of award of contract, contractor shall provide a schedule of all submittals employing the format as provided hereinafter and enumerating all drawings, samples and miscellaneous submittals by name, quantity, etc.

1.5 ACCEPTABLE MANUFACTURERS

- A. All equipment provided as part of this section shall be the product of a single fire alarm equipment manufacturer.
- B. To indicate the level of quality, system performance and operating features required, the model numbers of equipment manufactured by Simplex are referenced in this specification.
- C. Acceptable Manufacturers:
 1. Siemens Cerberus
 2. SimplexGrinnell
 3. Edwards

1.6 SYSTEM DESCRIPTION

Note: System description classification and code designation shall be in accordance with FDNY system classification and code designation.

- A. FireFinder XLSV System - The system shall be a complete, electrically supervised fire detection and notification system, with a microprocessor based operating system having the following capabilities, features, and capacities:
 1. Support of mobile test system capable of providing point test reports in NFPA standard format without manual report entries.
 2. The control panel shall allow control and monitoring from a wireless handheld display device during maintenance, inspection and troubleshooting tasks
 - a. The control panel shall allow complete control and monitoring from a wireless handheld display device during one-man testing of the system
 - b. Testing supported should be real smoke testing of devices, automatically logged and made available in NFPA format reports. Manual test entries will not be accepted.
 3. System shall provide an output port for monitoring purposes by external systems. Communications to an external system shall be RS-232 or RS-485 communications.
 4. A single node or system shall support at least 50 remote transponders
 5. At least 64 nodes shall be networkable.
 6. Communications between network nodes, each supporting an interactive, self-standing, intelligent local control panel, with system wide display. Any network node shall be capable of supporting a local system in excess of 4000 input/output points.
 7. The local system shall provide status indicators and control switches for all of the following functions:
 - a. Audible and visual notification alarm circuit zone control.
 - b. Status indicators for sprinkler system water-flow and valve supervisory devices.

- c. Any additional status or control functions as indicated on the drawings, including but not limited to: emergency generator functions, fire pump functions, door unlocking and security with bypass capabilities.
 8. Each intelligent addressable device or conventional zone on the system shall be displayed at the Central Alarm Receiving Terminal and the local fire alarm control panel by a unique alphanumeric label identifying its location.
 9. The FireFinder XLSV network shall have the ability to identify 4 levels of alarm for each of the 15 sectors of VFT-15 when used for Rack Level monitoring.
- B. FireFinder XLSV with Digital Voice Evacuation - The system shall be complete, electrically supervised fire detection and evacuation system using one way communication and firefighters' telephone and smoke control systems with microprocessor-based operating system having the following capabilities, features and capacities:
1. Voice amplification shall be supervised and backed up with like amplifiers. Back up shall be one for one. Backup amplifiers shall not share components and must be fully stand-alone.
 2. Amplifiers shall be rated for 25V or 70.7V RMS, and 40 or 180 watts.
 3. Amplifiers shall be sized as minimum, to accommodate speakers in corridors at 2 watts and other locations 1 watt.
 4. There shall be a separate booster amplifier. Amplifiers shall be rated for 25V or 70.7V RMS, 100 watts. The system shall have the capability to support Peer-to-Peer or Master-Slave network and voice configurations.
 5. Multiple nodes shall provide peer-to-peer voice capability in order to eliminate a single point of failure.
 6. Audio shall be synchronized between nodes in order to take into account common areas.
 7. The network, audio, and telephone risers between nodes shall be copper and support Class A loop configuration to allow communication to continue in the event of a fault.
 8. Speakers shall have the ability to play coded audio tones.
 9. The system shall provide status indicators and control switches for all of the following functions:
 - a. Firefighters' override functions controlling smoke management.
 - b. Audible and visual notification alarm circuit zone control.
 - c. Two-way firefighters' telephone communications circuit zone control.
 - d. Speaker circuit zone control.
 - e. Status indicators for sprinkler system water flow and valve supervisory devices.
 - f. Any additional status or control functions as indicated on the drawings, including but not limited to: emergency generator functions, fire pump functions, door unlocking and security with bypass capabilities.
- C. FireFinder XLSV Networked to Siemens Management Station, or equal - The system shall have to connect to the currently installed Siemens Management Station. A Siemens Management Station shall be a PC based, display and software package UL listed for this application. The Siemens Management Station shall have as a minimum, the following:
1. Intuitive graphical user interface.
 2. Global and local command abilities.
 3. Time-based control for entire system.
 4. SVGA graphics support.
 5. Built-in graphics editor.
 6. Event display by color and icon.
 7. Full touch screen support.
 8. Multi-level passwords.
 9. The system shall have the ability for multiple command centers with full control of the fire detection. (ALL)
 10. Integration with building automation Management Station

11. Integration with security system (ALL)
 12. Intergration into the Smoke Purge Panel
 13. Damper positioning from Fire Alarm System to Siemens BMS.
- D. FireFinder XLSV network compatibility with MXL feature(s) – FireFinder XLS system shall have the ability to be networked to MXL and MXL-IQ systems for purposes of annunciation and control.
- E. FireFinder XLSV shall have the ability to interface with existing MXL addressable devices. Replacement of existing field devices shall be unnecessary for proper system operation.
- F. FireFinder XLSV components shall have the ability to be mounted in MME-3, MME-3R, MLE-6, MLE-6R, MSE-2, MSE-2R or MBR-2 enclosures. Replacement of existing back boxes shall be unnecessary.

1.7 SYSTEM OPERATION

Note: Alarm operation shall be in accordance with NYC BC 907.5.2.2.

- A. General Performance: Comply with NFPA 72 and all contract documents and specification requirements.
- B. All interconnections between this system and the monitoring system shall be arranged so that the entire system can be UL-Certificated.
- C. System shall be a complete, supervised, non-coded, addressable multiplex fire alarm system conforming to NFPA 72.
- D. The system shall have Style 7 circuits for each floor. The system shall operate in the alarm mode upon actuation of any alarm initiating device. The system shall remain in the alarm mode until all initiating device(s) are reset and the fire alarm control panel is manually reset and restored to normal.
- E. The system shall provide the following functions and operating features:
1. The FACP and auxiliary power panels shall provide power, annunciation, supervision and control for the system.
 2. Provide Class A initiating device circuits.
 3. Provide Style 7 signaling line circuits for the network.
 4. Provide integrated fire and smoke management with firefighter's override functions.
 5. Provide Class B notification appliance circuits. Arrange circuits to allow individual, selective, and all-call voice and visual notification by zone. Notification Appliance circuits shall be zoned to correspond with the building fire barriers and other building features.
 6. Stair-towers: Each Stair-tower NAC shall be separately zoned
 7. Strobes shall be synchronized throughout the entire building.
 8. If a voice evacuation system is specified, the system amplifiers shall be configured as distributed, bulk, or a combination of distributed and bulk audio. If necessary, convenience paging and/or background music shall be available via UL-listed speakers. .
 9. Provide 8 channel for live and recorded voice messaging.
 10. Provide electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control panel.
- F. The system shall provide a field test function where one person can test the complete system or a specific area while maintaining full operational function of other areas not being tested. Alarms, supervisory signals and trouble signals shall be logged on the system printer and in system history during the walktest.

- G. Alarm functions shall override trouble or supervisory functions. Supervisory functions shall override trouble functions.
- H. Fire alarm signal initiation shall be by one or more of the following devices:
 - 1. Manual pull station
 - 2. Heat detector
 - 3. FirePrint® Addressable area smoke detector
 - 4. NEW Line of detectors including ASA line
 - 5. Duct smoke detector
 - 6. Automatic sprinkler system water flow switch
- I. Activation of any system fire, security, supervisory, trouble, or status initiating device shall cause the following actions and indications at all network Person Machine Interfaces using basic graphics and multiple detail screens.
 - 1. Fire Alarm Condition:
 - a. Sound an audible alarm and display a custom screen/message defining the building in alarm and the specific alarm point initiating the alarm in a graphic display.
 - b. Log into the system history archives all activity pertaining to the alarm condition.
 - c. Print alarm condition on system printer.
 - d. Sound the ANSI 117-1 signal with synchronized audible and synchronized strobes throughout the facility.
 - e. Audible signals shall be silenced from the fire alarm control panel by an alarm silence switch. Visual signals shall be programmable to flash until system reset or alarm silencing, as required.
 - f. A signal dedicated to sprinkler system water flow alarm shall not be silenced while the sprinkler system is flowing at a rate of flow equal to a single head.
 - g. Activation of any smoke detector in a single elevator lobby or an elevator equipment room shall, in addition to the actions described, cause the recall of that bank of elevators to the main exit discharge and the lockout of controls. In the event of recall initiation by a detector in the main extinguishing discharge lobby, the recall shall be to the alternate floor as determined by the AHJ.
 - h. Where indicated on drawings, heat detectors in elevator shaft and machine rooms shall activate an elevator power shunt trip breaker. The heat detectors shall be rated at a temperature below the ratings of the sprinkler heads in respective locations to insure that the power shall be shut off before activation of sprinkler system.
 - i. System operated duct detectors as per local requirements shall accomplish HVAC shut down.
 - j. Door closure devices shall operate by fire barrier area, by floor, by local requirements or by local requirements.
 - k. Send the event information to the Management Station with the device type and custom message.
 - 2. Additional system operation for Fire Alarm Condition for Voice:
 - a. Sound an pre-announce tone followed by a field programmable digitized custom evacuation message, on the floor of alarm, the floor below and the floor above. The visual signals shall operate in a similar pattern.
 - b. A simultaneous message shall be delivered via all alarm speakers installed on the remaining floors indicating the requirement for occupants of these floors to remain alert for further instructions.
 - c. A simultaneous message shall be delivered via all alarm speakers installed in stairways and elevators informing occupants of the imminent shutdown of elevator circuits and the expected high traffic load in the stairwells.

- d. An automatic announcement or tone evacuation signal shall be capable of interruption by the operation of the system microphone to give voice evacuation instructions overriding the pre-programmed sequences.
 - e. Status lights next to speaker selection switches on the control panel shall indicate speaker circuit selection.
 - f. Audible signals shall be silenced from the fire alarm control panel by an alarm silence switch. Visual signals shall be programmed to flash until system reset or alarm silencing, as required by the AHJ.
3. Supervisory Condition:
- a. Display the origin of the supervisory condition report at the local fire alarm control panel graphic LCD display.
 - b. Activate supervisory audible and dedicated visual signal.
 - c. Audible signals shall be silenced from the control panel by the supervisory acknowledge switch.
 - d. Record within system history the initiating device and time of occurrence of the event.
 - e. Print supervisory condition to system printer.
 - f. Send the event information to the Management Station with the device type and custom message.
4. Trouble Condition
- a. Display at the local fire alarm control panel graphic LCD display, the origin of the trouble condition report.
 - b. Activate trouble audible and visual signals at the control panel and as indicated on the drawings.
 - c. Audible signals shall be silenced from the fire alarm control panel by a trouble acknowledge switch.
 - d. Trouble conditions that have been restored to normal shall be automatically removed from the trouble display queue and not require operator intervention. This feature shall be software selectable and shall not preclude the logging of trouble events to the historical file.
 - e. Trouble reports for primary system power failure to the master control shall be automatically delayed for a period of time equal to 25% of the system standby battery capacity to eliminate spurious reports as a result of power fluctuations.
 - f. Record within system history: the occurrence of the event, the time of occurrence and the device initiating the event.
 - g. Print trouble condition to system printer.
 - h. Send the event information to the Management Station the device type and custom message.
- J. Smoke Control Strategies
1. General
- a. The Fire Alarm System shall be capable of incorporating mechanical equipment (point) commands and associated control functions for individual building Smoke Control System configurations into distinct groupings referred to as Smoke Control Strategies.
 - b. Each separate smoke zone shall have a corresponding Smoke Control Strategy which is activated upon the need to implement smoke control in response to a fire or smoke alarm originating in the respective zone.
 - c. The specific equipment commands and control functions which comprise each individual Smoke Control Strategy shall be as listed herein.
 - d. Air handling systems shall be automatically controlled from the fire alarm system control relays, as previously described.

- e. The Fire Command Station (FCS) provided by the Fire Alarm contractor shall be supplied with manual switches to provide manual purge control of each floor/zone. Operation of the "Purge Enable" keyswitch at the FCS and the "floor/zone purge" switch for a floor/zone shall start all return/exhaust fans and position all required dampers so that 100% of return air from the selected floor/zone shall be exhausted to the outside during the alarm condition.
 - f. The Fire Command Station (FCS) provided by the Fire Alarm contractor shall be supplied with visual LED indicators to provide on/off status indication of each air handling system return fan or exhaust fan used for smoke purge and open/closed status indication of smoke dampers.
 - g. The Fire Command Station (FCS) provided by Fire Alarm contractor shall be supplied with a manual switch to provide manual pressurization control for all floors/zones other than the floor/zone being exhausted. The pressurization control shall supply air to all floors/zones other than the floor of alarm when activated in conjunction with the "floor/zone purge" switch. A visual LED indicator to provide on/off status indication of the pressurization function shall be provided as part of the Smoke Purge Fan and Damper Control Panel.
 - h. All Smoke Control Strategies except shutdown shall be capable of only manual activation.
 - i. Individual pieces of equipment of a Smoke Control Strategy shall be activated in the sequence necessary to control the fans, dampers and other building equipment as noted in NFPA 92A and New York City Building Code.
 - j. Manual activation of Smoke Control Strategies at the Fire Alarm System shall be subject to the following conditions:
 - 1) Manual activation of a Smoke Control Strategy shall occur regardless of whether or not activation of a Smoke Control Strategy has already occurred previously by either automatic or (fan/damper shutdown only) manual means.
 - 2) The equipment commands and control functions resulting from previously activated Smoke Control Strategies shall be overridden as needed so that all equipment commands and control functions of the last activated Smoke Control Strategy will be in effect.
2. Smoke Strategies – Specific
- a. Refer to [Section 23 09 23] [Division 23] for sequence of operation to be followed for each system. Sequence of Operation to be implemented by the Fire Alarm System.
3. All smoke control strategies operational instructions shall be printed and kept at the Fire Command Station.

PART 2 - PRODUCTS

2.1 FIRE COMMAND STATION (FCS)

- A. The fire alarm control panel shall be microprocessor-based using multiple microprocessors throughout the system, providing rapid processing of smoke detector and other initiation device information to control system output functions.
- B. There shall be a watchdog circuit, which shall verify the system processors and the software program. Problems with either the processors or the system program the panel shall activate a trouble signal and reset the panel.
- C. The system modules shall communicate with an RS 485 network communications protocol. All module wiring shall be to terminal blocks, which will plug into the system card cage. The control panel shall be capable of expansion via up to 100 SLC's. Maximum system capacity shall be at least 2500 intelligent initiation devices per panel.

- D. The system shall be capable of supporting unshielded wiring applications.
- E. System Components:
1. The Device Loop Card (DLC) loop shall be capable of 252 intelligent devices distributed between two SLC circuits. Any trouble on one circuit shall not affect the other circuit. This module controls the signaling from the initiation devices reporting alarms and troubles to the control panel. Card shall not limit the address selection for sensors and input/output devices. This module shall also provide the signaling to the field devices for the controlling the output of specific initiation devices. The on board microprocessor provides the DLC with the ability to function even if the main microprocessor fails. LEDs on the board shall provide annunciation for the following: Power, Card Failure, Network Failure, Gnd. Fault, Alarm, Trouble, Short Zone 1, Short Zone 2, Style 6 Open Zone 1, and Style 6 Open Zone 2. This card shall plug into the system card cage. The card shall be model number DLC. [***circuit shall be capable of either input or output devices on any address without limitations. You can split the SLC in any ration while maintaining short circuit isolation between the two legs of the circuit***]
 2. The MXL Line Card (MLC) MLC for FireFinder XLS shall supply two SLC circuits utilizing Siemens "I" series, "IL" series, or "FP" series type intelligent addressable devices. Each MLC circuit shall support 0 to 60 addressable devices. Any trouble on one circuit shall not affect the other circuit. This module controls the signaling from the initiation devices reporting alarms and troubles to the control panel. This module shall also provide the signaling to the field devices for controlling the output of specific initiation devices. The on board microprocessor provides the MLC with the ability to function even if the microprocessor fails. Each circuit shall have the ability to be wired in either a Class B or Class A configuration. When using Class B, T-tapping shall be permitted with no loss of supervision.
 3. The Signal Line Circuits (SLC) shall be tested for opens, shorts and communications with all addressable devices installed before connection to the control panel. Systems without this capability shall have a test panel installed for initial testing to eliminate any possible damage, short term or long term, to the control panel. After initial testing replace the test panel and proceed with complete testing.
 4. The Person Machine Interface (PMI-2) shall provide the system information on ¼ VGA Color LCD, with Touch Screen and LED display. Color is event specific based on regulatory requirements alarms-red, Supervisory-blue, security-magenta, trouble yellow Graphic user interface shall be menu driven with four (4) tabs showing the level and the total events for each tab. The tabs shall be: Alarm, Supervisory, Trouble and Security. At least five (5) events shall be shown simultaneously with two full lines of text message for each event. Each event shall have a 32 character custom message describing the event's location. In addition, the time stamp and category of the event (i.e. Smoke, Water flow, Manual, etc.) shall be displayed. When configured for Canadian operation, nine (9) events shall be displayed simultaneously. The LED displays shall indicate Power, Audibles On or Silenced, and Partial System Disabled. Systems not having the above LEDs shall provide separate LEDs within the control panel enclosure with appropriate labels. Selection buttons shall be backlit to aid the operator in the selection process. There shall be controls for scrolling throughout the event list. A button shall provide zoom in and zoom out control for the amount of information desired for a specific entry. The PMI shall be capable of monitoring the power supply loading and show available capacity for future expansion planning. The PMI shall provide a "More Info" button that can display addition device information such as the device type and device address. This More Info button shall also have the ability to display a detailed screen that provides the following:
 - a. 200 character custom message associated with the group of the device and physical location in the building to alert personnel
 - b. NFPA symbols representing fire service equipment in the area
 - c. NFPA symbols representing hazards in the area
 - d. NFPA symbols representing people in the area

- e. Number of devices in the associated group that are in alarm
 - f. Name and phone number of emergency contact
5. The PMI-2 shall also have the ability to display a bitmap of a floor plan showing a “You are Here” symbol to tell the responding person exactly where they are in the building in relation to the event. Systems without this type of display shall supply a UL listed Graphics package with their system. The LCD shall have a keyboard screen to allow the technician ability to enter test and numbers for passwords or text changes. The PMI shall also have a Context Sensitive Help button. A globally configured PMI shall have the ability to view events, acknowledge, silence and reset networked FireFinder XLS and MXL systems. A globally configured PMI shall also have the ability to arm and disarm input and output points on FireFinder XLSs and MXLs. A globally configured PMI shall have the ability to be configured for control of the entire network, control of the local FireFinder XLS, or annunciation only. In a networked configuration, the Partial System Disable LED shall be indicative of all networked FireFinder XLSs. A globally configured PMI in a networked configuration shall have the ability to store 6 maps for every FireFinder XLS panel. At least 10 globally configured PMIs shall be supported in a network. The module shall be model number PMI.
 6. The PMI International (International Version) shall provide Spanish, Portuguese or Canadian overlays. The PMI shall have the ability to be configured display text in Spanish, Portuguese, Hebrew or French while having the ability to swap in English text at anytime by a simple button press at the panel. Printers shall also have the ability to be configured for Spanish, Portuguese or French.
 7. The Network Interface Card (NIC-C) shall provide either intranode (HNET) communication or internode (XNET) communication between enclosures. HNET and XNET communication shall support Class B Style 4 or Class A Style 7 wiring. NIC-C shall have the ability to be configured as an electrical repeater in order to increase communication distances. In addition, the NIC-C shall support CAN network communication. This card shall plug into the system card cage.
 8. The Network Ring Card (NRC2) shall provide the ability to network FireFinder XLS systems in a Class A Style 7 Ring configuration. A single NRC per system (node) shall provide XNET peer-to-peer communication between FireFinder XLS systems allowing a total of 59 FireFinder XLS systems to be networked together. The NRC Card shall reside in the same enclosure as the PMI (Person Machine Interface). The NRC shall supervise the XNET ring network to ensure proper operation. The NRC shall also isolate a short-circuit fault to each individual segment of the XNET network and perform ground fault detection on its outgoing ring port. Any faults that are detected by the NRC shall be reported to the PMI for annunciation. The NRC shall isolate faults only to the individual node in trouble allowing communication on the network ring to continue. The NRC shall act as an electrical repeater for each XNET pair.
 9. The System Status Display (SSD) shall provide a remote LED/LCD display that shows the local status of a FireFinder XLS system. An LED shall illuminate when alarm, supervisory, trouble and security events occur on the system. The SSD shall consist of a LCD display that has four lines of forty characters each that provides details of the event in alphanumeric form. The SSD-C and SSD-C-REM shall have three additional control buttons for acknowledging events, silencing audible circuits, and resetting the system. The SSD-C shall have an integral key switch that enables these control buttons to operate. The SSD-C-REM shall have the ability to be located within a locked cabinet, so no additional key switch is required for enabling the control buttons. The SSD and SSD-C shall be mountable in a 2-gang electrical box or 4-inch square electrical box. The SSD-C-REM shall be mountable in a model REMBOX2 or REMBOX4 Remote Lobby Enclosure. [Remote Display]
 10. The Zone Indicating Card (ZIC-4A) shall contain four (4) NAC circuits rated at 4 amps each with power-limited outputs. The zone inputs for the card shall be isolated and independently supervised. There shall be at least three (3) unique codes/signals for each circuit based on system logic. These signals shall be Temporal Code 3 (Evacuation), Steady (such as “Recall”) and Alert (such as “Tornado Alert”). The card shall be listed for

notification appliances, horns, bells, strobes, and speakers. The card shall also be listed for NFPA 13 Pre-Action Release, FE-227ea and NOVEC1230, Lease Line, and Municipal Tie. The card shall have the ability to wire the circuits Style Y or Style Z with outputs synchronized. The card shall have the following LEDs to provide trouble shooting and annunciation: Power, Card Failure, Network Failure, Gnd. Fault, Zone Activation or Trouble. This card shall plug into the system card cage. The card shall be model number ZIC-4A.

11. The Zone Indicating Card (ZIC-8B) shall contain eight (8) NAC circuits rated at 2 amps each with power-limited outputs. The zone inputs for the card shall be isolated and independently supervised. There shall be at least three (3) unique codes/signals for each circuit based on system logic. These signals shall be Temporal Code 3 (Evacuation), Steady (such as "Recall"), and Alert (such as "Tornado Alert"). The card shall be listed for notification appliances, horns, bells, strobes, and speakers. The card shall have the ability to wire the circuits Class B with outputs synchronized. The card shall have the following LEDs to provide trouble shooting and annunciation: Power, Card Failure, Network Failure, Gnd. Fault, Zone Activation or Trouble. This card shall plug into the system card cage. The card shall be model number ZIC-8B.
12. The Control Relay Card (CRC) shall contain six (6) fully programmable relays each rated at 4A, 30 VDC / 120 VAC resistive and 3.5A, 120 VAC 0.6 PF inductive. The card shall have the following LEDs to provide trouble shooting and annunciation: Power, Card Fail, HNET Fail, Relay 1 Active, Relay 2 Active, Relay 3 Active, Relay 4 Active, Relay 5 Active, and Relay 6 Active. The card shall be model number CRC-6.
13. The system card cage shall provide the mounting of all system cards, field wiring, and panel's inter-card wiring. All power limited field wiring shall connect to the top of the card cage. All non-power limited internal wiring shall be connected to the bottom of the card cage. The card cage shall hold the systems cards and have capability of connecting multiple card cages to meet system demands. All terminal blocks are removable. The card cage shall be model number CC-2 or CC-5.
14. The Supervised Input Module (SIM-16) shall provide sixteen input circuits for remote system monitoring. Each input shall have the ability to be individually programmed as supervised (dry contact only) or unsupervised (general purpose input). The SIM-16 shall provide two programmable Form C relays. The SIM-16 shall be mountable in an enclosure that is remotely located from the main control panel. The SIM-16 shall be capable of supervising inputs 500 feet away.
15. The Output Control Module (OCM-16) shall provide sixteen open collector outputs to drive LEDs, incandescent lamps or external relays. There shall also be an additional output for a local audible and two inputs for momentary lamp test as well as local audible silence switches. The OCM-16 shall be mountable in an enclosure that is remotely located from the main control panel.
16. The Switch Control Module (SCM-8) shall be a supervised module with eight (8) switches and two LEDs per switch for controlling such items as speaker/strobe or telephone circuits. The switches shall also be used as generic inputs into the system. The SCM-8s shall be mounted in the door for easy access. These modules shall be connected to the control area network and have a maximum distance of 1000 ft. The module shall be model number SCM-8.
17. The LED Control Module (LCM-8) shall contain eight (8) groups of two (2) LED's that shall be programmable by Zeus programming software. Eight LED's shall be dual color capable that can be lighted either RED or GREEN flashing or steady. The remaining LEDs shall be Amber color, flashing or steady. A space shall be provided for labeling of LED functions. The label shall slide behind a clear protective membrane. The LCM-8s shall be mounted in the door for easy access. These modules shall be connected to the control area network and have a maximum distance of 1000 ft.
18. The Fan Control Module (FCM-6) shall provide manual control of building HVAC system fans, motors and dampers. Each FCM-6 module shall provide six sets of 3 push button switches for manual system control. Each switch shall have 3 associated LEDs to indicate Fan/Damper/Motor status: with OFF shown by a Red LED, ON shown by a Green

- LED and TROUBLE shown by a Yellow LED. The FCM-6's shall be mounted in the door for easy access. These modules shall be connected to the control area network, and have a maximum distance of 1000 ft.
19. The Live Voice Module (LVM) shall have the supervised Microphone and pre-amplifier. The module shall contain 6 programmable switches. The module shall connect to the control area network, and also connect to the PMI. The module shall have remote capability using a Remote Network Interface (RNI). The module requires a Local Page Board (LPB) to convert the audio to a digital signal. The module shall contain a Local Speaker w/control, Ready to Page LED, and a Pre-Announcement tone LED. The module shall be mounted in the door for easy access and viewing. The module shall be model number LVM.
 20. The Digital Audio Card (DAC) shall provide eight (8) channels of digital audio and control of all voice and telephone functions, including background music or conventional paging. This module communicates with the PMI and to all other audio modules via the control area network. The module also contains an a sync serial interface buss to distribute the audio signals between the zone amplifiers and the Audio Input Card (AIC). The Local Page Board (LPB) shall plug into this card converting the LVM audio to a digital signal. The DAC shall plug in to the system card cage. The card shall be model number DAC-NET.
 21. The Zone Amplifier Card (ZAC-40) shall be a 40-watt amplifier supporting Class A or B speaker zone wiring configurations. The ZAC-40 shall be power limited and be configurable to provide 40 watts of audio at 25, 70.7 or 100 VRMS speakers. The ZAC-40 shall be able to reproduce signals from 200 hertz to 12,000 hertz for improved intelligibility of voice communication. The ZAC-40 shall be capable of amplifying any one of the 8 digital audio channels. The ZAC-40 can be used as a single 40 watt speaker zone or as a bulk amplifier for one or two channel applications feeding high level audio to a Zone Indicating Card.
 22. The Zone Amplifier Module (ZAM-180) shall be a 180-watt amplifier supporting Class A or B speaker zone wiring configurations. The ZAM-180 shall be configurable to provide 150 watts of audio at 25 VRMS, 180 watts of audio at 70 VRMS or 165 watts of audio at 100 VRMS. The ZAM-180 shall be able to reproduce signals from 200 hertz to 12,000 hertz for improved intelligibility of voice communication. The ZAM-180 can be used as a single 180 watt speaker zone or as a bulk amplifier for one or two channel applications, feeding high level audio to a Zone Indicating Card.
 23. The Audio Input Card (AIC) allows up to two (2) external audio sources such as background music or PBX conventional paging or any source such as CD and tape player. There are two relays on the module to control the inputs. The system shall support multiple AIC cards. This card shall plug into the system card cage. The card shall be model number AIC. Output amplifiers and audio zone cards shall perform dynamic supervision, meaning, they can supervise the speaker circuit during operation, meeting UL requirements for the use of fire speakers with background music/paging.
 24. The Audio Level Conversion Card (ALCC) shall provide the capability of conducting a global-emergency page (All Call) over copper across multiple, remote FireFinder XLSV nodes with each audio riser holding a maximum of 63 nodes. The emergency page originates at a FireFinder XLSV or MXLV global-paging station, where it is broadcast at 70VRMS over an audio riser by a ZAC-40 (FireFinder XLSV) or ZAC-30 (MXLV) amplifier. A single, remote FireFinder XLS node containing one ALCC, steps the incoming speaker-level audio down to line-level audio that is compatible with the AIC audio input (0.775VRMS, independently adjustable to $\pm 6\text{dBu}$).
 25. The Audio Level Conversion Card (ALCC) shall provide the ability to output line-level audio messages originating from the FireFinder XLSV system to other compatible 3rd party audio systems for enhanced integration.
 26. The Firefighter's Master Telephone (FMT) shall communicate with the firefighters' telephones in the field. The system shall operate 5 telephones off hook simultaneously without loss of audio quality. The FMT shall have "Warden Page" capability. The FMT shall communicate with the system through the control area network. The FMT shall be

- door mounted for easy access. With the use of FMT-A-ADPT, the phone riser shall be configurable for Class A operation.
27. The Telephone Zone Card (TZC) shall provide 8 Class B telephone circuits. This card shall produce dial tone and busy signals where appropriate. The TZC shall communicate with the FMT through the control area network. This card shall plug into the system card cage. The card shall be model number TZC-8.
 28. The XLS digital Message card (XDMC) shall provide 300-message capacity with 100 minutes of recording time, and enables multi-layered and custom (pinpoint specific) messages. The card supports MP3 and WAV files, and broadcast up to two different messages simultaneously.
- F. System response time from alarm to output shall be an average of three (3) seconds.
- G. To expedite system troubleshooting, the system cards shall have ground fault detection and diagnostic LEDs by card.
- H. All system cards and modules shall have Flash memory for downloading the latest module firmware.
- I. Passwords:
1. Maintenance/Control Password - There shall be a 5 character password that a user must enter into the control panel in order to perform such maintenance- and control-related functions at the panel as:
 - a. Arming and disarming devices.
 - b. Activating, deactivating or modifying detector ASD and sensitivity settings.
 - c. Activating and deactivating the History Log function, and deleting obsolete entries.
 - d. Changing the system time and date.
 2. Function Key Password - There shall be a 5 character password that a user must enter into the control panel in order to access the panel's Function Keys: touch screen buttons which perform custom-programmed system functions.
 3. Reports Password - There shall be a 5 character password that a user must enter into the control panel in order to access the panel's reporting functions.
 4. Walktest Password - There shall be a 5 character password that a user must enter into the control panel in order to access the panel's walk testing functions.
 5. Acknowledge Silence Reset Password - There shall be a 5 character password that a system user must enter into the control panel in order to acknowledge events, turn silenceable audibles and visuals on and off, and perform panel resets.
- J. Networking:
1. Digital communication capabilities supporting Style 4 (Class B) or Style 7 (Class A) communications using either DC digital or fiber optics technologies or combinations of both as required for the control panel to communicate with at least 50 remote transponders.
 2. Digital communication capabilities supporting Style 4 (Class B) or Style 7 (Class A) communications using either DC digital or fiber optics technologies or combinations of both as required for the control panel to communicate with at least 59 network nodes.
 3. Capability shall exist within the system to extend the network at any node. The system shall support a maximum of two network extension circuits in series on any system branch, extending the inherent distance limitations for network communications.
 4. Communication protocol shall be of the CSMA/CD (carrier sense, multiple access, collision detect) type, eliminating delays incorporated into other protocols. Communication techniques using token passing and requiring sensing of delays and re-generation of the token to re-establish network communications in the event of a fault shall not be acceptable.

K. Network Fiber Modules

1. Equal to Siemens model D2300CPS (multimode) and D2325CPS (single mode).
2. The network fiber interface modules shall be used to transmit RS-485 communications between the NCC, MXL and FireFinder XLS intelligent addressable fire alarm control panels. This includes the H-Net communications between FireFinder XLS panels, M-Net communications between MXL panels and X-Net communications between FireFinder XLS, MXL and the Management Station. Each module shall have power, transmit and receive status LEDs. The module can act as a repeater or end-point unit, in a daisy chain or star configuration. It shall be capable of being powered by 24VDC from the FireFinder XLS, MXL or Siemens model PAD-3/4 or PS-35 remote power supply. It can mount in the FireFinder XLS or MXL backbox, or can be mounted in a Siemens MBR-2 or MME-3 remote backbox. It can be located up to 5,000' from the local FACP using 1 pair #18AWG twisted/shielded cable between the fiber interface module and the FACP.
3. The connection between the D2300CPS multimode fiber interface modules shall use 2 high quality duplex 50/125 or 62.5/125 fiber optic cables and ST style fiber connectors. Each segment of the fiber network can be up to 1.9 miles. The fiber module shall have a minimum operating power output budget of -13dB for 62.5/125 cable and -9 dB for 50/125 cable. It shall be possible to connect the fiber interface modules directly to the NCC without the need for additional interface devices or control equipment.

L. Network Fiber Modules with Voice

1. The DFM shall provide a fiber optic interface for the digital audio network between data gathering panels. The DFM shall support Style 4 or Style 7 wiring. The DFM shall use 62.5/125 μ m fiber at distances up to 2KM. The DFM shall have the ability to be mounted in the panel's enclosure.

M. Degrade Mode Alarm Activation:

1. Each data gathering panel shall support the ability to have its corresponding ZIC-4A, ZIC-8B and output devices on a DLC's loop activate when the DLC or CDC-4 is in Degrade Mode (has lost HNET communication with the PMI control panel). For example, if the device loop includes HFP detectors with relay bases and lamps, the relays and lamps will activate upon any system alarm when the DLC is in Degrade Mode.
2. Degrade Mode Alarm Activation with Voice: Each data gathering panel shall support the ability to have its corresponding DAC-NET turn on audio when the DLC or CDC-4 is in Degrade Mode (has lost HNET communication with the PMI control panel).

N. Smoke Control: The FireFinder XLS family of fire alarm panels shall have the ability to be configured as a smoke control station that complies with UL/UUKL (UL 864) and NFPA 92A and ULC/ORD-C100 requirements. The system shall have the capability to monitor and override smoke control systems and equipment provided at designated locations within the same building.

O. Digital Voice Command:

1. The Digital Voice Command Center, located with the FACP, shall contain all equipment required for all global audio control, emergency telephone system control, signaling and supervisory functions. This shall include speaker zone indication and control, telephone circuit indication and control, digital voice units, microphone and main telephone handset.
2. Up to 5 Digital Voice Command Centers shall be supported per system with the ability to limit control to one Digital Voice Command Center via a Request/Grant/Deny mechanism.
3. Function: The Voice Command Center equipment shall perform the following functions:
 - a. Operate as a supervised multi-channel emergency voice communication system.
 - b. Operate as a two-way emergency telephone system control center.
 - c. Audibly and visually annunciate the active or trouble condition of every speaker circuit and emergency telephone circuit.

- d. Audibly and visually annunciate any trouble condition for digital tone and voice units required for normal operation of the system.
 - e. Provide all-call Emergency Paging activities through activation of a single control switch.
 - f. As required, provide vectored paging control to specific audio zones via dedicated control switches.
 - g. Provide a factory recorded "library" of voice messages and tones in standard WAV. File format, which may be edited and saved on a PC.
 - h. Provide a software utility capable of off-line programming for the VCC operation and the audio message files. This utility shall support the creation of new programs as well as editing and saving existing program files. Uploading or downloading the VCC shall not inhibit the emergency operation of other nodes on the fire alarm network.
 - i. The Digital Voice Command shall be modular in construction, and shall be capable of being field programmable without requiring the return of any components to the manufacturer and without requiring use of any external computers or other programming equipment.
 - j. The Digital Voice Command and associated equipment shall be protected against unusually high voltage surges or line transients.
- P. Software Modifications: The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made. Systems that require the use of external programmers or change of EPROMs are not acceptable.
- Q. Management Station Interface: The fire alarm control panel shall network to the Management Station via the NIC-C.
- R. Logic: The fire alarm system shall support generic functions that deal with binary states (True/False, high/low), and produce desired outputs from one or more binary inputs (for example, alarm outputs from spot detectors, VESDA detectors, monitor modules or manual station inputs). AND, OR, NOT, Any N, D Latch, RS Latch, Time Base Control, Start Timer, Restart Timer are generic functions. Generic functions can be used as inputs to other function. The system shall support 2500 logic functions.
- S. History: The system shall store 5000 events in history while in straight mode and 4500 in circular mode. In straight mode, trouble warnings will occur at 4000 and 4500 events. In circular mode, the control panels shall maintain a 2000 event Alarm History buffer, which consists of the 2000 most recent alarm events from the 4500 event history file.
- T. Reports:
- 1. The system shall have the ability to provide configuration, status, queue and history reports.
 - 2. Configuration reports shall provide the following information:
 - a. Custom Messages
 - b. Database information
 - c. Entity type
 - d. Device usage
 - e. Device category
 - f. Firmware revision
 - 3. Status reports shall provide the following information:
 - a. Disarmed cards and devices
 - b. ASD settings
 - c. Sensitivity in %/foot

- d. Alarm threshold in %/foot
 - e. Temperature in degrees C
 - f. LOW TEMP DETECTOR Condition
 - g. Walktest
4. Queue reports shall provide the following information:
- a. Alarm events with custom message and event time
 - b. Supervisory events with custom message and event time
 - c. Security events with custom message and event time
 - d. Trouble events with custom message and event time
5. History reports shall provide Address, History Type, Description, Time & Date and Custom Message. The following event types shall be reported:
- a. Alarm events
 - b. Supervisory events
 - c. Security events
 - d. Status changes
 - e. Alarm verification
 - f. Output activation from logic
 - g. System Reset
 - h. Event Acknowledgements
 - i. Block Acknowledgements
 - j. Audible Silence System Flag Changes
 - k. Sensitivity Changes
 - l. Arm / Disarm Commands
 - m. Arm / Disarm By Logic
 - n. Manual Output Overrides
 - o. Output Overrides By Logic
 - p. Time Changes
 - q. Menu Logins
 - r. ASD Changes
 - s. Walktest
 - t. Device Input to Logic Activations/Deactivations

U. Fire Alarm Programming Requirements

- 1. Requirement that FACP messages must be approved by the Engineer and that custom messages must be provided as directed.
- 2. Requirement that FACP descriptors utilize room/space designation and numbers to be used by the facility after occupancy and that descriptors be approved by the Engineer.
- 3. Requirement that the Contractor shall allow for three (3) fire alarm system reprograms, as directed by the Owner.

2.2 POWER SUPPLY

- A. The system Power Supply/Charger (PSC) shall be a 12-amp supply with battery charger. The power supply shall be filtered and regulated. The power supply shall have a minimum of 1 power limited output rated at 4 amps, and a minimum of 1 output rated at 12 amps. The system power supply can be expanded up to 48 amps. The auxiliary power supply module shall share common batteries with the primary power supply. The system power supply shall have 4 relays, 1 for common alarm, one for common trouble and two programmable relays. The power supply shall be rated for 120/208V AC 60 Hz. The module shall be model number PSC-12 or
- B. An extender power supply (PSX-12) shall be available for additional system power requirements.

- C. The battery charger shall be able to charge the system batteries up to 100 AH batteries. Battery charging shall be microprocessor controlled and programmed with an optional Thermistor for monitoring battery temperature to control charging rate shall be available.
- D. The power supply shall have a plug for an AC adapter cable, which allows a technician to plug in a laptop computer for up or down loading program information or test equipment.
- E. Transfer from AC to battery power shall be instantaneous when AC voltage drops less than 90% or brown out conditions it is not sufficient for normal operation.

2.3 SYSTEM ENCLOSURE

- A. Enclosure needed to hold all the cards and modules as specified with at least spare capacity for extra cards. The enclosure outer door shall be either black or red. Provide the color as to the local AHJ requirements. The outer doors shall be capable of being a left hand open or a right hand open. The inner door shall have a left hand opening. System enclosure doors shall provide where required ventilation for the modules or cards in the enclosure.
- B. Provide system enclosure for all amplifiers. Where required by the manufacturer, provide means for venting heat from the enclosure either by having enclosure sides and top vented or the doors vented.

2.4 INTELLIGENT INITIATING DEVICES

- A. General
 - 1. All initiation devices shall be insensitive to initiating loop polarity. Specifically, the devices shall be insensitive to plus/minus voltage connections.
- B. Smoke Detectors – Standard Addressable H-Series
 - 1. The detector shall be guaranteed in writing not to false alarm when configured by the factory trained certified technician. The detector must provide up to 11 different environmental algorithms that allow the detector to provide superior false alarm immunity without the need for additional alarm verification delays.
 - 2. The detector shall have a multicolor LED to streamline system maintenance/inspection by plainly indicating detector status as follows: green for normal operation, amber for maintenance required, red for alarm.
 - 3. The multi-criteria smoke detector shall be an intelligent digital photoelectric detector with a programmable heat sensor. Detectors shall be listed for use as open area protective coverage, in duct installation, and sampling assembly installation and shall be insensitive to air velocity changes. The detector communications shall allow the detector to provide alarm input to the system and alarm output from the system within four (4) seconds. So as to minimize the effort required by the installing and maintenance technician to appropriately configure the detector to ensure optimal system design, the detectors shall be programmable as application specific. Application settings shall be selected in software for a minimum of eleven environmental fire profiles unique to the devices installed location.
 - 4. The detector shall be designed to eliminate the possibility of false indications caused by dust, moisture, RFI/EMI, chemical fumes, and air movement while factoring in conditions of ambient temperature rise, obscuration rate changes and hot/cold smoke phenomenon into the alarm decision to give the earliest possible real alarm condition report.
 - 5. The intelligent smoke detector shall be capable of providing three distinct outputs from the control panel. The outputs shall be from an input of smoke obscuration, a thermal condition or a combination of obscuration and thermal conditions. The detector shall be designed to eliminate calibration errors associated with field cleaning of the chamber.

6. The detector shall support the use of a relay, or LED remote indicator without requiring an additional software address. Low profile, white case shall not exceed 2.5 inches of extension below the finish ceiling.
7. For the detector where required, there shall be available a locking kit and detector guard to prevent unauthorized detector removal.
8. The smoke detector shall be model number HFP-11.
9. Where required, there shall be available a programmable remote lamp configurable to remotely duplicate the on-board LED status of another system device. It shall be model ILED-H.

C. Smoke Detectors –S-Line Addressable FDOO-Series

1. The detectors shall be guaranteed in writing not to false alarm when configured by the factory trained certified technician. The detectors must provide at least 19 different environmental algorithms that allow the detector to provide superior false alarm immunity without the need for additional alarm verification delays.
2. The detectors shall have a tri-color LED to streamline system maintenance/inspection by plainly indicating detector status as follows: green for normal operation, amber for maintenance required, red for alarm.
3. Detectors shall utilize state of the art forward/backward light scattering technology, with improved detection for smoldering and flaming fire signatures. The detectors shall replace the need for ionization detectors due to improved response characteristics to flaming fires.
4. When required, the detectors shall incorporate an addressable Carbon Monoxide (CO) sensor. The CO sensor shall be selectable as an input to the multi-criteria fire detector algorithm and as an independent life-safety CO gas detector (in compliance with NFPA 720).
5. Detectors shall provide pre-alarm signal at 0.2% obscuration/ft. and a full alarm at 1.0% obscuration/ft. to meet the performance requirements of National Fire Protection Association Standard 76, Fire Protection of Telecommunications Facilities as a Very Early Warning Fire Detector (VEWFD).
6. The forward/backward light scattering technology shall provide improved immunity to spurious activation (deceptive phenomena). The detectors shall have a “No False Alarm Guarantee”.
7. The detectors shall be RoHS-compliant: it shall meet standards for Reduction of Hazardous Substances (RoHS) by reduction in lead content and other restricted substances.
8. The multi-criteria detector with CO input shall be UL 2075 compliant as a gas and vapor detector.
9. The multi-criteria fire detectors shall be an intelligent digital photoelectric detector with a programmable heat detector. Detectors shall be listed for use as open area protective coverage, in-duct installation and sampling assembly installation and shall be insensitive to air velocity changes. The detectors’ communications shall allow the detectors to provide alarm input to the system and alarm output from the system within four (4) seconds. So as to minimize the effort required by the installing and maintenance technician to appropriately configure the detector to ensure optimal system design, the detectors shall be programmable as application specific. Application settings shall be selected in software for a minimum of 19 environmental fire profiles unique to the devices installed location.
10. The detectors shall be designed to eliminate the possibility of false indications caused by dust, moisture, RFI/EMI, chemical fumes and air movement while factoring in conditions of ambient temperature rise, obscuration rate changes and hot/cold smoke phenomenon into the alarm decision to give the earliest possible real alarm condition report.
11. The detectors shall be UL listed for operation in a 95% relative humidity (RH) environment.
12. The detectors shall be designed to eliminate calibration errors associated with field cleaning of the chamber.

13. The detectors shall support the use of a relay, or LED remote indicator without requiring an additional software address. Low profile, white case shall not exceed 2.5 inches of extension below the finish ceiling.
14. The detectors shall support the use of an ambient temperature warning signal at the panel. This temperature shall be user-configurable for the set temperature of the warning and the event type generated by the warning. This event can be used to trigger system logic.
15. The multi-criteria detector with CO sensor shall support the use of an ambient Carbon Monoxide (CO) warning signal at the panel. This ambient CO level shall be user-configurable in parts per million (PPM) for the set threshold of the warning and event type generated by the warning. This event can be used to trigger system logic.
16. For the detectors where required, there shall be available a locking kit and detector guard to prevent unauthorized detector removal.
17. UL Listed as "direct in-duct" mounting.
18. Available models:
 - a. FDOOT441. Multi-Criteria incorporating 2 Optical sensors and 2 Thermal sensors with an operating temperature range of 32°F to 120°F. Nineteen selectable profiles. Polarity insensitive installation wiring. Three color LED.
 - b. FDOOTC441. Multi-Criteria incorporating 2 Optical sensors, 2 Thermal sensors, and Carbon Monoxide sensing technologies with an operating temperature range of 32°F to 120°F. Twenty-Five selectable profiles. Polarity insensitive installation wiring. Three color LED. CO sensor may be programmed as part of the multi-criteria, or may be an independent CO detector.

D. Heat Detectors – Addressable

1. Thermal Detectors shall be rated at 135 degrees fixed temperature and 15 degrees per minute rate of rise. Detectors shall be constructed to compensate for the thermal lag inherent in conventional type detectors due to the thermal mass, and alarm at the set point of 135 degrees Fahrenheit. The choice of alarm reporting as a fixed temperature detector or a combination of fixed and rate of rise shall be made in system software and be changeable at any time without the necessity of hardware replacement.
2. The detectors furnished shall have a listed spacing for coverage up to 2,500 square feet and shall be installed according to the requirements of NFPA 72 for open area coverage. The thermal detector shall be model number HFPT-11.
3. Model FDT421 heat detector shall have the following temperature settings:
 - a. Fixed temperature at 135°F, 145°F, 155°F, 165°F, 174°F
 - b. Rate of Rise at 15°F/ min (8.3°C) at 135°F (57°C)
 - c. Rate of Rise at 15°F/ min (8.3°C) at 174°F (79°C)
 - d. Low temperature warning at 40°F (4.4°C)

E. Duct Smoke Detectors – Addressable

1. For duct detector applications, the smoke detector shall be an intelligent digital photoelectric detector. Detectors shall be listed for use as open area protective coverage, in duct installation and sampling assembly installation and shall be insensitive to air velocity changes.
2. The detector communications shall allow the detector to provide alarm input to the system and alarm output from the system within four (4) seconds. The detector shall be mounted in a duct detector housing listed for that purpose. The duct detector shall support the use of a remote test switch, relay or LED remote indicator. The duct detector shall be supplied with the appropriate sampling tubes to fit the installation.
3. Where duct detectors are exposed to the weather a weatherproof enclosure shall be available. A NEMA-3R and NEMA-4X option shall be available. The duct housing cover shall include a test port for functional testing of the detector without cover removal. The

duct housing shall include a cover removal switch capable of indicating cover removal status to the fire alarm control panel.

4. The intelligent duct detector shall have a model number from the FDBZ-Series. Where required there shall be available a duct housing with an on-board relay. Also where required, there shall be a standalone housing available with its own power supply and test/reset switch that does not require connection to a fire alarm control panel. It shall be model FBZ492-PR.
5. Duct smoke detector housing shall allow use in duct systems with air velocity ranging from 100 to 4,000 feet per minute, within temperature ranges of 32°F to 120°F per minute, and with relative humidity ranging from 0 to 95%.
6. Duct Housings and Accessories:
 - a. FDBZ492 Global Air Duct Housing for Conventional and Addressable Detectors
 - b. FDBZ492-R Global Air Duct Housing for Addressable P2 Detectors with Relay Application
 - c. FDBZ492-R Global Air Duct Housing for Conventional Detectors with Relay Application
 - d. FDBZ492-PR Global Air Duct Housing for Conventional Detectors with Relay Application and Built-in Power Source
 - e. FDBZ-WP Weather-Proof housing to accommodate all versions of Global Air Duct Housings
 - f. FDBZ-RTL Remote Test Lamp for Conventional Detectors

F. Detector Bases – Addressable

1. Detector bases shall be low profile twist lock type with screw clamp terminals and self-wiping contacts. Bases shall be installed on an industry standard, 4" square or octagonal electrical outlet box.
2. Multi-Criteria Fire Detector Model FDOOTC441 shall be listed as providing CO detection in duct application.
3. The model number for the standard base shall be DB-11 - 6" Version.
4. The model number for the standard base shall be DB-11E - 4" Version.

G. Manual Pull Stations – Addressable

1. Provide addressable manual stations where shown on the drawings, to be flush or surface mounted as required. Manual stations shall contain the intelligence for reporting address, identity, alarm and trouble to the fire alarm control panel. The manual station communications shall allow the station to provide alarm input to the system and alarm output from the system within less than four (4) seconds.
2. The manual station shall be equipped with terminal strip and pressure style screw terminals for the connection of field wiring. Surface mounted stations where indicated on the drawings shall be mounted using a manufacturer's prescribed matching red enamel outlet box.
3. The double action pull station shall be model number HMS-D.
4. Where required, there shall also be available pull stations with break glass, capable of explosion proof installation, capable of weatherproof installation, reset key operation, and metal housings.

H. Addressable Interface Devices

1. Addressable Interface Devices shall be provided to monitor contacts for such items as water-flow, tamper, and PIV switches connected to the fire alarm system. These interface devices shall be able to monitor a single or dual contacts. An address will be provided for each contact. Where remote supervised relay is required the interface shall be equipped with a SPDT relay rated for 4 amps resistive and 3.5 amps inductive. The addressable interface modules shall be model number HTRI or FDCIO Series.

2. Where needed, a Conventional Zone Module shall connect to the Signal Line Circuit, which will allow the use of conventional initiation devices. This module shall have the ability to support up to 15 conventional smoke detectors and an unlimited number of contact devices. This module shall also be capable of monitoring Linear Beam detectors and conventional Flame detectors. Where required, there shall be an intrinsically safe detection solution for NEMA defined intrinsically safe installations (model DI-3IS with ISI-1) compatible with the conventional zone module. The module shall be model HZM.
3. Single Device Damper Monitoring and Control: A single HTRI switch input shall be able to monitor all 3 states of a damper – open, closed, and in transit. A single HTRI-R shall be able to fully control a damper (through the relay connected to the motor control) while also using its switch input for monitoring all 3 states of the damper.
4. Model FCIO422 addressable input/output module shall be insensitive to polarity and shall have capability for up to 4 separate inputs (Class B) or 2 separate Class A inputs and 4 separate outputs (Class B).
5. Model HCP addressable control point shall provide remote, independent control of any of the following:
 - a. A notification appliance circuit (NAC)
 - b. A telephone zone
 - c. A speaker zone.

2.5 DEVICE PROGRAMMING UNIT

- A. Device Programming Unit: The programming tool shall program the intelligent devices with addresses. The unit shall test the device to respond to its address. Dipswitches and rotary switches shall not be acceptable. The programmer shall be model DPU with carrying case.

2.6 NOTIFICATION APPLIANCES

- A. Series SEH – High Fidelity Speakers and Speaker Strobes
 1. Speaker appliances shall be Siemens Series SEH Speakers, and the speaker-strobe appliances shall be Siemens Series SEH Speaker Strobes or approved equals
 2. Speakers shall be UL Listed under Standard 1480 for Fire Protective Service, and speakers equipped with strobes shall be listed under UL Standard 1971 for Emergency Devices for the Hearing-Impaired
 3. Speaker with strobes shall be certified to meet the requirements of FCC Part 15, Class B
 4. All speakers shall be designed for a field-selectable input of either 25 or 70 VRMS; with selectable power taps from 1/8 watt to 2 watts
 5. Both wall-mount and ceiling mount models shall have listed sound output of up to 87 dBA at 10 feet and a listed frequency response of 300 to 8000 Hz
 6. Speaker shall incorporate a sealed-back construction
 7. All inputs shall employ terminals that accept #12 to #18 AWG wire sizes
 8. Strobe intensity, where Multi-Candela appliances are specified, shall have field-selectable settings, and shall be rated per UL Standard 1971 for:
 - a. 15/30/75/110cd (wall mounting)
 - b. 135/185cd (wall mounting)
 9. Strobe intensity, where Multi-Candela appliances are specified, shall have field-selectable settings, and shall be rated per UL Standard 1971 for:
 - a. 15/30/75/110cd (ceiling mounting)
 - b. 135/185cd (ceiling mounting)
 10. Selector switch for selecting the candela shall be tamper resistant
 11. The strobe portion, when synchronization is required, shall be compatible with DSC sync modules, FireFinder XLS panel, FC2025-2050, or PAD-3/4 power supply with built-in sync protocol

12. The strobes shall not drift out of synchronization at any time during operation
13. The strobes shall revert to a non-synchronized flash-rate, if the sync module or Power Supply should fail to operate (i.e. – contacts remain closed)
14. Wall-mount speaker and speaker-strobe appliances shall be designed for indoor-flush mounting to 4" x 2-1/8" electrical boxes without need for an extension ring or surface mounting
15. Ceiling-mount, speaker-strobe appliances shall be designed for indoor-flush mounting
16. Speaker and speaker strobe shall incorporate a speaker-mounting plate with a snap-on grille cover
17. The finish of the Series SE speakers and speakers strobes shall be white or red
18. All speaker and speaker-strobe appliances shall listed for Special Applications: Strobes are designed to flash at 1-flash-per-second minimum over their "Regulated Input Voltage Range"

B. Series SEFH – High Fidelity Speakers and Speaker Strobes

1. Speaker appliances shall be Siemens Series SEFH Speakers, and the speaker-strobe appliances shall be Siemens Series SEFH Speaker Strobes or approved equals
2. Speakers shall be UL Listed under Standard 1480 for Fire Protective Service, and speakers equipped with strobes shall be listed under UL Standard 1971 for Emergency Devices for the Hearing-Impaired
3. Speaker with strobes shall be certified to meet the requirements of FCC Part 15, Class B
4. All speakers shall be designed for a field-selectable input of either 25 or 70 VRMS; with selectable power taps from 1/8 watt to 2 watts
5. Both wall-mount and ceiling mount models shall have listed sound output of up to 87 dBA at 10 feet and a listed frequency response of 300 to 8000 Hz
6. Speaker shall incorporate a sealed-back construction
7. All inputs shall employ terminals that accept #12 to #18 AWG wire sizes
8. Strobe intensity, where Multi-Candela appliances are specified, shall have field-selectable settings, and shall be rated per UL Standard 1971 for:
 9. 15/30/75/110cd (wall mounting)
 10. 135/185cd (wall mounting)
11. Strobe intensity, where Multi-Candela appliances are specified, shall have field-selectable settings, and shall be rated per UL Standard 1971 for:
 12. 15/30/75/95cd (ceiling mounting)
 13. 115/177cd (ceiling mounting)
14. Selector switch for selecting the candela shall be tamper resistant
15. The strobe portion, when synchronization is required, shall be compatible with DSC sync modules, FireFinder XLS panel, FC2025-2050, or PAD-3/4 power supply with built-in sync protocol
16. The strobes shall not drift out of synchronization at any time during operation
17. The strobes shall revert to a non-synchronized flash-rate, if the sync module or Power Supply should fail to operate (i.e. – contacts remain closed)
18. Wall-mount speaker and speaker-strobe appliances shall be designed for indoor-flush mounting to 4" x 2-1/8" electrical boxes without need for an extension ring or surface mounting
19. Ceiling-mount, speaker-strobe appliances shall be designed for indoor-flush mounting
20. Speaker and speaker strobe shall incorporate a speaker-mounting plate with a snap-on grille cover
21. The finish of the Series SE speakers and speakers strobes shall be white or red
22. All speaker and speaker-strobe appliances shall listed for Special Applications: Strobes are designed to flash at 1-flash-per-second minimum over their "Regulated Input Voltage Range"

C. Series ST Strobes

1. Visual-notification appliances shall be eSeries ST Strobe Appliances or approved equals

2. The Series ST shall meet and be listed for UL Standard 1971 (Emergency Devices for the Hearing-Impaired) for Indoor Fire Protection Service
3. Strobe shall be listed for indoor use, and shall meet the requirements of FCC Part 15 Class B
4. Strobe appliances shall produce a flash rate of one (1) flash per second over the Regulated Voltage Range, and shall incorporate a Xenon flashtube enclosed in a rugged Lexan® lens
5. All inputs shall be compatible with standard, reverse polarity supervision of circuit wiring by a Fire-Alarm Control Panel (FACP)
6. Strobe Plates, when installed, shall be the ST-MC-RETRO Strobe Plate, and shall have the same electronic circuitry as the Series ST strobe.
7. The Series ST Strobe shall be of low-current design
8. The strobe intensity shall have field-selectable settings, and shall be rated per UL Standard 1971 for 15/30/75/95cd or 115/177cd for ceiling mount where Multi-Candela appliances are specified
9. The selector switch for selecting the candela shall be tamper resistant
10. The appliance shall be compatible with the DSC sync modules, FireFinder XLS panel, FC2025-2050, or PAD-3 power supply with built-in sync protocol when synchronization is required
11. The strobes shall not drift out of synchronization at any time during operation
12. If the sync module or Power Supply fails to operate, (i.e. - contacts remain closed), the strobe shall revert to a non-synchronized flash rate
13. The strobes shall be designed for indoor surface of flush mounting
14. The Series ST Strobe Appliances shall incorporate a Patented, Integral Strobe Mounting Plate that shall allow mounting to single-gang, double-gang, 4-inch square, 100mm European type back boxes, or the SHBBS Surface Back box
15. The Series ST Multi-Candela or Single-Candela Strobe Plate shall mount to either a standard, 4-inch square back box for flush mounting, or shall mount to the SBL2S back box for surface mounting
16. All notification appliances shall be backward compatible

2.7 FIREFIGHTERS' TWO-WAY TELEPHONE COMMUNICATION SERVICE

- A. Dedicated, two-way, supervised, telephone voice communication links between fire-alarm control unit, the fire command center, and remote firefighters' telephone stations. Supervised telephone lines shall be connected to talk circuits by controls in a control module. Provide the following:

Retain one of first two subparagraphs below.

1. Common-talk type for firefighter use only.
2. Selective-talk type for use by firefighters and fire wardens.
3. Controls to disconnect phones from talk circuits if too many phones are in use simultaneously. An indicator lamp shall flash if a phone is disconnected from the talk circuits.
4. Addressable firefighters' phone modules to monitor and control a loop of firefighter phones. Module shall be capable of differentiating between normal, off-hook, and trouble conditions.
5. Audible Pulse and Tone Generator, and High-Intensity Lamp: When a remote telephone is taken off the hook, it causes an audible signal to sound and a high-intensity lamp to flash at the fire-alarm control unit, fire command center.
6. Selector panel controls to provide for simultaneous operation of up to six telephones in selected zones. Indicate ground faults and open or shorted telephone lines on the panel front by individual LEDs.
7. Display: Graphic digital to indicate location of caller.
8. Remote Telephone Cabinet: Flush- or surface-mounted cabinet as indicated, factory-standard red finish, with handset.

- a. Install one-piece handset to cabinet with vandal-resistant armored cord. Silk-screened or engraved label on cabinet door, designating "Fire Warden Phone" or "Fire Emergency Phone."
 - b. With "break-glass" type door access lock.
9. Remote Telephone Jack Stations: Single-gang, stainless-steel-plate mounted plug, engraved "Fire Warden Phone" or "Fire Emergency Phone."
10. Handsets: Push-to-talk-type sets with noise-canceling microphone stored in a cabinet adjacent to fire-alarm control unit in the fire command center.

2.8 FIREFIGHTERS' SMOKE-CONTROL SYSTEM

Note: Operation sequence for the transformer building as it relates to interface with existing FCC in transformer building air handling equipment, and FSD's associated with the operation, shall match existing building.

A. Initiate Smoke-Management Sequence of Operation:

1. Comply with sequence of operation as described in Section 230993.11 "Sequence of Operations for HVAC DDC."
2. Fire-alarm system shall provide all interfaces and control points required to properly activate smoke-management systems.
3. First fire-alarm system initiating device to go into alarm condition shall activate the smoke-control functions.
4. Subsequent devices going into alarm condition shall have no effect on the smoke-control mode.

B. Addressable Relay Modules:

1. Provide address-setting means on the module. Store an internal identifying code for control panel use to identify the module type.
2. Allow the control panel to switch the relay contacts on command.
3. Have a minimum of two normally open and two normally closed contacts available for field wiring.
4. Listed for controlling HVAC fan motor controllers.

2.9 MAGNETIC DOOR HOLDERS

Retain this article unless door holders are specified in Section 087100 "Door Hardware." If retaining, coordinate "Description" Paragraph below with Drawings and with Section 087100 "Door Hardware."

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
3. Retain one of two "Rating" subparagraphs below.
4. Rating: 24-V ac or dc.
5. Rating: 120-V ac.

B. Material and Finish: Match door hardware.

2.10 ADDRESSABLE INTERFACE DEVICE

A. General:

1. Include address-setting means on the module.
2. Store an internal identifying code for control panel use to identify the module type.

3. Listed for controlling HVAC fan motor controllers.
- B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- C. Retain "Integral Relay" Paragraph below for elevator recall, shutdown duty, or other relay functions.
- D. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall to circuit-breaker shunt trip for power shutdown.
 1. Allow the control panel to switch the relay contacts on command.
 2. Have a minimum of two normally open and two normally closed contacts available for field wiring.
- E. Control Module:
 1. Operate notification devices.
 2. Operate solenoids for use in sprinkler service.

2.11 GRAPHICS ANNUNCIATOR

- A. Shall connect to the current Siemens Graphic Command Center. The Color Graphics Annunciator shall be capable of annunciating all initiating devices in the Fire Alarm and BMS system in the current building.
- B. The Color Graphics Annunciator shall display in an electronic graphical format, the location of the device in an alarm/trouble/supervisory condition. Graphic Annunciators that utilize physical graphic templates and LED's shall not be acceptable.

PART 3 - EXECUTION

3.1 FIRE ALARM SYSTEM

- A. The entire system shall be installed in a workmanlike manner, in accordance with approved manufacturer's wiring diagrams and U.L. UOJZ criteria. The contractor shall furnish all conduit, wiring, outlet boxes, junction boxes, cabinets and similar devices necessary for the complete installation. All wiring shall be of type recommended by the manufacturer and approved by the New York City Fire Department and shall be installed in conduit throughout. In recessed installations, steps shall be taken to maintain any required fire ratings of attendant walls and/or structures.
- B. End of Line Devices: Shall be furnished as required for mounting as directed by manufacturer.
- C. All wiring shall be to City of New York Electrical Code Standards throughout. The emergency telephone and speaker wiring shall be #16, twisted, shielded.
- D. The system shall be arranged to receive power from emergency 120 VAC circuits. All low voltage 24 VDC operation shall be provided within control cabinets.
- E. Field Quality Control: The completed system shall be fully tested under the supervision of a trained manufacturer's representative. The system shall be demonstrated to perform all of the functions as specified.

- F. Each individual system operation on a device-by-device basis shall be tested for its complete operation. Procedure for testing entire Fire Alarm Life Safety System shall be set forth with the consent of the Owner's representative, engineer and manufacturer.
- G. Solid state components are to be programmed by manufacturer, including all basic items for program-by-event functions.
- H. All conduits shall enter control panels and transponders from the bottom only.
- I. Provide all wiring between sprinkler flow valves, sprinkler tamper switches, smoke detectors, manual stations, elevator control panel, Building automated system controls, control station equipment, speakers, fire alarm annunciators, fan controls for override and fire alarm control panel, in accordance with manufacturer's instructions.
- J. Provide all outlet boxes required for the installation of the complete system.
- K. Color codes to be used throughout for all wiring. All wires to be tagged at all junction points, and shall test free of grounds or shorts between conductors.
- L. Final connection between equipment and the wiring system shall be made under direct supervision of a representative of the manufacturer.
- M. The contractor shall guarantee all wiring to be free from inherent mechanical and electrical defects for one (1) year from date of acceptance.
- N. The manufacturer shall guarantee all equipment to be free from inherent mechanical and electrical defects for one (1) year from date of acceptance.
- O. The manufacturer's local service facility shall, upon request, provide to the owner information about and prices for a system service and inspection agreement.
- P. Final acceptance test shall include, among other requirements, that the system perform for a 30-day time period completely free of any defects of system origin prior to system certification and commencement of any warranty period.
- Q. Duct type smoke detectors shall be furnished, installed and wired by this Contractor, but all openings required in ducts shall be made under separate contract.
- R. A separate ground (isolated from conduit ground) must be pulled to all cabinets.
- S. This contractor shall provide penetrations for all new work and required fire sealant to match wall/slab rating.
- T. Provide outlet boxes, junction boxes painted red, raceways and fittings for the entire fire alarm system as required. All fire alarm wiring shall be installed in its own separate conduit. All junction boxes shall be labeled "Fire Alarm". The use of wiremold is unacceptable unless approved by the Engineer, Architect and Owner.
- U. Conduit sizes, in general, are not indicated on the drawings. Provide all conduits sized as required to accommodate all the fire alarm system wiring, as previously described per NYCEC. All conduit sizes, routing, wire count, etc., shall be clearly indicated on shop drawing submittals.
- V. The conduit where shown on the drawings shall be considered minimum size and shall be for a complete and workable system, any additional conduit or changes in conduit sizes because of variation in a particular manufacturer's requirements shall be made at no additional cost.

- W. Detector shall not be installed within 3 feet of air supply outlet or stair openings as per NFPA 72.
- X. Detector shall be mounted on ceiling slab and shall not be on or within 18" of any protrusion. Contractor should not install uncovered smoke detector heads in bases of duct housing until final checkout time to ensure that dirt and dust does not contaminate the detectors.
- Y. Detector shall be located to be serviceable and visible from floor.

3.2 OPERATIONAL TRAINING

- A. Upon acceptance of the system, the manufacturer shall provide a minimum of four (4) eight (8) hour sessions of onsite training for the Owner's selected personnel. Training must cover the basic operations (interrogating the system, sending commands, acknowledgment of alarms, smoke detector maintenance).
- B. All instruction shall be conducted on the system as installed in the building and include a tour of the building and adequate instructional manuals.

3.3 LABELING OF DEVICES

- A. A permanent label shall be placed on the base of each device with the address number of that device. The label size shall be large enough to be read from the floor and approved by the Fire Department.

3.4 TESTING

- A. The completed fire alarm system shall be fully tested in accordance with NFPA-72 and Fire Department of New York requirements by the Contractor in the presence of the Owner's representative and New York City Fire Department. The manufacturer shall provide a factory trained representative to assist the Contractor in testing:
 - 1. The operation of the control panel and all functions.
 - 2. The operation of all peripheral initiating devices (smoke detectors, manual stations, etc.) for proper alarm initiation.
 - 3. The supervisory feature of all initiating, signaling and control circuits.
- B. The manufacturer's representative shall provide a set of instructions to all parties at the time of final test.
- C. The contractor shall notify the manufacturer and all parties at least one (1) week (five (5) working days) before final tests.
- D. Upon completion of a successful test, the manufacturer's representative shall provide a complete test report, in writing, to the Owner, General Contractor and Engineer.
- E. Testing shall be completed for the New York City Fire Department, New York City Building Department, Owner, and Engineer. Testing shall be completed on the normal day of the weekly job meeting. Electrical Contractor shall include in his bid 2 man days for Owner and 4 man days for New York City Acceptance.
- F. Furnish as part of the installed system, a UL listed programmer and tester.
 - 1. The programmer shall set and verify the device address and perform a device test to ensure operation within UL defined detection window. The programming and testing shall be done independent of the control panel and system wiring.
 - 2. The programmer tester shall dynamically display, in real time, the detector chamber analog voltage.

- G. Acceptance testing to be witnessed by DASNY.

3.5 ALTERNATIVE PROPOSALS

- A. Provide alternative deduct price for providing all wiring Teflon insulated of the type and size recommended by the manufacturer and approved by the New York City Fire Department. Where installed in exposed areas and where installed below eight feet above finished floor provide in conduit.

END OF SECTION

SECTION 264113
LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide all labor, materials and items of service required for the completion of a functional and unobtrusive Faraday lightning protection system in accordance with the Contract Documents.
- B. The lightning protection system coverage includes the building, associated structures, and outdoor electrical and mechanical equipment.

1.2 STANDARDS

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest provisions and latest recommendations of the following:
 - 1. Underwriters' Laboratories Master Label Code 96 and 96A.
 - 2. N.F.P.A. No. 780.
 - 3. Lightning Protection Installation Standard LPI-175.
- B. Certificates: Provide Underwriters' Laboratories Master Label for attachment to the building.

1.3 QUALITY ASSURANCE

- A. The system shall be the standard product of a manufacturer regularly engaged in the production of lightning protection systems and shall be the manufacturer's latest approved design. The equipment manufacturer shall also be a U.L. listed and approved manufacturer.
- B. Installer shall be certified by Nationally Recognized Testing Laboratory (NRTL).
- C. Materials shall be sized in accordance with the material requirements of UL96A. Class I materials shall be used for systems on structures not exceeding 75 feet in height and Class II materials shall be used for systems on structures 75 or more feet above grade.

1.4 COORDINATION

- A. Ensure that the installation, including air terminals, do not conflict with the operation of other rooftop systems. Where required, provide alternate components such as spring mounted air terminals to accomplish this coordination.
- B. Coordinate location of Master Label mounting with the Architect/Engineer prior to installation.
- C. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture.

1.5 SUBMITTALS

- A. Submit shop drawings for review, indicating locations of all air terminals, down conductors, equipment connections, layouts, installation procedures and details, manufacturer's data sheets of all components, accessories and miscellaneous equipment to be used in the installation. Submittal to include details of raceway concealments.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Heary Brothers.
- B. Approved Lightning Protection Co.
- C. Erico.
- D. AC Lightning Security.
- E. Harger Lightning Protection Co.

PART 3 - EXECUTION

3.1 TYPE OF SYSTEM

- A. Install all conductors and complementary parts in a concealed manner so the completed work is unobtrusive and does not detract from the appearance of the structure.
- B. All areas of flat roofs shall be cross run with the same size conductor cable so that no area larger than 50 feet by 150 feet remains unprotected. Mount points on cast copper bronze point bases and cable clips to the finished roof to avoid any roof penetrations.
- C. General: All materials shall be copper. Aluminum shall be used on surface materials incompatible with copper.

3.2 AIR TERMINALS

- A. Air terminals shall be 3/8" x 12" solid copper nickel tipped and shall extend at least 10 inches above the object to be protected. All air terminal bases shall be cast bronze with stainless steel bolt-pressure cable connectors. The air terminals shall be spaced so as to not exceed 20' apart around the outside perimeter of the roof or the ridge and not over 50 square feet apart through the center of flat roof areas. All air terminal bases shall be equipped with bolt pressure cable connections and be securely mounted with stainless steel screws or bolts. Air terminals shall be located within 18" of roof edges and outside corners of protected areas.

3.3 CONDUCTORS

- A. Conductors shall consist of a U.L. listed #4/0 AWG with 28 strands of 14 gauge copper wire weighing 375 lbs. per 1000 feet and installed in accordance with the U.L. requirements. A perimeter conductor shall be installed around the entire main roof, and all penthouses and mechanical equipment. Each perimeter conductor shall be connected to at least two (2) down leads, providing a two way path to ground from each air terminal. All center roof air terminals shall be interconnected with conductors to the outside perimeter conductor. Conductors on the flat roof areas shall be run exposed. Ground connections shall be made around the perimeter of each roof and to the main down conductor at a maximum of 100'-0" on centers.
- B. Utilize conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.4 CONNECTORS AND FASTENERS

- A. Use approved connectors of proper electrical and mechanical characteristics. Use only approved exothermic welded connections for all conductor splices and connections.
- B. Rigidly and permanently attach conductors and air terminals to the building with fasteners of proper strength and design.
- C. Fasteners shall be spaced not to exceed 3'-0" centers.

3.5 DOWN CONDUCTORS

- A. On buildings with structural steel frame work, the structural steel columns of the building may be used as the main down conductor from the roof to ground for the lightning protection system providing it is electrically continuous and is in compliance with UL 96A and NFPA 780. The steel columns used shall in no case average over 100' apart. Where the steel columns are used, a connection to the top of steel shall be made thru the roof using a 3/4" fiberglass sleeve.
- B. All pitch pans or proper roof membrane flashings shall be furnished, installed and weatherproofed by the roofing contractor.
- C. All 3/4" fiberglass sleeves shall be furnished, installed, weatherproofed and maintained free from obstructions by the electrical contractor. All vertical system conductors shall be concealed.
- D. The down conductors shall be connected to the ground rods using a UL listed bronze ground rod clamp having at least 1 1/2" of contact between rod and the conductor.

3.6 GROUNDING SYSTEM

- A. Interconnect the lightning protection ground system to other building ground systems.

3.7 GROUNDING OF METAL ELEMENTS

- A. Interconnect and ground the mechanical piping system and equipment, antennas, satellite dishes, metal drain covers, ventilators, vent stacks, pipes, roofing or siding, ridge rolls, valleys, crickets, eaves troughs, downspouts, ladders, ducts, cold water supply piping, and any other metallic objects or surfaces of a size presenting a capacitance hazard, or within 6 feet of any portion of the lightning protection system, including grade mounted items.

3.8 GROUND RODS

- A. Ground rods and grounding perimeter grid shall be provided as part of the foundation electric package by this Contractor. Extend ground conductor to the steel column and connect as indicated on the Contract Documents. Where the ground conductor must be extended, all connections shall be made with exothermic welds.
- B. Ground rods shall be copper clad 3/4" x 10' minimum. One set of tripod ground rods shall be installed for each down conductor.
- C. Ground plates of high conductivity copper sheet, 20 gauge minimum, 24" square may be used in lieu of or in combination with ground rods to achieve the 10 ohm resistance grounding system requirement. Conductor attachments to the ground plates shall be via cast bronze bond plate of eight (8) square inches of contact area.

- D. Ground rods and/or ground plates shall be installed a minimum of one (1) foot below grade and a minimum of 2 feet away from the building foundation. All grounding locations shall be evenly spaced around the building perimeter as possible.
- E. A minimum of one (1) ground inspection well, rated for traffic of the installation area, shall be installed for each down conductor.
- F. Bonding of the grounding systems shall be with main size conductors. The bonding shall be accomplished to achieve equal potential of all grounds.

3.9 SERVICE AND TESTING

- A. The installation of equipment shall be done under the direct supervision of the equipment manufacturer and per the manufacturer's requirements.
- B. The lightning protection installing contractor shall provide photos and/or video of the installation, including but not limited to, air terminal mounting, bonding connections (waterline and structural steel) down conductors, ground rods/plates/grids and all buried, concealed or inaccessible connections and components. This information shall be forwarded to the manufacturer for evaluation, certification, archiving and documentation. A copy shall be submitted to the Owner.
- C. The ground resistance of the completed system shall be measured using IEEE "Fall of Potential Method" in the presence of the Architect/Engineer and shall be forwarded to the manufacturer. Ground resistance shall be ten (10) ohms or less. Submit all testing data to the Engineer.
- D. Include all results in the O&M manuals.

3.10 COORDINATION

- A. The Contractor shall coordinate with other trades to insure a correct, neat and unobtrusive installation.
- B. The Contractor shall be responsible for bonding to the water services and/or electrical grounding system.
- C. The Contractor shall install approved "through-roof" connectors as specified. The roofing contractor shall be responsible for flashing, booting, or pitch panning all "through-roof" assemblies per roofing manufacturer's specifications.
- D. Approved through-roof assemblies only with solid bronze or stainless steel rods shall be allowed to penetrate the roof. In no instance shall the conductor be allowed to penetrate the roof. The roofing contractor shall be responsible for flashing, booting, or pitch panning all "through-roof" assemblies per roofing manufacturer's specifications.
- E. Conductor cable bonded to the building's steel structure shall be attached utilizing approved bonding plates measuring a minimum of 8 square inches in size. Conductor cable embedded in concrete columns shall be bonded to column rebar at both top and bottom locations.
- F. A ground loop counterpoise shall be installed per NFPA-780 specifications. The counterpoise loop shall be interconnected to the structure to assure equipotential grounding.

3.11 INSPECTION

- A. Upon completion of this installation the contractor shall furnish the Master Label issued by Underwriters Laboratories Inc. for this system to the Owner.

END OF SECTION

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SECTION 264313

SURGE PROTECTION DEVICE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide surge protection devices (SPD) for the protection of all AC electrical circuits and electronic equipment from the effects of lightning induced voltages, external switching transients and internally generated switching transients, in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Surge Protective Devices

1.3 SUBMITTALS

- A. The surge protective device submittals shall include, but shall not be limited to, the following information:
 - 1. Data for each suppressor type indicating ratings, capacities, operating weight, conductor sizes, conductor types, and connection configuration and lead lengths.
 - 2. Manufacturer's certified test data indicating the ability of the product to meet or exceed requirements of this specification.
 - 3. Drawings, with dimensions, indicating SPD mounting arrangement and lead length configuration, and mounting arrangement of any optional remote diagnostic equipment and assemblies.
 - 4. List and detail all protection systems such as fuses, disconnecting means and protective materials.
 - 5. SPD wiring, bonding, and grounding connections shall be indicated on the wiring diagrams for each system. Include installation details demonstrating mechanical and electrical connections to equipment to be protected.

1.4 QUALITY ASSURANCE

- A. The latest edition of the following standards and publications shall comply to the work of this section:
 - 1. ANSI/IEEE C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
 - 2. ANSI/IEEE C62.45, Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits
 - 3. Underwriters Laboratories UL 1449
 - 4. Underwriters Laboratories, UL 1283
 - 5. National Fire Protection Association, NFPA 70 and 780 - National Electrical Code
 - 6. National Electrical Manufacturer's Association LS-1, (NEMA LS-1)
 - 7. ISO 9001:, Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation and Servicing
 - 8. UL 96A – UL Lightning Protection System Master Label
- B. All surge protective devices for service entrance, distribution, and branch circuit protection within a facility shall be provided by a single manufacturer.

- C. The manufacturer must be regularly engaged in the manufacture of surge suppression products for the specified categories for no less than ten (10) years.

1.5 WARRANTY

- A. The SPD and supporting components shall be guaranteed by the manufacturer to be free of defects in material and workmanship for a period of ten (10) years from the date of substantial completion of service and activation of the system to which the suppressor is attached. Any additional diagnostic circuits (LEDs, surge counter, etc.) must meet the same warranty period and conditions listed within these specifications.
- B. An SPD that shows evidence of failure or incorrect operation during the warranty period shall be replaced free of charge. Since "Acts of Nature" or similar statements typically include the threat of lightning to which the SPDs shall be exposed, any such clause limiting warranty responsibility in the general conditions of this specification shall not apply to this section. That is, the warranty is to cover the effects of lightning, single phasing, and all other electrical anomalies. The warranty shall cover the entire device, not just various components, such as modules only.
- C. The installation of SPDs in or on electrical distribution equipment shall in no way compromise or violate equipment listing, labeling, or warranty of the distribution equipment.

PART 2 - PRODUCTS

2.1 PERFORMANCE

- A. General
 - 1. SPDs installed in switchgear, switchboards, or power panels shall have an integral non-fused disconnect, independently tested to the maximum surge current rating of the device. SPDs installed in lighting panels shall be either direct connected to the main bus or via a dedicated branch breaker. Use of plug-in type suppression modules is not allowed.
 - 2. SPDs installed external to switchgear, switchboards, or power panels shall be fed by a dedicated 30A/3P circuit breaker or disconnect switch. The SPD shall be connected directly to the side of the equipment enclosure.
 - 3. The SPD shall protect all modes and there shall be seven (7) discrete suppression circuits: three (3) modes connected Line to Ground, three (3) modes connected Line to Neutral, and one (1) mode connected Neutral to Ground for a 3-phase, 4-wire, plus ground voltage system. Line to Neutral to Ground is not an acceptable substitute for Line to Ground. Line to Neutral to Line and Line to Ground to Line (in combination) will be acceptable for Line to Line protection.
 - 4. All SPDs must have passed the UL 1449 Fault Current Test with a Rating of 200,000 AIC. Documentation substantiating this claim must be provided.
 - 5. SPDs shall use a separate path to building ground; the equipment safety ground is not to be used as a transient ground path. Ground to ground bar in the main service room. Provide cabling and conduit per manufacturer's requirement.
 - 6. Each metal-oxide varistors (MOV) shall be individually fused with a dual-purpose fuse at the component level (one (1) fuse system for each MOV). The fusing system must be comprised of a portion that will open in the event of a high fault current condition and a portion that will open in the event a limited fault current condition. This feature must be a standard design feature and not an optional feature of the product. The individual component level fusing shall allow a reduction of protection rather than a complete loss of protection. Individually fused modules are not acceptable where there is more than one (1) MOV per module.

7. The maximum continuous operating voltage (MCOV) of all components shall not be less than 115% for 480Y/277V systems and 125% for 208Y/120V systems.
8. Standard diagnostic features are to include green LEDs (one (1) per phase - normally "ON") indicating power and suppression status, one (1) red LED indicating protection status (normally "OFF") and a form C dry relay contact.
9. Extended diagnostics must include an audible alarm and surge counter to be displayed on an LCD display on the front of the suppressor. The surge counter must include a reset option. Products requiring diagnostic test kits will not be acceptable.

2.2 SERVICE ENTRANCE PROTECTION

- A. The SPD for this location shall be as indicated on the Contract Documents.
- B. The service entrance SPD equipment shall meet or exceed the minimum performance criteria as follows:
 1. The single-impulse surge-current rating shall be a minimum of 300,000 Amperes per phase (150,000 Amperes per mode).
 2. Nominal discharge current rating (In): 20kA.
 3. Any SPD mounted on the line side of the service disconnect(s) shall be TYPE 1 rated. SPDs mounted on the secondary side of the service disconnect shall be TYPE 2 or TYPE 1.
 4. Minimum Surge Life Rating: 20,000 pulses.
 5. The UL 1449 Suppressed Voltage Protection Rating (VPR) for the following configurations shall not exceed the following:

SPD Voltage Configuration	L-G	L-N	N-G	L-L
480Y/277V	1800V	1800V	1800V	2500V
208Y/120V	1200V	1200V	1500V	1500V
480V Delta	2000V	—V	—V	3500V

- C. SPDs shall be of compact design. The mounting position of the SPD shall allow a straight and short lead-length connection between the SPD and the point of connection in the equipment.
- D. Visual indication of proper SPD connection and operation shall be easily viewed on the front panel of the enclosure. The indicator lights shall indicate suppression circuit status, phase status, phase loss, reduced protection level and suppression fault.
- E. Whereas there is no dedicated breaker in the protected electrical distribution equipment, the SPD shall be equipped with an integral disconnect switch.
- F. A set of normally open/normally closed form "C" dry contacts shall be provided for remote monitoring.
- G. The enclosure type shall be NEMA 1 rated for indoor installations and NEMA 4 rated for all outdoor.
- H. SPDs shall have a diagnostics LCD panel display providing information surge/transient event count.
- I. SPDs shall be equipped with an audible alarm with mute, reset and acknowledge features.
- J. The maximum value for the attenuation for the suppressor must exceed a minimum of 36 dB. All measurements for this requirement must be taken using the MIL STD 220A method and with only six (6) inches of lead length extending outside of the normal exit location of leads for the

enclosure. Test results taken with leads extending past six (6) inches are not acceptable or compliant. Additional or excessive lead length used in the test setup is not acceptable.

2.3 SECONDARY DISTRIBUTION

A. Secondary Distribution Locations

1. Maximum Single Impulse Surge Current Rating: 80kA per mode.
2. Normal Discharge Current Rating (In): 20kA.
3. Minimum Surge Life Rating: 5,000 impulses.

B. Lighting Panels

1. Maximum Single Impulse Surge Current Rating: 60kA per mode (120kA per phase).
2. Nominal Discharge Current Rating (In): 20kA.
3. Minimum Surge Life Rating: 5,000.

C. Protection modes and UL 1449 VPR for grounded wye circuits with voltages of 480Y/277, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 1200V.
2. Line to Ground: 1200V.
3. Neutral to Ground: 1200V.
4. Line to Line: 2000V.

D. Protection modes and UL 1449 VPR for grounded wye circuits with voltages of 208Y/120, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 700V.
2. Line to Ground: 700V.
3. Neutral to Ground: 700V.
4. Line to Line: 1200V.

E. Protection modes and UL 1449 VPR for 240/120V, single-phase, 3-wire circuits shall be as follows:

1. Line to Neutral: 700V.
2. Line to Ground: 700V.
3. Neutral to Ground: 700V.
4. Line to Line: 1200V.

2.4 ACCEPTABLE MANUFACTURERS

- A. General Electric
- B. Eaton
- C. Liebert
- D. Siemens
- E. Square D
- F. Surge Suppression Inc.

PART 3 - INSTALLATION

3.1 INSTALLATION

- A. Install correct fusing, circuit breaker, or disconnect to comply with the product UL 1449 listing
- B. At Service Entrance or Transfer Switch, a UL listed disconnect switch shall be provided as a means of servicing disconnect if not connected to at least a 30A or 40A breaker.
- C. At distribution or branch, SPD shall have an independent means of servicing disconnect such that the protected panel remains energized. A 30A breaker (or larger) may serve this function.
- D. SPDs shall be installed per manufacturer's installation instructions with lead runs as short and straight as possible avoiding sharp corners. Gently twist conductors together to reduce impedance along the length.
- E. Installer may rearrange breaker locations to ensure short & straightest possible leads to SPDs. The location of field-mounted SPD devices must allow adequate clearances for maintenance.
- F. Use crimped connectors only; use of wire nuts is unacceptable.

3.2 FIELD QUALITY CONTROL

- A. Perform the following inspections below and submit written confirmation of results:
 - 1. Compare equipment nameplate data for compliance with the Contract Documents and Specifications
 - 2. With grounded systems verify that electrical system bonding jumper has been connected between neutral and ground before any SPDs are energized.
 - 3. Verify compliance with Startup Service per below
 - 4. Verify that proper operation indication lights are displayed on the SPD.
- B. An SPD device and installation will be considered defective if it does not pass the above tests and inspections.

3.3 STARTUP SERVICE

- A. Complete any startup checks according to the manufacturer's written instructions
- B. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD connected. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.
- C. Before energizing, installer shall verify service or separately derived system Neutral to Ground bonding jumpers per the NEC.
- D. Energize only after initial system voltages have stabilized and testing is completed. Warning, voltages are typically unstable during initial start-up of generators and voltage stabilizing transformers and can damage SPDs.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to operate and maintain SPDs.

3.5 CLEANING AND ADJUSTMENT

- A. After completion, clean the interior and exterior of dirt, paint, and construction debris.
- B. Touch up paint all scratched or marred surfaces with factory furnished touch-up paint of the same color as the factory applied paint.
- C. Adjust and align equipment interior and trim in accordance with manufacturers' recommendations, and to eliminate gaps between the two.

END OF SECTION

SECTION 264314

TWO-WAY RADIO EMERGENCY COMMUNICATION ENHANCEMENT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. System Description – Highlight equipment deployed, frequencies utilized, modes of operation, statement declaring if the system is actively or passively distributing signal, statement declaring if the system share infrastructure with other non-emergency services related communications (i.e. house radio channels).
- B. Floor plan layout for all levels
- C. System riser diagram.

1.2 SUMMARY

- A. This specification describes an in building radio amplification system for emergency responder radio coverage for First Responder use. The features and capacities described in this specification are a requirement for this project and shall be furnished by this contractor.
- B. The system as described shall be installed, tested, and delivered to the Owner in fully operational condition. Provide on-site project management and supervision during system installation, perform interim assembly and final equipment testing, and instruct operational personnel on the system operation.
- C. Awarded contractor is be responsible for all labor, materials and equipment to furnish and install all of the items specified herein, indicated on the drawings and as necessary for the proper and complete performance of work.
- D. During bid, Contractor shall submit separate price for the system, including power supply, system testing to acceptance of the authorities. The purchase and installation of the system shall not proceed until directed by the Owner.

1.3 REFERENCES

- A. Publications listed below are referenced in the design, implementation and commissioning of the system:
 - 1. Underwriter's Laboratories (UL) standards:
 - a. No. 50: Cabinets and Boxes
 - b. No. 467: "Grounding and Bonding Equipment."
 - 2. ANSI/TIA/EIA-568-Commercial Building Telecommunications Wiring Standard
 - 3. ANSI/TIA/EIA-569-Commercial Building Standard for Telecommunications Pathways and Spaces
 - 4. ANSI/TIA/EIA-569-Commercial Building Standard for Telecommunications Pathways and Spaces.
 - 5. ANSI/TIA/EIA-606-Administration Standard of the Telecommunications Infrastructure of the Commercial Buildings

6. ANSI/TIA/EIA-607-Commercial Building Grounding and Bonding Requirements for Telecommunications
7. NFPA 70, National Electric Code.
8. NFPA 72, National Fire Alarm and Signaling Code.
9. Federal Communications Commission (FCC) – title 47 of the Code of Federal Regulations Part 90.
10. Federal Communications Commission (FCC) Rules, Parts 15, 22 and 101.
11. All requirements of local Authority Having Jurisdiction (AHJ)

B. Definitions

1. SS - Signal Strength expressed in dBm in this document is referenced to an impedance of 50 ohms (resistive).
2. FM – Frequency Modulation. In the case of specified frequencies for system usage, the radio signals are FM modulated (emission designator F3E) and have channel bandwidths of up to 20KHz consistent with the technical requirements set forth in title 47 of the Code of Federal Regulations part 90 et al.
3. BDA - Bi Directional Amplifier System (BDA system): a system of amplifiers, transmission lines, cables, power supplies, antennas and other ancillary equipment that allows radio signals to pass to and from the interior of a structure for the purpose of facilitating radio communications with the public safety radio systems.
4. FCC - Federal Communications Commission refers to the United States government agency that is the controlling authority for title 47 of the Code of Federal Regulations and other statutory issues regarding radio (wireless) communications in the United States of America.
5. GROL - General Radio Operator License refers to a person holding a valid General Radio Operators License issued by the Federal Communications Commission in accordance with title 47 of the Code of Federal Regulations.
6. RF – Radio Frequency
7. UPS – Uninterruptable Power Supply

1.4 SUBMITTALS

A. Materials and equipment requiring submittals shall include, but not be limited to the following:

1. A materials submittal cover sheet identifying all equipment model numbers.
2. System operation description covering this specific project, including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are unacceptable.
3. Product data for each product and component specified. Include the type, size, rating, catalog number, manufacturer's names, photos and/or catalog data sheets for all items to ensure compliance with these specifications. This equipment shall be subject to approval, and no equipment shall be ordered without prior approval.
4. Complete riser diagram showing equipment size.
5. Product wiring diagrams from manufacturer differentiating clearly between factory-and field installed wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Make all diagrams specific to this project.
6. Calculations to support the size of standby batteries and power supplies submitted.
7. Wiring type proposed for installation. Include the proposed color code for system conductors to allow rapid identification of circuit types.
8. Installer Certificate Signed by the contractor: Confirmation that the equipment supplier and installer has been factory trained and certified on the system to be supplied. Training

shall have included proper application and installation procedures, for all equipment to be supplied.

9. Qualification data for field-testing organization certificates, signed by the contractor, certifying that the organization complies with the requirements specified in Quality Assurance below. Include list of completed projects with project names, addresses, names of Design Professionals and Owners, plus other information specified.
10. Outline of the end-user-training program to be provided as required by this specification.
11. Operating and Maintenance Manuals:
 - a. Maintenance data for systems to include in the operation and maintenance manual specified in Division 1. Manuals shall contain all of the information submitted in the approved shop drawings plus all manufacturer's drawing incorporating modifications to the system whether made as a field change or by change order.
 - b. Include recommendations for spare parts to be stocked at the site. Provide the names, addresses, and telephone numbers of service organizations that carry stock of repair parts for the system to be furnished.
 - c. As-built documentation which incorporates all modifications to the system, whether made as a field change or by a change order.
 - d. Include a copy of the final test report, UL certificate (where applicable) and test contract.
12. Submission to Authorities Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the construction manager for submission to the Authorities Having Jurisdiction. Include copies of annotated Contract Drawings as needed to depict component locations to facilitate review. Upon receipt of comments from the Authorities Having Jurisdiction, submit them to Design Professional for review. Resubmit if required to make clarifications or revisions to obtain approval.

1.5 QUALITY ASSURANCE

- A. Conform to the most stringent requirements when more than one standard is specified for products or installation.
- B. Compliance with Local Requirements: Comply with the applicable building code, local ordinances, and regulations, and the requirements of the Authorities Having Jurisdiction.
- C. Comply with the Federal Communications Commission Rules Part 22, Part 90 and Part 101.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate installation of fire alarm system with the installation of other building systems and components, including electrical wiring, supporting structures, building materials and building finishes.
- B. Obtain detailed information from manufacturers of equipment provided under this Section as to proper methods of installation.
- C. Obtain final roughing dimensions and other information as needed for complete installation of items furnished under other Sections or by Owner.
- D. Keep fully informed of shape, size and position of openings required for material and equipment provided under this and other Sections. Ensure that openings required for work of this Section are coordinated with work of other Sections. Provide cutting and patching as necessary.

1.7 WARRANTY

- A. The manufacturer shall guarantee all system equipment for a period of one (1) year from the date of final acceptance.

1.8 MAINTENANCE CONTRACT

- A. The system supplier shall include a maintenance contract for the system. The contract shall include the one (1) year warranty period as well as a two (2) year maintenance period for a total of three (3) years from installation acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The Manufacturer shall be a nationally recognized company specializing at in-building first responder communication systems. This organization shall employ factory trained and NICET certified technicians, and shall maintain a service organization within 100 miles of this project location. The Manufacturer and service organization shall have a minimum of 10 years' experience with at a minimum of three (3) previous projects of similar scope successfully completed.
 - 1. NAMSNET
- B. All exceptions, variances and substitutions of operating capabilities or equipment called for in these specifications shall be listed in writing, and forwarded to the Design Professional at the time of bid.

2.2 PERFORMANCE REQUIREMENTS

- A. Provide an in-building radio communications system throughout the building to provide complete coverage in the building.
- B. Early completion of the radio amplification system will be required so as to permit a certificate of occupancy to be obtained in a timely manner, in accordance with a schedule established by the Construction Manager.
- C. The entire system shall meet with the approval of the agencies and Authorities Having Jurisdiction.
- D. The work of this section shall include the responsibility for all filings with the Building Department, and any other Agencies Having Jurisdiction. Where filings require the Design Professional's signature, documents shall be submitted for his review and signature. This responsibility shall include furnishing of required quantities of floor plans, descriptive notes and/or specifications, wiring diagrams, shop drawings and amendment forms, as well as the payment of any required filing fees.
- E. BDA Applications and Permits necessary for installation of the work shall be obtained prior to the commencement of the work. All permit costs and inspection fees shall be included as part of the required work. There shall be no connectivity between the in-building communication system and the building fire alarm system.

- F. Include as part of the base bid quotation the cleaning and adjustment of all components of the system as needed during the warranty period and the testing of system devices during the warranty period.
- G. Include a minimum of two (2) 4 hour training sessions, conducted by factory representatives to thoroughly familiarize Owner's maintenance and operating personnel with all system feature and functions.

2.3 SYSTEM DESCRIPTION

A. Design Requirements

- 1. The system shall provide an FCC certified Class B Bi-directional Amplifier(s) as needed.
- 2. The radio system shall receive radio broadcasts from emergency responder handheld radio units and rebroadcast the signal.
- 3. Final power levels, equipment selection, frequencies used and cabling & antenna plant configuration to be determined by the awarded contractor.

B. Power Requirements

- 1. The signal booster shall operate from 120 VAC source (emergency) using internal power supplies and regulators. Optional external DC battery operation shall include a power transfer circuit, a weather tight MIL spec rated connector mounted at the bottom of the cabinet.
- 2. The signal booster shall be designed to allow degraded performance in adverse conditions, such as high temperatures in the event heat from a nearby fire, voltage fluctuations or other abnormal conditions that may occur during an emergency. Circuits that intentionally disable the signal booster in such situations (i.e. under/over voltage, over/under current, over/under temperature, etc.) are not acceptable. It is the purpose of this specification to assume the maximum possible level of communications to public safety personnel depending upon the signal booster, even to the extent of damaging the signal booster, as long as some communications benefit can be provided during the emergency. Signal booster requirements:
 - a. All signal booster components shall be contained in a NEMA 4-type waterproof cabinet.
 - b. The battery system shall be contained in a NEMA 4-type waterproof cabinet.
 - c. The system shall include automatic alarming of malfunctions of the signal booster and battery system. Any resulting trouble alarm shall be automatically transmitted to an approved central station or proprietary supervising station as defined in NFPA 72 or when approved by the fire code official, shall sound an audible signal at a constantly attended location.
 - d. Equipment shall have FCC certification prior to installation.
- 3. System design shall be such that neither the failure of the normal power source, the transfer to an emergency source, nor the retransfer to the normal source shall cause a change in system status.
- 4. Any part of the installed system or systems containing an electrically powered component shall operate on an independent DC battery system dedicated to the BDA system for a minimum period of twelve (12) hours without external power input. The battery system shall automatically charge in the presence of an external power input.
- 5. The Contractor shall provide but not be limited to:
 - a. Bi-directional amplifiers

- b. Solid Coaxial cable
 - c. Radiating Coaxial Cable
 - d. Antennas
 - e. Termination loads
 - f. Directional Couplers
 - g. Power Dividers
 - h. Mounting Accessories
 - i. Other components and interconnecting circuitry as required.
 - 6. Battery Systems: The active components of the installed system shall be capable of opening on an independent battery system for a period of at least 12 hours without external power input. The battery shall automatically charge in the presence of external power. Battery shall be in a NEMA 4-type waterproof cabinet.
 - 7. Roof RAU unit shall be provided with an independent battery system for a period of at least 12 hours without external power input. The battery shall automatically charge in the presence of external power.
- C. The amplifier and all associated filters shall be housed in a single NEMA 4 rated, painted steel weather tight enclosure, with hinged lockable doors to guard against unauthorized access or removal of components. The cabinet shall be large enough to dissipate internal heat without venting the inside of the cabinet to the outside atmosphere. External or exposed filters are unacceptable. Each unit shall have an attached engraved nameplate identifying the unit. The cabinet shall be painted fire engine red and bear the letters as follows: "Emergency Responder Radio" in white.
- D. System Monitoring Alarm
- 1. Provide a standalone monitoring panel with each BDA for monitoring the BDA operation. The panel shall be located in the Fire Command Room with alarms connected to fire alarm system.

PART 3 - EXECUTION

3.1 SPECIAL RESPONSIBILITIES

- A. Coordinate installation.

3.2 INSTALLATION

- A. Obtain construction permit prior to system purchase and installation.
- B. The battery shall automatically charge in the presence of external power. Battery shall be in a NEMA 4-type waterproof cabinet.
- C. The BDA system shall be installed to meet the survivability from attack by fire requirements per NFPA 72.
- D. The radio and bi-directional amplifiers shall not be located in normal power electric closets. They shall be located in the 2-hour rated Emergency Electric Closets as approved by the Design Professional and/or where specifically shown on the drawings. Cables other than radiating coaxial cables shall be run in conduit where required. Conduit shall be electrical metallic tubing or threaded steel conduit subject to the restrictions specified elsewhere in this section.

- E. Radiating coaxial cables shall be run without conduit. Where installed in a plenum type ceiling cable, insulation shall be of a fire-resistant low-smoke producing type, UL classified as plenum cable. This classification shall be clearly marked on the outer surface of the cable at regular intervals.
- F. Components indicated on the drawings shall be located where shown. Components which are required for proper operation, but which are not indicated on the drawings shall be located in mechanical rooms, at accessible locations within suspended ceilings or at locations for which express permission of the Design Professional has been obtained.

3.3 TESTING

- A. Upon completion of the installation the work shall include making all arrangements and providing any assistance necessary for inspection and test as required for approval by the Agency. Modifications, adjustments and/or corrective work necessary to obtain approval along with subsequent inspection and test resulting from the issuance of a "Notice of Defect" shall precede any consideration of formal acceptance by the Design Professional. In conjunction with the above, training as deemed necessary to instruct authorized building personnel in the proper operation of the system shall also form a part of the required work.
- B. Compliance Testing
 - 1. Compliance testing for an in-building radio system is required, upon completion of installation.
 - 2. Each floor of the building shall be divided into a grid of approximately twenty (20) equal areas. A maximum of one (1) grid area will be allowed to fail the test per floor. A spot located approximately in the center of a grid area will be selected for the test. Once the spot has been selected, prospecting for a better spot within the grid area will not be permitted. The field strength testing instruments are to be recently calibrated (1 year) and of the frequently selective type incorporating a flexible antenna similar to the ones used on the hand held transceivers.
 - 3. All compliance testing to be done with 50 OHM loads in place of the antenna to avoid interference to fire alarm.
 - 4. Delivered audio quality (DAQ) testing will be conducted by the system installer during their sample testing of the accuracy for the BDA Compliance Test Report. All test results and as built drawings shall be submitted when the sample test date is requested. At least five (5) business days' notice is required prior to the DAQ test. Talk back testing from the site to the fire alarm office shall use a two (2) watt portable transceiver with speaker/microphone and flexible antenna and shall be conducted by emergency responder personnel. A spot located approximately in the center of a grid area will be selected for the test, then the radio will be keyed to verify two-way communications to and from the outside of the building through the emergency responder dispatch office. The minimum delivered audio quality (DAQ) is 3.4.
 - 5. The gain values of all amplifiers shall be measured and the results kept on file with the building Owner so that the measurements can be verified each year during the annual tests. In the event that the measurement results become lost, the building Owner will be required to rerun the acceptance test to re-establish the gain values.
 - 6. A Certificate of Occupancy shall not be issued to any structure if the building fails to comply with this section.
 - 7. A representative of the emergency responder radio shop shall oversee the acceptance test. Notify the emergency responder two weeks prior to any testing.

C. Qualifications of Testing Personnel

1. All tests shall be conducted, documented, and signed by a person in possession of a current FCC
2. General Radiotelephone Operator License or a technician certification issued by the Association of
3. Public-Safety Communications Officials International (APCO) or the Pernal Communications
4. Industry Association (PCIA). All test records shall be retained on the inspected premises by the building Owner and a copy submitted to the OFFICIALS.

3.4 MAINTENANCE

A. Maintenance shall include a system service contract that includes 24 hour per day, 7 days per week, and 365 days per year emergency response on site for system trouble or failure, with a maximum 6 hours response time to the building BDA site

B. Annual Testing

1. All active components of the in-building radio system, including but not limited to amplifier, power supplies, and backup batteries, shall be tested a minimum of once every 12 months.
2. Amplifiers shall be tested to insure that the gain is the same as it was upon initial installation and acceptance. The original gain shall be noted and any change in gain shall be documented.
3. Backup batteries and power supplies shall be tested under load for a period of one (1) hour to verify that they will operate during an actual power outage.
4. Active components shall be checked to determine that they are operating within the manufacturer's specifications for their intended purpose.
5. Documentation of the test shall be maintained on site and a copy forwarded to local AHJ upon completion of the test.

C. Radio Service Provider

1. All tests shall be conducted, documented, and signed by a person in possession of a current FCC General Radiotelephone Operator License, or a technician certification issued by the Association of Public Safety Communications Officials International (APCO) or equivalent.

END OF SECTION

SECTION 265000

LUMINAIRES AND ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide luminaires and accessories in accordance with the Contract Documents.

1.2 WORK INCLUDED

- A. Luminaires and Accessories.

1.3 SUBMITTALS

A. Shop Drawings

1. Provide scaled and dimensioned detail drawings of all luminaire types, except where specified fixtures are standard, unmodified, catalogued units. For catalogued units, fully detailed catalog information may be substituted for shop drawings. Provide full size cross sections for major luminaires and all custom designed luminaires. Indicate finished dimensions, metal thicknesses and gauges, material finishes, electrical and mechanical connections, fasteners, welds, joints, and provisions for the work of others. For fixtures specified as "continuous runs", provide scaled drawings showing fixture, connector, and lamp layout for the actual length of run. Detail all required fittings.
2. For standard catalog items with no modifications, submit catalog cut sheets, which clearly show all elements to be supplied, and all corresponding product data (including lamping, ballast quantity, ballast manufacturer and model number, voltage, input watts, materials, finishes, accessories and/or options and any miscellaneous items detailed in the written description of the specification). If a cut sheet shows more than one (1) fixture type, all non-applicable information shall be crossed out. Submittals must be prepared by the manufacturer or manufacturer's local representative agency and clearly indicate the manufacturer's name and representative agency's name on the submittals.
3. For standard Catalogued Fixtures:
 - a. Submit a certificate of compliance with Alzak finish requirements with all requests for approval.
 - b. When more than one (1) louver panel occurs in a fixture, submit the dimensional layout of individual louver panels and supporting "tee" members as part of shop drawings.
4. For luminaires such as custom, modified, linear mounted in continuous rows, and solid state lighting systems with remote ballasts and/or controllers submit a reproducible drawing prepared by the manufacturer showing all details of construction, lengths of required runs, lamp layout, power locations, ballast locations, pendant locations where applicable, finishes and list of materials. Drawings must be to scale. Contractor shall provide manufacturer with field dimensions of all architectural coves where continuous runs are to be mounted. If scallop shields, wallwash reflectors or baffles are required, drawings shall indicate relative position to wall or adjacent vertical surface.
5. For all submittals, manufacturer shall provide submittals within two (2) weeks of receipt of order. All submittals shall have project name and fixture type clearly shown.
6. Fixture cuts and shop drawings shall be submitted in quantities and format as described in the General Conditions Section of these Specifications.

7. The Architect shall make the final determination as to whether or not the submittal contains sufficient information, and reserves the right to request a shop drawing if the fixture cut is insufficient.
8. Submit fixture data with mounting details that include appropriate mounting accessories for each ceiling type.

B. Product Data

1. Indicate type of ballast and manufacturer, ballast quantity and location. Include information as to power factor, input watts, voltage and ballast factor. Indicate mounting distance limitations and standard wire sizes for remote ballasts for all luminaires.
2. Indicate quantity, color, temperature, and type of lamps to be used.
3. Provide independent laboratory photometric data for all luminaire types. Photometric testing and reporting shall conform to I.E.S. procedures. Where the lamps and/or ballasts specified are other than ones for which published photometric data is available, submit additional test data.
4. For air handling fixtures, submit CFM and total pressure data for end slots and side slots used for return air.

C. Samples

1. Provide "samples" as called for in the Contract Documents. Supply a completely operable fixture with a grounded plug and 96" cord for standard 120 volt service. Provide lamps and component parts as specifically requested by the Architect/Engineer. Provide samples for all custom designed luminaires and modified standard luminaires.
2. In addition to the above, submit to the Architect:
 - a. Samples of any lens, louvers, or diffusers as requested. A two inch by four inch sample is the minimum size acceptable.
 - b. Samples of any colors or finishes as requested.
3. Where a sample is submitted or requested, do not fabricate that fixture type until the sample is accepted. Resubmit samples until accepted.
4. Tag samples with the catalog part number, name of the project, referenced specification paragraph or drawing number, the fixture type, and any other identifying data.
5. Ship the sample to the address specified by the Architect. All transportation charges for samples shall be paid by the Contractor.
6. Do not install any sample fixtures in this project.
7. If samples are not accepted by the Architect, samples will be returned to the Contractor, at his expense. Upon receipt of unacceptable sample, immediately make a new submission of samples meeting the contract requirements.

D. Mockups

1. If specifically called for in the fixture descriptions, temporarily install, connect and adjust the specified number of fixtures at no additional cost to the Owner. Place the mockup fixtures where and when directed. Remove and store mockup fixtures when accepted, at the Contractor's expense.

1.4 QUALITY ASSURANCE

- A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
1. Underwriters Laboratories (U.L.)
 2. ASHRAE 90.1 and the State Energy Code.
 3. National Electric Code (N.E.C.)
 4. National Fire Protection Agency (N.F.P.A.)

5. Certified Ballast Manufacturers Association (C.B.M.)
 6. Illuminating Engineering Society (I.E.S.)
 7. American Society for Testing and Materials (A.S.T.M.)
 8. American National Standards Institute (A.N.S.I.)
 9. National Electrical Manufacturers Association (N.E.M.A.)
 10. ETL (Intertek Testing Service)
 11. All applicable local codes.
- B. Emergency and exit lighting shall comply with UL924.
- C. All luminaires and assembled components shall be new, of good quality, and approved by and bear the label of UL or other approved testing agencies (i.e., ETL) unless otherwise specified in writing. Documentation of such testing shall be provided upon request.
- D. Luminaires installed in outdoor protected areas (such as building soffits) and indoors in area subject to water or extreme humidity shall be UL Listed for damp locations. Luminaires in outdoor protected areas shall be UL Listed for damp and wet locations.
- E. LED color temperature values shall not deviate from three (3) McAdam ellipse threshold steps from ANSI color temperature target.

1.5 WARRANTIES

- A. All fixtures and workmanship shall be guaranteed free of defects and fully operational for a minimum of one (1) year after installation, unless otherwise noted below. Any fixtures or workmanship found to be defective during the warranty period shall either be fixed or replaced to the Owner's approval by the Contractor at no cost to the Owner.
- B. Ballasts for fluorescent and high intensity discharge fixtures shall be covered by a minimum two (2) year warranty after installation unless otherwise specified against defects in workmanship or material. Warranty shall include in-warranty service program providing for payment of authorized labor charges incurred in replacement of inoperative in-warranty ballasts.
- C. Solid state lighting luminaires, drivers, controllers, and other system components shall be covered by a minimum five (5) year warranty after installation unless otherwise specified against defect in workmanship or material. Warranty shall include in-warranty service program providing for payment of authorized labor charges incurred in replacement of inoperative in-warranty ballasts.
- D. LED emergency battery power supply shall be capable of operating the LED fixtures specified. Battery shall have a five (5) year guarantee.
- E. Guarantee ballasts against defects for a period of two (2) years, except electronic ballast guarantee shall be for three (3) years. Guarantee shall include replacing defective ballast with a new ballast.
- F. LED drivers shall carry minimum of five (5) years warranty.
- G. Fluorescent emergency battery power supply shall have a five (5) year guarantee.
- H. Minimum of five (5) year warranty on all LED boards.
- I. All painted surfaces for exterior luminaires shall have a guarantee of an outdoor life expectancy of not less than twenty (20) years.

PART 2 - PRODUCTS

2.1 MARKING OF FIXTURES

- A. Plainly mark fixtures equipped with ballasts for operation of rapid start lamps "Use Rapid Start Lamps Only." Similarly, mark other fixtures according to proper lamp type. Clearly mark ballasts that have multilevel outputs, and indicate proper terminals for the various outputs. Provide markings that are clear and which are readily visible to service personnel, but not visible from normal viewing angles when lamps are in place.
- B. Manufacturer must provide all labeling information that is applied with the submittals, i.e., warning labels, special wiring requirements restrictions in mounting, disclaimers, etc.

2.2 FABRICATION AND MATERIALS

- A. Provide fixtures completely factory-assembled and wired, and equipped with necessary sockets, ballast, wiring, shielding, reflectors, channels, lenses and other parts necessary to complete the fixture installation, and deliver to project site ready for installation.
- B. Unless otherwise noted, use only completely concealed hardware. Weld exposed metal at joints, fill with weld material, grind smooth, and make free from light leaks. Gasket incandescent fixtures with overlapping trim. Weld ballast support studs, socket saddle studs and reflector support studs to fixture body. Self-threading screws are not approved. Ventilate ballast compartments and firmly secure ballast to conducting metal surface. Provide fixtures using bottom relamping, unless otherwise noted.
- C. Construct fixtures with the minimum number of joints. Make unexposed joints by approved method such as welding, brazing, screwing or bolting. Soldered joints are not acceptable. Do not use self-tapping methods or rivets for fastening part which shall be removed to gain access to electrical components requiring service or replacement, or for fastening any electrical components or their supports.
- D. Provide metallic cast or extruded parts of fixtures that are close grained and free from imperfections or discolorations. Provide cast or extruded parts that are rigid, true to pattern, and of ample weight and thickness. Provide cast or extruded parts that are properly fitted, filed, ground, and buffed to provide finished surfaces and joints free of imperfections.
- E. Provide housings for discharge lamps (fluorescent, H.I.D.) fixtures that make electrical components easily accessible and replaceable, without removing the fixture body from its mounting.

2.3 FINISHES

- A. Apply fixture finishes after fabrication in a manner that will assure a durable wear-resistant surface. Prior to finishing, hot clean the surfaces by accepted chemical means, and treat them with corrosion inhibiting (phosphating) treatment to assure positive paint adhesion. Give exposed metal surfaces, brass, bronze, aluminum, etc. and finished castings (except chromium plated or stainless steel parts) an even coat of high grade methacrylate lacquer or transparent epoxy. Anodize exposed aluminum surfaces in a 20 minute bath for corrosion resistance. Make sheet steel fixture housing, and iron and steel parts which have not received phosphating treatment, or which are to be utilized in exterior applications, corrosion resistant by zinc or cadmium plating, or hot-dip zinc galvanizing after completion of all forming, welding, or drilling operations.

- B. Cadmium plate screws, bolts, nuts and other fastening or latching hardware.
- C. Unless specifically indicated otherwise, provide fixtures with a high-temperature baked enamel coating of color and finish as specified. Unless otherwise specified, provide white baked enamel reflective surfaces with a minimum reflectance of 86%. Give all parts proper etched surface preparation prior to painting to assure paint adherence and durability.

2.4 ACCEPTABLE FIXTURE MANUFACTURERS

- A. Acceptable manufacturers are listed in the Lighting Fixture Schedule in the Contract Documents and within these specifications. The designations indicated on the Lighting Fixture Schedule are a design series reference (not necessarily a complete catalog number), and do not necessarily represent all of the special requirements as specified in the Contract Documents. Contractor is responsible for meeting all requirements of the Contract Documents and applicable codes.
- B. The listing of a manufacturer as "acceptable" does not assure acceptance of a particular fixture. It is the sole responsibility of the Contractor to insure that any price quotations and submittals made are for lighting equipment which meets or exceeds the specifications included herein. Substitution of fixture manufacturers are acceptable only by prior written approval. Acceptable manufacturers shall provide proof of satisfactory production of equal or similar fixtures for a period of at least five (5) years prior to bidding.

2.5 BALLASTS

- A. General
 - 1. Provide ballasts which are suitable for the electrical characteristics of the supply circuits to which they are to be connected, and which are suitable for operating the specified lamps. No extra compensation will be allowed for failure to properly coordinate ballast voltage with circuitry or dimming requirements.
 - 2. Provide ballasts that are listed with Underwriters Laboratories and bear the U.L. label. All ballasts shall be designed, built and tested in accordance with ANSI and NEC standards.
 - 3. Provide ballasts having the lowest sound rating available for the lamps specified; clearly show their respective sound ratings. Replace ballasts found by the Architect/Engineer to be too noisy, without charge, prior to acceptance of the project.
 - 4. Provide identical ballasts within each fixture type. All ballasts within the same luminaire must be of the same manufacturer.
 - 5. Provide dimmer type ballasts of design recognized and approved by U.L. These ballasts shall coordinate with dimming control devices specified for the particular application.
 - 6. Ballasts shall be approved for the respective application. Approval shall be in writing from the ballast manufacturer. The manufacturer shall perform an 8 hour documented test before installation verifying the ballast compartment and lamp temperatures will not exceed the manufacturer's published limits.
 - 7. Provide UL listed damp location ballasts and UL listed cold weather ballasts for luminaires installed in outdoor unprotected areas.
- B. Fluorescent
 - 1. Provide ETL/CBM certified ballasts which are super low heat, energy-saving, rapid-start type, sound rated 'A' unless noted otherwise. Multi-lamp rapid start ballasts shall be of the series sequence type. Use only two-lamp ballasts unless otherwise indicated.
 - 2. Provide Class "P" protected ballasts, indicating that the ballasts have an integral self-resetting, thermally-actuated device that will remove the ballast from line when excessive ballast temperature is reached, and allow reconnection to line when normal temperature is resumed.

3. Rigidly mount ballasts, unless specifically indicated otherwise to the inside of the top of the fixture housing, with ballast surfaces and housing in complete contact for efficient conduction of heat. Permanently affix ballast mounting screws to the fixture housing. Provide only fixtures whose design, fabrication, and assembly prevent overheating or cycling of lamps and ballasts.
 4. For outdoor use and wherever ballasts are used outside a heated environment (such as walk-in freezers or cold food handling areas) provide fluorescent ballasts capable of lamp-starting at any temperature down to minus 20° F.
 5. Ballasts for T5HO lamps or smaller shall have end of life sensing circuits.
 6. Ballasts for T5HO lamps or smaller shall have end of life sensing circuits.
 7. Fluorescent electronic ballasts shall conform to the following requirements:
 - a. FCC Regulations, Part 18, Class A, for electromagnetic interference.
 - b. IEEE C62.41, "Guide for Surge Voltages in Low-Voltage AC Power Circuits," Category A, for resistance to voltage surges for normal and common modes.
 - c. UL 935, "Fluorescent Lamp Ballasts."
 8. High Frequency Solid State Electronic Ballasts:
 - a. Provide ballasts with the following:
 - 1) High power factor (95% or above).
 - 2) Minimum starting temperature of 50°F.
 - 3) Provide ballasts with sound rating of 'A'.
 - 4) Instant start, parallel operation.
 - 5) Total harmonic distortion (THD) of 10%.
 - 6) Minimum .87 ballast factor.
 - 7) Ballast case temperature not to exceed 90°C during normal operation in 30°C ambient temperature.
 - 8) Certified Ballast Manufacturer's (CBM) Certification.
 - 9) Maximum Crest Factor: 1.70.
 - 10) Acceptable Ballast Manufacturers
 - a) Advance Transformer Co.
 - b) MagneTek
 - c) Motorola
 - d) General Electric
 9. Fluorescent – Dimming Type
 - a. Fluorescent dimming ballasts shall meet all the criteria outlined above for fluorescent electronic ballasts. In addition, the dimming performance shall be as follows:
 - 1) Dimming range shall be continuous between 100% and 10% light output for general lighting applications.
 - 2) Dimming range shall be continuous between 100% and 1% light output for all conference and meeting room applications.
 - b. Acceptable Manufacturers
 - 1) Advance – Mark X (10-100%)
 - 2) Lutron Electronics Co., Inc.
 - a) Hi-Lume (1-100%)
 - b) ECO-10 (10-100%)
- C. High Intensity Discharge (H.I.D.)

1. Provide H.I.D. ballasts that are U.L. listed, regulated type, fused in the primary circuit. Ballast shall allow maximum of 10% lamp wattage change with a line variant of $\pm 5\%$ voltage.
 2. High intensity discharge ballasts shall be core and coil construction constant wattage autotransformer type, with integral automatically reset thermal overload protection and high power factor. HID ballasts located indoors shall be "quiet" type. Ballasts shall have a minimum power factor of 90%. Provide 12" minimum leads.
 3. Comply with NEMA C82.4 and UL 1029.
 4. Acceptable Manufacturers
 - a. Advance
 - b. Universal Lighting Technologies
 - c. Wide-Lite
- D. Solid State LED
1. Provide LED drivers with the following:
 - a. High power factor (95% or above)
 - b. Minimum starting temperature of 0°C.
 - c. Provide driver with sound rating of 'A.'
 - d. LED driver is UL certified.
 - e. Total harmonic distortion (THD) of less than 20%.
 - f. LED driver is certified by UL for use in a dry or damp location. Outdoor drivers shall be weatherproof. Provide enclosure acceptable to the manufacturer to maintain driver criteria.
 - g. Provide input and output voltages, and wattage for operating.
 - h. Provide dimming standard (0-10V, etc.).
 - i. Inherent thermal protection.
 2. LED drivers shall be installed within an electrical enclosure, unless it is rated as a remote mounted enclosure.
 3. LED color temperature shall be within a McAdam ellipse with three (3) threshold units.

2.6 FIXTURE WIRING

- A. Provide wiring between fluorescent lamp holders and associated operating and starting equipment, of similar or heavier gauge than the leads furnished with the approved types of ballasts, and having equal or better insulating and heat resisting characteristics. Provide internal wiring of fixtures containing a minimum number of splices. Make splices with acceptable mechanical insulated steel spring type connectors, suitable for the temperature and voltage conditions to which the splices are to be subjected.
- B. Make connections of wires to lamp holder terminals and other accessories in a neat and workmanlike manner, electrically and mechanically secure, with no loose strands protruding. Provide the number of wires extending to or from the terminals of a lamp holder or other accessory that does not exceed the number which the accessory is designed to accommodate.
- C. Provide wiring channels and wireways free from projections and rough or sharp edges. At points or edges over which conductors shall pass and may be subject to injury or wear, round bush to make a smooth contact surface with the conductors.
- D. Install insulated bushings at points of entrances and exit of flexible wiring.
- E. Where outlet boxes are required to support a luminaire, the wall or ceiling outlet box must be securely fastened to support at least 50 pounds. A box may be used to support a luminaire weighing more than fifty pounds if the box is listed and marked for the maximum luminaire

weight to be supported. A wall box intended to support a luminaire must be marked to indicate the maximum weight of the luminaire to be supported, if other than fifty (50) pounds.

2.7 LAMPS

- A. Provide a complete set of new lamps in each fixture immediately prior to turnover to the Owner.
- B. Unless specified otherwise, provide lamps as follows:
 - 1. For fluorescent fixtures, provide lamps as indicated in the Lighting Fixture Schedule. Supply lamps from one (1) manufacturer and of one (1) color temperature unless otherwise noted.
 - a. T8 and T5 RAPID-START LAMPS: CRI of 80 minimum, color temperature of 3000 K, average rated life of 20,000 hours, unless otherwise indicated.
 - b. COMPACT FLUORESCENT LAMPS: CRI of 80 minimum, color temperature 3000 K, average rated life of 10,000 hours at 3 hours operation per start, unless otherwise indicated.
 - 2. For incandescent fixtures, provide long-life inside frosted, with an average life of 3,000 hours, 130 volt lamps unless otherwise indicated in the Lighting Fixture Schedule. Supply lamps from one (1) manufacturer unless otherwise noted.
 - 3. Provide pulse start type metal halide lamps with a lamp life of 10,000 hours and a color temperature of 3000K.
 - 4. For other fixtures, provide lamps as specified. If not specified, and for fixtures by others, provide lamps as rated by the manufacturer. For each lamp type, provide all lamps from one (1) manufacturer.
 - 5. For LED fixtures, manufacturers are to meet the following criteria:
 - a. LED color consistency, color shift not to exceed 200 degrees Kelvin.
 - b. LED efficiency should not be less than 80 lumens per watt.
 - c. LED maintenance to be L70 or 70% lumen output after 50,000 life span.
 - d. LED color rendering index (CRI) to be no less than 80.
 - 6. For LED fixtures, manufacturers are to meet the following criteria:
 - a. LED color consistency
 - b. LED efficiency should not be less than 80 lumens per watt.
 - c. LED maintenance to be L70 or 70% lumen output after 50,000 life span.
 - d. LED color rendering index (CRI) to be no less than 80.
 - e. Minimum of 5 year warranty on all LED boards.
- C. All lamps shall be low mercury type.
- D. Acceptable Lamp Manufacturers - Lamp catalog numbers specified in the Contract Documents define performance criteria. Equal products by any of the following manufacturers may be utilized unless otherwise noted.
 - 1. General Electric
 - 2. Philips Lighting Corp.
 - 3. Osram Sylvania, Inc.

2.8 LAMP HOLDERS

- A. Provide incandescent and H.I.D. lamp sockets with porcelain housings over copper screw shells, with medium base sockets rated at 660W. Plastic or metal sheet sockets are not acceptable.

- B. Provide fluorescent fixture sockets that are white, of heat resistant plastic and rated at 660W. Fluorescent lamp sockets operating with an open circuit voltage in excess of 300 volts shall be of the safety type which opens the supply circuit when the lamp is removed from the sockets.
- C. Rigidly and securely attach lamp holding sockets to the fixture enclosure or husk.
- D. Provide sockets suitable for specified lamps, and set to position the lamps in optically correct spacing and relationship to lenses, reflectors, filters, and baffles.
- E. Where fluorescent lamps are to be used "bare", without diffusers or lenses, provide at least two (2) acceptable lamp retaining clips per fluorescent lamp, for safety.
- F. Lamp holders shall hold lamps securely against normal vibrations and maintenance handling.

2.9 REFLECTORS

A. Aluminum Reflectors

- 1. Provide reflectors and reflecting cones or baffles fabricated from #12 aluminum reflector sheet, .057 inch (15 gauge) or heavier; and absolutely free of tooling marks including spinning lines, and free of marks or indentation caused by riveting or other assembly techniques. No rivets, springs, or other hardware shall be visible after installation.
- 2. The finish of the inner surface of the reflector shall be produced under the Alzak process. The reflector shall have an anodic coating of not less than four (4) mils thick. The reflector inner surface shall be free of water spotting and shall maintain a reflectivity ratio of not less than 83 percent on clear specular finish. The reflector shall have a low iridescence finish free from multiple colors seen from normal viewing angles. Colors shall be derived from dyes supplied by Sandoz Chemical Company or approved equal.
- 3. Luminaires provided with tri-phosphor type lamps shall be provided with low iridescence aluminum reflectors to eliminate discoloration on aluminum reflector.
- 4. The reflecting surface of the cone shall be tested for proper seating. Test per ASTM B136-63T.
- 5. Provide reflectors and baffles of first-quality polished, buffed and anodized finish, "Alzak" or accepted equal, and with specular finish color as selected by the Architect/Engineer.
- 6. Provide other aluminum reflectors where required; formed and finished as noted on the Contract Documents and elsewhere in the specifications. Provide only reflectors free from blemishes, scratches, or indentations which would distort their reflective function and finished by means of the "Alzak" process, or accepted equal, unless otherwise noted.

B. Painted Reflectors

- 1. Provide painted reflectors completely formed before application of primer and enamel paint. Make reflectors and reflector bodies for fluorescent fixtures, having baked-on white enamel finish, applied to meet the following requirements and tests: Provide minimum tested reflectance of 86%. After 100 hours exposure to fade-o-meter, reflectance may not be less than 86%, and finish may show no visible color change. Exposure to 100% humidity at 100°F, for 100 hours (cook box test) may show no blistering or other effects. Salt spray (20% sodium chloride) for 150 hours may cause no breakdown of film. When requested, submit a sufficient quantity of flat steel panels having the same primer and paint, applied in the same manner as proposed for the contract items, for subjection to any one or all of the tests listed above by an approved independent testing laboratory. Contractor will pay the cost of the tests. Tests will be required only in case of dispute about reflector characteristics. Reflectors which do not meet the criteria expressed here shall be replaced at the Contractor's expense.

2. Provide 45-degrees lamp and lamp image cut-off unless otherwise specified. In fixtures where upper reflector is separate from cone, cut-off shall be 45 degrees to match field conditions.
3. Reflector cone retention devices shall not deform the cone in any manner.

2.10 LENSES, FACEPLATES AND TRIMS

- A. Plastic lenses shall be of virgin methyl methacrylate, unless otherwise indicated. No polystyrene lenses will be accepted.
- B. Make lenses, louvers, or other light diffusing elements contained in frames, removable but positively held within the frames so that hinging or other motion of the frame will not cause the diffusing element to drop out.
- C. Provide faceplates of recessed fixtures which open for access to the interior of the fixture, serve as a ceiling trim, and are positively held to the fixture body by adjustable means that permit the faceplate to be drawn up to the ceiling as tight as necessary to insure complete contact of faceplate with ceiling.
- D. Provide ceiling trims for rectangular recessed fixtures with mitered corners, continuously welded and smoothed before shop finishing. Lapping of trim metal is not acceptable.
- E. All prismatic lenses shall have an efficiency of 83% or greater.

2.11 EXTERIOR FIXTURES

- A. Provide fixtures designed and manufactured specifically for outdoor service. Make components, including nuts, bolts, rivets, springs, and similar parts, of corrosion resistant materials or of materials which will assure such resistance.
- B. Provide fixtures for use outdoors, or in areas designated as damp locations, which are suitably and effectively gasketed to prevent access of moisture into electrical components or enclosing diffusers, lenses or globes. Outdoor fixtures which are directly exposed to the elements shall be rated for wet locations. Fixtures which are aimed up, shall be approved for wet locations in this position.
- C. Metal parts of fixtures requiring painting, shall be painted with suitable weather and moisture-resisting paint equal to epoxy-based coatings.
- D. Provide anodized aluminum for aluminum parts of exterior fixtures which are not specified as requiring a painted finish.
- E. Installations shall be UL labeled as "Suitable for Wet Locations."
- F. Surfaces shall be prepared, primed and material applied in accordance with manufacturer's requirements.
- G. Supply pole luminaires with davit arms, brackets, pole hand-hole covers, base components, and all other accessories complete by specified manufacturer who will be responsible for proper fitting of all elements.
- H. Manufacturer will supply pole luminaire assembly to withstand a minimum of 100-mile-per hour winds with a 1.3 gust factor without permanent deflection.
- I. Manufacturer shall be responsible for the structural integrity of complete pole luminaire.

2.12 ACCESSORIES

- A. Recessed incandescent luminaires shall be furnished with thermal protection in accordance with Article 410 of the NEC.
- B. Where utilized as raceways, luminaires shall be suitable for use as raceways. Provide feed through splice boxes where necessary.
- C. Provide plaster frames or mounting frames for fixtures that require them. Such frames shall be appropriate for the ceiling construction in which they shall be installed.
- D. Provide necessary hardware with fixtures, such as stems, plates, plaster frames, hangers, and similar items, for safe support of fixtures for the ceiling construction in which they shall be installed. Provide plaster frames made of non-ferrous metal, or of steel that has been suitably rustproofed after fabrication.
- E. For air handling luminaires, provide matte black baffles for end and/or side slots as required so that ceiling plenum is not visible from below.
- F. For fluorescent and H.I.D. luminaires used indoors, where ballast sound rating of 'A' is not available, provide acoustic mounting pads between luminaire housing and ballast to minimize vibration and noise level. Pads shall be installed to the Architect's/Engineer's acceptance.
- G. Provide tempered glass lenses for all high intensity discharge (HID) fixtures.
- H. Provide fastening devices of a positive locking type, which do not require special tools to apply or remove them. Do not use tie wires in place of fastening devices.
- I. Attach reflectors to the housing by means of safety chains, to prevent reflectors from falling. No part of the chain may be visible after installation, when viewed from any angle up to 45 degrees from horizontal.
- J. Provide an approved ceiling canopy for each stem, exactly matching stem finish, unless otherwise requested by the Architect/Engineer.

2.13 EMERGENCY LIGHTING

- A. General
 - 1. Provide emergency lighting as required by referenced standards and indicated on the Contract Documents. The main function of emergency lighting is to direct building occupants safely out of the building in the event of an emergency.
 - 2. Connect emergency lighting to the emergency power distribution systems.
 - 3. Provide integral battery ballast power for emergency lighting where an emergency power distribution system does not exist. Provide all long life batteries. High temperature, maintenance free, nickel-cadmium batteries are acceptable, however, lead-calcium type are not.
 - 4. All battery ballasts shall be capable of providing full illumination in emergency mode.
- B. Exit Signs
 - 1. Exit signs shall have cast-aluminum housings and stencil edge-lit faces. Letters shall be red and 8" high. Light source shall be light emitting diodes (LED). Exit signs shall employ a diffuser lens for even illumination of letters. Products that exhibit "dots" or "hot spots"

shall not be acceptable. Exit signs shall have internal sealed lead calcium maintenance free battery rated for 90 minutes.

C. Fluorescent Battery Systems

1. Emergency battery power supply suitable for installation remote from or in ballast compartment of fluorescent luminaires, rated for 90 minutes continuous. Unit shall be capable of providing normal fixture operation in a switched fixture. Include "TEST" switch and "AC ON" indicator light capable of installation in the luminaire or remote from the luminaire. Power supply shall have self-test diagnostic feature. Test shall be performed at a minimum of 30 seconds every 30 days and 90 minutes once a year.
2. Emergency battery power supply shall be capable of operating one (1) lamp, providing a minimum of 1400 lumens.
3. Night light connector: operate one (1) fluorescent lamp continuously.
4. Acceptable Manufacturers
 - a. Bodine Co.
 - b. Dual-Life
 - c. Lithonia.

D. LED Battery Systems

1. Emergency battery power supply suitable for installation remote from or in the driver compartment of the LED luminaire. Unit shall be capable of providing normal fixture operation in a switched fixture. Include "TEST" switch and "AC ON" indicator light capable of installation in the luminaire or remote from the luminaire. Power supply shall have self-test diagnostic feature.
2. Emergency battery power supply shall be capable of operating the LED fixtures specified.
3. Provide LED battery with the following:
 - a. Rated input and output voltage and wattages.
 - b. Temperature rating.
 - c. Illumination time (minimum 90 minutes)
 - d. Suitable for indoor and damp locations and for sealed and gasketed features.
4. LED battery shall meet all associated UL ratings, including UL924.
5. Acceptable Manufacturers
 - a. Bodine Co.
 - b. Dual-Life.
 - c. Lithonia.

PART 3 - EXECUTION

3.1 GENERAL

- A. Fixture locations as indicated on the Contract Documents are generalized and approximate. Carefully verify locations with the Architect's plans, reflected ceiling plans and other reference data, prior to installation. Check for adequacy of headroom and non-interference with other equipment, such as ducts, pipes, conduit, or openings. Bring conflicts to the Architect's/Engineer's attention before proceeding with any work.
- B. Although the location of equipment may be shown on the Contract Documents in certain places, actual construction may disclose that the work does not make its position easily and quickly accessible. In such cases, call the Architect's/Engineer's attention to this situation before installing this work, and comply with the installation instructions.

- C. Verify ceiling conditions and ceiling types prior to ordering any fixtures. Furnish appropriate luminaire mounting accessories for each fixture. Such mounting details shall be reviewed by the Architect/Engineer.
- D. Install fixtures in mechanical areas after the ductwork and piping installation. Locate and mount fixtures as indicated on the Contract Documents unless mechanical equipment prohibits or makes it impractical to do so. In such cases, chain or wall mount fixtures so that serviceable equipment is illuminated.
- E. Install fixtures complete with lamps, as indicated, and with equipment, materials, parts, attachments, devices, hardware, hangers, cables, supports, channels, frames and brackets necessary to make a safe, complete, and fully operative installation.
- F. Verify and provide fixtures that are appropriate for the ceiling mounting conditions of the project.
- G. Reject and do not install blemished, damaged or unsatisfactory fixtures. Replace imperfect or unsatisfactory fixtures, if installed, as directed by the Architect/Engineer.
- H. When installed, fixtures shall be free of light leaks, warps, dents, or other irregularities. No light leaks are permitted at the ceiling line or from any visible part or joint of the fixtures.
- I. Provide finish for exposed parts or trims as specified or indicated on the Contract Documents. If finish for exposed parts are not indicated, provide a finish as directed by the Architect/Engineer.
- J. Do not install reflector cones, aperture plates, lenses, diffusers, louvers, and decorative elements of fixtures until completion of wet work, plastering, painting and general clean-up in the area of the fixtures.
- K. Mount fixtures at heights and locations indicated on the Contract Documents, or as requested by the Architect/Engineer.
- L. Adequately protect the housing of recessed lighting fixtures during the installation by internal blocking or framing to prevent distortion of sides, or dislocation of threaded lugs, which, upon completion, shall be in perfect alignment and match the corresponding holes in frames and rims. Holding screws shall be inserted freely without forcing, and shall remain easily removable for servicing. Threads intended to receive holding screws shall be chased after plating and finished to insure easy installation and removal of knurled headed screws.
- M. Parabolic luminaires shall be installed with Mylar cover over louvers; cover shall be U.L. listed for temporary lighting. Upon completion of work, remove Mylar cover with white gloves.
- N. Fixture supports shall, as a minimum, be adequate to support the weight of the fixtures.
- O. Provide visible hanging devices that are finished to match the fixture finish, unless indicated otherwise.
- P. Where necessary to meet fire resistance requirements set forth by the NYCBC, provide enclosure housings for recessed fixtures that are constructed to provide required fire resistance rating.
- Q. Provide attachment devices, including brackets, plaster rings, saddle hanger and tie bars, made of formed, rolled, or cast metal shapes with the requisite rigidity and strength to maintain continuous alignment of installed fixtures. Attach fixtures to the ceiling supporting members, and do not depend upon lathing, plaster or ceiling tile for alignment or support.

- R. Provide fixtures mounted in suspended ceilings that are supported by saddle hangers or the bars attached to runners or between crossbars of ceiling systems. Provide mounting splines or other positive means of maintaining alignment and rigidity.
- S. Provide pendant or surface mounted fixtures with required mounting devices and accessories, including hickey, stud-extensions, ball aligners, canopies, and stems. Make mounting stems of pendant fixtures of the correct length to uniformly maintain the fixture heights shown on the Contract Documents or established in the field. The allowable tolerance in mounting individual fixtures shall not exceed ¼ inch and may not vary more than ½ inch from the floor mounting height shown on the Contract Documents. Install fixtures hung in continuous runs absolutely level, and in line with each other. Hanging devices shall comply with code requirements.
- T. Provide hanging devices which, if visible from normal viewing angles, exactly match fixture finishes, unless otherwise requested by the Architect/Engineer.
- U. Place stems to be vertical.
- V. Provide at least two (2) supports for individually mounted fluorescent fixtures. Where fixtures are ganged, provide supports at 8 ft. minimum intervals, unless otherwise indicated. All fixtures shall be supported to the structure or black iron. Fixtures and appliances shall not be supported by ceiling tiles, sheet rock, or plaster.

3.2 ACCESSIBILITY

- A. Install equipment such as junction and pull boxes, fixture housings, transformers, ballasts, switches and controls, and other apparatus that requires occasional access for operation and maintenance, to be easily accessible and appropriate for mounting and ceiling conditions.
- B. All remote LED luminaires and drivers shall be located in a dry, well ventilated and easily accessible location determined by the Architect.

3.3 ADJUSTMENT

- A. Provide manpower and tools for final focusing and adjustment, under the Architect's/Engineer's supervision, of all adjustable fixtures (including fixtures with variable socket positions) after regular working hours, whenever necessary, at no additional cost of the Owner.

3.4 CLEANING

- A. Immediately prior to occupancy, clean reflector cones, reflectors, aperture plates, lenses, louvers, lamps and decorative elements. Destaticize lenses after cleaning, installing them to leave no finger or dirt marks. At the time of final observation, fixtures shall be clean and free from marks, dust, spotting or other defects. Replace any broken or defective parts prior to final inspection. Replace or make good all defects revealed by final observation.
- B. Remove labels and other markings, except the UL listing label.
- C. Regulated Waste Disposal
 - 1. All waste shall be labeled, stored, handled, transported, and disposed of in accordance with applicable State and Federal regulations.
 - 2. All fluorescent lamps shall be assumed hazardous waste and shall be boxed and removed to an approved lamp recycler. Provide required documentation and comply with all hazardous waste regulations.

3. All ballast waste shall be labeled, stored, handled, transported and disposed of in approved plastic lined drums. Contractor shall arrange for the proper disposal of the ballasts with an approved recycler. Provide all required documentation and comply with all hazardous waste requirements.

3.5 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage then replace damaged fixtures and components. Verify normal operation of each fixture after installation.
- B. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify normal transfer to battery power or emergency power source and retransfer to normal.
- C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. Retest to demonstrate compliance with specification requirements where adjustments are made. Replace fixtures with damage or corrosion during warranty period.

3.6 SPARE PARTS

- A. Provide spare materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Provide at least one (1) of each type.
 1. Lamps: Five (5) for every 100 of each type and rating installed.
 2. Plastic Diffusers and Lenses: One (1) for every 100 of each type and rating installed.
 3. Battery and Charger: One (1) for every 20 emergency lighting units installed.
 4. Ballasts: One (1) for every 100 of each type and rating installed.
 5. Globes and Guards: One (1) for every 20 of each type and rating installed.
 6. Exit Signs: Ten (10) additional exit signs to be installed at locations determined in the field, if necessary. If not used in the field, turn over to the Owner for attic stock.
- B. Submit Operations and Maintenance instructions, including parts list, for each luminaire installed.

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SECTION 270800

TESTING OF COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Applicable requirements of Division 27 - Communications shall be considered a part of this section and shall have the same force as if printed herein full.
- B. This document describes the equipment and execution requirements relating to Testing and Commissioning of Communications.
- C. Equipment specifications, general considerations, and guidelines are provided in this document. The successful vendor shall meet or exceed all requirements described in this document and on the drawings.

1.2 WORK INCLUDED

- A. The work included under this specification consists of furnishing all labor, equipment, materials, supplies and performing all operations necessary to complete installation. The Contractor will provide and install all of the required material whether specifically addressed in the Specification or not.

PART 2 - TESTING

2.1 TESTING REQUIREMENTS

- 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 ANSI/TIA-568-C.0, ANSI/TIA-568-C.1, and/or ANSI/TIA-1152. All conductors/strands 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/strands in all cables installed.
- B. Copper Testing
 - 1. All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category 5e/6/6A performance. Horizontal balanced twisted pair cabling shall be tested using a level IIe, III, or IV test unit for category 5e/6/6A performance compliance.
 - 2. Continuity - Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. The test shall be recorded as pass/fail as indicated by the test unit and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.

3. Length - Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA-568-C.2 Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the shortest pair length shall be recorded as the length for the cable.
 4. Approved copper test equipment manufacturers are as follows:
 - a. Copper Twisted Pair Testers
 - 1) Fluke – DSX-5000
 - 2) Fluke – DTX-1800
- C. Optical Fiber Testing
1. All fiber testing shall be performed on all fibers in the completed end-to-end system. There shall be no splices unless clearly indicated in the project documents. These tests also include continuity checking of each fiber.
 2. Multimode
 - a. Test the optical fiber cable bi-directionally with an OTDR and uni-directionally with a power meter/light source. Fiber must be tested at both 850nm and 1300nm. Maximum attenuation dB/Km @ 850nm/1300nm shall be 3.5/1.5. Maximum attenuation per connector pair shall be .75 dB. Attenuation testing shall be performed with a stable launch condition using a one-meter or two-meter jumper, wrapped around a mandrel sized according to fiber type, to attach the light source to the cable plant. Fiber jumper shall be wrapped around mandrel no less than five (5) times. The jumper-mandrel assembly shall remain connected to the light source after calibration and the power meter moved to the far end using a new jumper to take measurements. Test set-up and performance shall be conducted in accordance with ANSI/TIA-568-C.3, and to the manufacturer's application guides.
 3. Singlemode
 - a. Test the optical fiber cable bi-directionally with an OTDR and uni-directionally with a power meter/light source. Fiber must be tested at both 1310nm and 1550nm. Maximum attenuation dB/Km @ 1310nm/1550nm shall be 0.5/0.5 for outside plant and 1.0/1.0 for inside plant. Maximum attenuation per connector pair shall be .75 dB. Attenuation testing shall be performed with a stable launch condition using one-meter or two-meter jumpers to attach the test equipment to the cable plant. The light source shall be left in place after calibration and the power meter moved to the far end to take measurements. Test set-up and performance shall be conducted in accordance with ANSI/TIA-568-C.3, and to the manufacturer's application guides.
 4. Approved optical fiber test equipment manufacturers are as follows:
 - a. Power Meters & Light Sources
 - 1) Optical Wavelength Laboratories (OWL)
 - 2) Noyes
 - 3) Photonix
 - 4) Fluke
 - 5) Agilent

b. Optical Time Domain Reflectometers (OTDR)

- 1) GN Nettest
- 2) Agilent
- 3) Fluke
- 4) Anritsu
- 5) Tektronix

D. Test Results

1. Test documentation shall be provided on disk as part of the as-built package. The disk shall be clearly marked on the outside front cover with the words "Project Test Documentation," the project name, and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair (or strand) and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.
2. The field test equipment shall meet the requirements of ANSI/TIA-568-C.2, ANSI/TIA-568-C.3, and/or ANSI/TIA-1152.
3. Printouts generated for each cable by the wire (or fiber) test instrument shall be submitted as part of the documentation package. Alternately, the Contractor may furnish this information in electronic form (CD). These CDs shall contain the electronic equivalent of the test results as defined by the Specification and be of a format readable from Microsoft Word.
4. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.

PART 3 - DOCUMENTATION, AS-BUILTS, TRAINING AND RECORDS

3.1 DOCUMENTATION & AS-BUILTS

A. As-Built record documentation for communications work shall include:

1. Cable routing and identification
2. System function diagrams
3. Manufacturers' description literature for equipment
4. Connection and programming schedules as appropriate
5. Equipment material list including quantities
6. Spare parts list with quantities
7. Details not on original Contract Documents
8. Test results
9. Warranties
10. Release of liens

B. The Contractor shall provide and maintain at the site a set of prints on which shall be accurately shown the actual installation of all work under this section, indicating any variation from contract drawings, including changes in pathways, sizes, locations and dimensions. All changes shall be clearly and completely indicated as the work progresses.

- C. Progress prints shall be available for inspection by the Owner or any of his representatives and may be used to determine the progress of communications infrastructure work.
- D. At the completion of the work, prepare a new set of as-built drawings, of the work as actually noted on the marked-up prints, including the dimensioned location of all pathways.
- E. Furnish as-built drawings and documentation. As-built drawings shall be generated in AutoCAD 2008 or later. Submit as-built drawings electronically on CD and hard copy.

3.2 OPERATIONS AND MAINTENANCE MANUAL

- A. After completion of the work, the Contractor shall furnish and deliver to the Engineer three (3) copies of a complete Operations & Maintenance Manual. A system wiring diagram shall be furnished for each separate system.
- B. The manual shall be subdivided into separate sections with tab dividers to identify subsystems of the integrated system. Reference appropriate Specification sections.
- C. Provide the following additional information for each electronic system. Information shall be edited for this project where applicable.
 - 1. Operations manuals for components and for systems as a whole
 - 2. Maintenance manuals for components and for system as a whole
 - 3. Point-to-point diagrams, cabling diagrams, construction details and cabling labeling details
 - 4. List of spare parts, materials and suppliers of components. Provide name, address and telephone number for each supplier.
 - 5. Emergency instructions for operational and maintenance requirements
 - 6. Delivery time frame for replacement of component parts from suppliers
 - 7. Recommended inspection schedule and procedures for components and for system as a whole
 - 8. List of spare parts, materials and suppliers of components. Provide name, address and telephone number for each supplier.
 - 9. Complete "reviewed" shop drawings and product data for components and system as a whole
 - 10. Troubleshooting procedures for each system and for each major system component

3.3 TRAINING

- A. The Contractor shall be responsible for training of facility personnel. Training shall take place after occupancy and before acceptance and shall include programs for on-site operations and maintenance of technology and communications systems. Training shall be for not more than ten (10) people, shall be held at the Owner's site and shall be of sufficient duration and depth to ensure that the trained personnel can operate the installed systems and can perform usual and customary maintenance actions.

3.4 WARRANTY

- A. General
 - 1. All equipment is to be new and warranted free of faulty workmanship and damage.
 - 2. Replacement of defective equipment and materials and repair of faulty workmanship within 24 hours of notification, except emergency conditions (system failures), which

must be placed back in service within eight (8) hours of notification, all at no cost to the Owner.

3. The minimum warranty provisions specified shall not diminish the terms of individual equipment manufacturer's warranties.

B. Voice & Data Structured Cabling

1. Manufacturer(s) shall provide a minimum 25-year warranty for components used in the installed Voice & Data Structured Cabling System. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

C. Pathway and Support Infrastructure

1. Manufacturer(s) shall provide a minimum 1-year warranty for components used in the installed Pathway & Support Infrastructure. Defective and/or improperly installed products shall be replaced and/or correctly installed at no cost to the Owner.

END OF SECTION

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SECTION 271000
STRUCTURED CABLING

PART 1 - GENERAL

1.1 GENERAL

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 27 Specification Sections, apply to this Section.
- B. This specification calls out actions to be taken, tasks to be performed by and responsibilities of the Communications Cabling Contractor in order to provide a complete telecommunications cabling system. Unless otherwise noted all following sections that describe such actions, tasks and responsibilities refer to the Contractor.
- C. Comply with all applicable governmental regulations and with all federal, state, city and other codes and ordinances.
- D. Work called for in this specification includes work to be performed by the Contractor, and any Sub-Contractors under the employ of the Contractor or others who work on behalf of the Contractor.
- E. This Specification covers the communications cabling systems for the Javits Transformer Building construction project in New York, NY.

1.2 SYSTEM INTEROPERABILITY

- A. To achieve and maintain manufacturer-guaranteed system performance, all key components of the structured system, e.g., cables, connectors, patch panels, etc., shall be:
 - 1. Produced by the same manufacturer, or
 - 2. Produced by two or more manufacturers who have established a certification partnership to provide and warranty structured system performance, and
 - 3. Installed by a qualified contractor who is formally authorized under the manufacturer's certification to provide a warrantee system installation.

1.3 WORK INCLUDED

- A. The work covered by this specification includes the construction described, including all labor necessary to perform and complete such construction; all materials and equipment incorporated or to be incorporated in such construction; and all services, facilities, tools and equipment necessary or used to perform and complete such construction.
- B. Provide the following:
 - 1. All communications unshielded twisted pair (UTP) copper service cables from the Telecommunications Service Entry Facilities (TSEF) to the Main Distribution Frame (MDF), including terminations.
 - 2. All optical fiber service cabling from the TSEF to the Main Lightguide Frame (LGX), including connectorization.

3. All communications backbone unshielded twisted pair (UTP) copper cables from the Main Distribution Frame (MDF) to the Intermediate Distribution Frames (IDFs) in the Telecommunications Rooms (TRs), including terminations.
4. All optical fiber backbone cabling from the Main Lightguide Frame (LGX) to the OF panels in the Telecommunications Rooms (TRs) and other locations as shown on drawings, including connectorization.
5. All horizontal telecommunications cables from the Telecommunications Rooms (TRs) to the Work Area Outlets (WAOs) and Wireless Access Points (WAPs) as indicated on drawings, in the quantities and locations indicated, including terminations.
6. All factory-assembled patch cords and mounting cords, in the sizes, colors and quantities specified.
7. All cross connections of copper systems backbone to horizontal cables with appropriate termination hardware (as indicated).
8. Copper cable termination blocks and patch panels, optical fiber termination boxes, panels and shelves, wiring frames, equipment racks and cabinets, wire managers, cross connect supports and guide rings in the equipment rooms and other locations as shown on drawings.
9. All jacks, connectors, adapters, terminating devices, faceplates, dust caps, etc.
10. All secondary distribution cable supports (J-hooks, slings, etc.), including mounting and installation hardware, within ceilings and below raised access flooring, except as provided for in the cable pathways specifications.
11. All field cutting and grommeting, as required, of furniture system wireways to accommodate work area outlet cable infeeds.
12. Labeling and documentation of all cables, racks, outlets and hardware installed under this contract.
13. All cable termination, cross connection and patching schedules for all cables installed under this work, with cable and outlet identification numbering as described herein.
14. Cable testing and test documentation.
15. All connections of communications components to the telecommunications grounding system.
16. Fire-stopping of all rated wall and floor penetrations and openings through rated walls and floors after installation of communications cabling.
17. All non-specified miscellaneous hardware, e.g., nuts, bolts, tie wraps, wire rings, supporting hardware, etc.

1.4 RELATED WORK NOT INCLUDED IN THIS SECTION AND SPECIFIED ELSEWHERE, UNLESS OTHERWISE NOTED.

- A. Security, Audio-Visual, BMS and Display systems cabling and equipment (to be designed and specified by others)
- B. Raceway, cable tray, ladder runway, sleeves, channels, conduits and pull boxes specified under Section 27 05 28 Pathways for Communications Systems and Electrical specifications.
- C. A J-607-A standard-compliant telecommunications grounding system to be provided under Section 27 05 26.
- D. Raised access flooring (specified under Architectural design).
- E. Conduit stubs below floors and above the finished ceilings at designated locations to be provided under the Electrical contract.
- F. Double gang, 2-1/4" deep back boxes at each wall mounted outlet location to be provided under the Electrical contract.

- G. Shared power/telecom raised access floor flush mounted boxes to be provided under the Electrical contract.
- H. All fire rated plywood in equipment spaces.
- I. Installation of and cross-connection to hardware and cabling assemblies supplied by telephone system, data or data hardware vendors.
- J. Provision of inter-machine cabling and ancillary communications cabling within the equipment rooms, except as indicated on the drawings.
- K. Cutting, patching, and painting.

PART 2 - EXECUTION

2.1 GENERAL

- A. Follow manufacturers' instructions for installing all communications cabling. Where instructions are unavailable, follow industry standards.
- B. Compare communications drawings and specifications with the drawings and specifications of other trades, report any discrepancies to the Engineer and obtain written instructions for changes necessary in the work. Include most stringent requirements in bid.
- C. Repairs or changes caused by contractor's neglect shall be made at contractor's expense. Protect finished work of other trades from damage or defacement and remedy any damages as required.
- D. Clean up all debris generated by installation activities and discard as directed.
- E. Maintain a current copy of this bid specification at the job site at all times.

2.2 STAFFING

- A. The Contractor shall have a minimum of five (5)-years' experience with projects of comparable size installing Category 5e/6 unshielded twisted pair cabling in compliance with ANSI/TIA/EIA-568 standards.
- B. The Contractor shall designate a qualified foreman formally certified in manufacturer's cabling system to be installed. The foreman shall be present in the field at all times during the performance of the work.
- C. Provide a supervisory work force sufficient to maintain efficient performance of the contractor's responsibilities.
- D. Use only skilled and reliable work force and discontinue the services of anyone employed on this project upon written request by the owner, architect or engineer.
- E. Craft personnel shall be qualified (at minimum) to perform all of the installation and testing work activities required under the contract.

- F. Provide and use the proper tools in good working order for the performance of the work. The engineer reserves the right to review the tools and tool maintenance procedures of the contractor and require replacements be obtained.
- G. Telephone and data industry cable installation standards, TIA/EIA and BICSI standards, and manufacturers' instructions shall be used for in-process quality control and final acceptance of the work.

2.3 CABLE INSTALLATION

- A. Furnish and install communications cables per the drawings and specifications and manufacturers' recommendations.
- B. Cable Pulling
 - 1. Pulling tension on a 4-pair UTP cable shall not exceed 25-lbs.
 - 2. Pulling tension on optical fiber shall not exceed the fiber's rated maximum tensile load.
 - 3. To limit the incidence of micro-bending of the individual fiber strands, mesh-type, swivel-eye pulling grips shall be employed for all fiber optic cable pulling.
- C. Cable Slack
 - 1. Leave at least 6-inches of slack at each terminal box or behind each faceplate after jack installation is completed to allow for easy dismounting and extension of outlet covers and wire terminations.
 - 2. Provide a minimum of 3-feet slack in a loop in horizontal UTP in the ceilings at the top of each stub-up, secured to a ceiling support with a Velcro strap.
 - 3. Provide a minimum of 6-feet slack in a loop in horizontal UTP in floors below each flush floor box, secured to a floor pedestal with a Velcro strap.
 - 4. Provide a minimum of 10-feet of slack in a loop in optical fiber backbone cable at its point of entry to an equipment room. Secure slack loop to ladder runway or other permanent support with a Velcro strap.
 - 5. Provide a minimum of 30' slack in each Wireless Access Point cable, coiled in a loop and secured to the ceiling support black iron within the ceiling void with a Velcro strap.

2.4 CABLE DISTRIBUTION

- A. Cables run open, concealed within the voids above suspended accessible ceilings shall be supported throughout the length of their runs on open steel basket cable tray and on J-hooks or adjustable cable slings mounted on all threaded rods installed in the ceiling slabs every 5-feet on center.
- B. Cables run above inaccessible ceilings or within other inaccessible areas shall be contained in conduit. In no case shall ceiling support grids, plumbing pipes, electrical conduits, service hangers, HVAC ducts or other tradework be used to support communications cabling.
- C. Vertical transition from suspended ceilings to flush mounted outlets shall be in 1" ID conduits with plastic end bushings. All flush mounted outlets shall be fitted with single gang faceplates mounted on two-gang junction boxes with plaster reducing rings.
- D. Vertical transition from cable tray run openly below ceilings shall be within 1" ID conduits run within walls or via surface mounted wiring channels.

- E. Vertical transition from suspended ceilings to two-gang distribution boxes serving as in-feeds to furniture system wireways shall be in 1-1/2" conduits with plastic end bushings run to the nearest accessible ceiling.
 - 1. Furniture distribution back boxes shall be fitted with split stainless steel faceplates with grommets 1-1/2" round openings.
 - 2. The maximum quantity of Category 6 UTP run through any single 1-1/2" conduit to furniture distribution shall not exceed twenty (20) cables.
- F. Raised access floor outlets shall be contained in either shared power/telecom flush floor boxes with cable run open beneath the floor or in flush mount wall junction boxes with access provided via 1" ID conduit extended from the floor void.
- G. Wherever cable bundles descend from cable tray or conduit/sleeve ends to other means of support, they shall be supported by cable ladders or grids to be provided for that purpose. Cabling shall be attached to supports by Velcro straps only.
- H. Utilize the shortest practical cable run length within the designated pathways. The Contractor shall be held responsible for horizontal cable runs that exceed maximum distance limitations (90 meters overall) due to circuitous routing or poor slack management.
- I. All cables, after entry into equipment rooms must be secured to backboards and dressed into supports. The Contractor shall attach the cables where required to plywood backboards using Velcro cable ties at spacing of approximately 12 inches. Velcro cable ties shall be secured to backboards using #10 machine screws and metallic washers or rigid tabs.

2.5 EMI/RFI AVOIDANCE

- A. To avoid electromagnetic interference (EMI) route cables to maintain the following minimum distances:
 - 1. Three-inches from power lines of 2 KVA or less installed in conduits or grounded flexible armor below access floors.
 - 2. Three-inches from fluorescent fixtures with remotely installed ballasts. Five-inches from standard fixtures.
 - 3. Five-inches from power lines 2 KVA or less.
 - 4. Twelve-inches from power lines of between 2 to 5 KVA.
 - 5. Twelve-inches from 110 to 277 volt lighting.
 - 6. Twenty-four inches from power lines of 5 KVA or greater.
 - 7. Three-feet from transformers or motors.
- B. Maintain minimum a twelve inch separation between telecommunication cables running exposed in ceiling or floor voids and parallel electrical cables/conduits.
- C. Telecommunication cables shall cross electrical cables/conduits at 90 degree angles.

2.6 FIRESTOPPING

- A. Seal all penetrations through fire rated walls, floors and walls created by or made on the behalf of the contractor so that the original fire rating of the floor or wall is maintained as required by Article 300-21 of the National Electric Code.

- B. The sealant material shall have been subjected to fire exposure in accordance with standard time-temperature curve in the standard, UL, ASTM E 119, and NFPA 251. The fire-stop material shall have also been subjected to the hose stream test in accordance with UL 10B.
- C. Provide removable fire-stopping pillows in an approved fashion in openings greater than 4-inches in diameter, or 4" X 4" square cross section. Provide wire mesh grate over bags as recommended by manufacturer subsequent to installation. Provide intumescent putty in all openings smaller than 4" in diameter.
- D. Refer to Specification 07 84 00 – Firestopping – for additional requirements.

2.7 WARRANTY AND ACCEPTANCE

- A. Warranty all portions of the work in accordance with manufacturer's maximum warranty program allowances.
- B. Once cable testing has been completed, as-built and testing documentation delivered to the Engineer, and the Engineer is satisfied that all work is in accordance with the contract documents, the Engineer shall notify the contractor in writing of the acceptance of the work performed. The date of this acceptance shall constitute the commencement of the warranty period.

END OF SECTION

SECTION 280000

SECURITY GENERAL SYSTEM REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general conditions for contracts of construction, referred to in the contract documents as the general conditions, together with the following articles of the security systems specifications, which amended, modify or supplement various sections, articles and provisions of the general conditions, are made part of the Contract and shall apply to all work under the Contract.
- B. All articles or parts of articles of the general conditions not so amended, modified or supplemented by these security systems specifications shall remain in full force and effect. Should any discrepancy become apparent between the general conditions and these security systems specifications the contractor shall notify client, in writing and the client's representative shall interpret and decide such matters in accordance with the provisions of the General Conditions.
- C. The contractor will comply with all applicable governmental regulations and with all City, and other applicable codes and ordinances.
- D. These specifications call out certain duties of the contractor and his suppliers. They are not intended as a materials list of items required by the contract.
- E. These divisions of the Specifications cover the security systems requirements for client.
- F. It is the intent of these specifications to provide a complete workable security system ready for the client's use as described within the sections 28000-284000. Any items not specifically detailed on the drawings or described in the Specifications, but normally required to conform to the intent, are to be considered as part of the Contract.
- G. These specifications are equipment and performance specifications. Actual installation shall be as indicated on drawings, specifications and/or contained within the manufacturers written installation instructions. Any discrepancies found between the specification, drawings and manufacturers installation instructions shall be immediately brought to the attention of engineer/client in writing at once. Installation and details indicated on the drawings shall govern if they differ from the specifications.

1.2 RELATED DIVISIONS/SECTIONS

- A. DIVISION 8, 080671, Door Hardware Schedule
- B. DIVISION 26, Electrical Provisions
- C. DIVISION 27, Communications
- D. DIVISION 28, Sections 280000-284000

1.3 SUMMARY

A. General Systems Overview

1. The security contractor for the project shall be responsible for the coordination and providing the interface for all the systems, to include interfacing and coordinating the signals from other systems from BMS, Fire Alarm (FA), intrusion, video surveillance, access control systems, as applicable.
2. Video surveillance- The video surveillance system will be integrated with the Access Control System to the greatest extent possible. The number of camera views is to be user definable based on bandwidth of the Ethernet connection. The video surveillance system will be configured to allow all cameras to be setup with video motion or field of view changes to trigger alarms requiring action from the operators. These triggers are to be audible and visual. When an alarm is triggered a sound will be generated and the frame around the camera view will flash in "red." Alarms will also be triggered for the video surveillance system by the intrusion control system. All alarm points are to be connected to the video surveillance system and upon activation of any point the video surveillance system will activate the presets for that point and Pan, Tilt, Zoom associated cameras to the general location, if no direct view is available from a fixed camera.
3. The Door monitoring system will provide alarm input and output points for all doors shown on drawings and listed in the Architectural door schedule. The alarm relay for 16 inputs shall be wired to provide an alarm output for all and future input points for each control panel. The Alarm or relay outputs shall provide the inputs to the video surveillance system allowing the programming of presets to any or all alarm points. All cabling is to be supervised with EOL resistor(s) or relay for the system. This is to include relays in case of power failure the security monitoring station will know of failure without testing.

B. Labor and Materials

1. Unless otherwise provided in the drawings and specifications, the contractor shall provide and pay for all labor, materials, equipment, tools, utilities, permits, construction equipment and machinery, transportation and other facilities and services necessary for the proper execution, operation and completion of the work.

C. Specification Language

1. Specifications and notes are written in imperative and abbreviated form. Imperative language of the technical specifications is directed at the contractor, unless specifically noted otherwise. Inserting "shall", "shall be", "the contractor shall", and similar mandatory phrases shall complete incomplete sentences by inference. The words "shall be" shall be supplied by inference where a colon (:) is used within product specifications.
2. Certain terms such as "shall, provide, install, complete, startup" are not used in some parts of these specifications. This does not indicate the items shall be less than completely installed or the systems shall be less than complete.

D. Drawings and Specifications

1. Contractor shall be provided three (3) sets of the drawings and Specifications for his use. Additional sets, if requested by contractor, shall be furnished to the contractor for the actual cost of reproduction.
2. Contractor shall carefully study the drawings and Specifications, and shall report any errors, unforeseen circumstances, inconsistencies or omissions that may be discovered at once to the engineer/client in writing.

3. The client's project manager shall be the interpreter of the requirements of the drawings and Specifications and subject to the final approval of client. All interpretations and opinions of the Security engineering Consultant shall be made in writing or in the form of drawings.

E. Intent and Correlation

1. The intent of the Project drawings and Specifications is to include all items necessary for the proper execution and completion of the work.
2. The Project drawings and Specifications are complementary, and what is required by any one shall be as binding as if required by both.

1.4 REFERENCES

- A. Submit the names and phone numbers of customers for at least three other projects of similar size and complexity using similar technologies and equipment.
- B. Security contractors must meet eligibility requirements of the project or other approving agencies prior to bid.

1.5 CODES, REGULATIONS, AND STANDARDS

- A. The installation shall be in compliance with the requirements of the National Electrical Code, recommendations and the rules, regulations and requirements of Federal Communications Commission.
- B. The installation shall comply fully with all City, county and state laws and ordinances, regulations and codes applicable with the installation.
- C. Local electrical and building codes may differ with national codes. Follow the most stringent code or recommendations. Where there are instances of ambiguity refer to the Engineer/client's project manager for interpretation.
- D. All equipment shall be equal to or exceed the minimum requirements of NEMA, IEEE, ASME, ANSI and Underwriters Laboratories and approved for commercial installation.
- E. When any change in the plans or specifications is required to comply with governmental regulations, the contractor shall notify the engineer/client at the time of submitting the construction schedule.
- F. Utilize the following abbreviations for applicable codes, standards and regulations on the drawings and within the Specifications which apply to the security system and are to be considered part of these specifications:
 1. NEC National Electric Code
 2. ANSI American National Standards Institute
 3. NFPA National Fire Protection Association
 4. IEEE Institute of Electrical and Electronics Engineers
 5. UL Underwriters' Laboratories, Inc.
 6. ASTM American Society of Testing Materials
 7. EIA/TIA Electronic Industries Association/ Telecommunications Industries Association
 8. FCC Federal Communications Commission

1.6 DEFINITIONS

- A. Words that are in common use are used throughout the drawings and Specifications, except:
1. Words, which have well-known technical or trade meanings, are used in accordance with such recognized meanings.
 2. Whenever the following listed words and phrases are used, they shall be mutually understood to have the following respective meanings:
 - a. The words "as indicated" means: as shown on the drawings and in accordance with the Specifications.
 - b. The words "as required" means: as required to provide complete and satisfactory work in full conformance with the drawings and Specifications.
 - c. The word "New" means: new work to be provided by contractor.
 - d. The word "work": The work is the completed construction required by the drawings and Specifications, and includes all labor necessary to produce such construction, and all materials and equipment incorporated or to be incorporated in such construction.
 - e. "PROVIDE" or "FURNISH" means to supply, purchase, transport, place, erect, connect, test and turn over to client, complete and ready for regular operation, the particular work referred to.
 - f. "SUPPLY" means to purchase, procure, acquire, and deliver complete with related accessories.
 - g. "INSTALL" means to move from property line, set in place, join, unite, fasten, link, attach, set up or otherwise connect together before testing and turning over to client of equipment supplied under another division. Installation to be complete and ready for regular operation, the particular work referred to.
 - h. "WIRING," means the inclusion of all fittings, conductors, connectors, connector strips, connections, termination and all other items necessary and/or required in connection with such work.
 - i. "CONDUIT" means the inclusion of all fittings, hangers, supports, sleeves, etc.
 - j. "AS DIRECTED" means: as directed by client or his representative.
 - k. "CONCEALED," means embedded in masonry or other construction, installed behind wall furring or within double partitions, or installed within hung ceilings.
 - l. "EXPOSED" means not installed underground or "CONCEALED" as defined above.
 - m. "Bypass" and "Shunt" means to provide or divert (current) by means of a shunt. As applied to access control, not sound or send an alarm when a door is "shunt or bypassed".

1.7 CONTRACTOR DESIGN REQUIREMENTS

- A. The Project drawings represent the level of system design to be provided by client. The contractor shall provide all additional system design work required, including:
1. Conduit layout and sizing
 2. Wire and cable layout and sizing
 3. Point-to-point wiring and equipment hook-up information
 4. Equipment mounting details
 5. Design and layout of equipment cabinets
 6. Other detailed design work required

- B. Contractor's design shall conform to all applicable codes and ordinances. All electrical design, including the sizing and placement of conduit, raceways and conductors, shall be in accordance with:
 - 1. Current edition of NFPA 70 National Electrical Code, (unless local codes establish more stringent requirements).
 - 2. Division 26 Specifications
- C. Contractor's design work is subject to review and approval by engineer/client's project manager.
- D. Contractor's design shall also include:
 - 1. The addition of all wire, cable, conduit, connectors and junction boxes required for system operation.
 - 2. Install conduit between all equipment as specified and/or necessary.
 - 3. Complete "as-built" documentation of all security systems, including documentation of existing equipment, wiring, conduits, and raceways.
 - 4. Other work as defined within the Project drawings and Specifications.

1.8 SUBMITTALS

- A. Shop Drawings: Shop drawings shall be submitted in accordance with Division 1, and shall consist of a complete list of equipment and materials, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions
- B. After notice to proceed or as directed by the client or client's Representative, or after execution of client/contractor Agreement, prepare an index of all submittals for the project. Include a submittal identification number, a cross-reference to the Specification sections or Drawing number, and an item description. Prefix the submittal identification number by the Specification sections to which they apply. Indicate on each submittal, the submittal identification number in addition to the other data specified. All subcontractors shall utilize the assigned submittal identification number.
- C. After the contract is awarded, obtain complete shop drawings, product data and samples from the manufacturers, suppliers, vendors, and all subcontractors, for all materials and equipment as specified.
- D. Submit to the engineer for review all equipment, data and details of such materials. Prior to submission, certify the shop drawings, product data and samples are in compliance with the Contract Documents.
- E. Check all materials and equipment upon their arrival on the job site and verify their compliance with the Contract Documents. Modify any work that proceeds prior to receiving accepted shop drawings as required to comply with the Contract Documents and the shop drawings.
- F. Review of submittals is for general compliance with the design concept and Contract Documents. Comments or absence of comments shall not relieve the contractor from compliance with the Contract Documents. The contractor remains solely responsible for details and accuracy, for confirming and correlating all quantities and dimensions, for selecting fabrication processes, for techniques of construction, for performing the work in a safe manner and for coordinating the work with that of other trades.

- G. No part of the work shall be started in the shop or in the field until the shop drawings and samples for that portion of the work have been submitted reviewed and accepted.
- H. A minimum period of ten working days, exclusive of transmittal time, is required in the Engineer's office each time a shop drawing, product data and/or samples are submitted for review. The contractor in the scheduling of the work must consider this time period.
- I. Submit two prints of all items required in shop drawings. Submit six copies of manufacturer's product submittals.
- J. Submittals will be stamped as follows:

Stamp	Interpretation
No Exceptions Noted	Fabrication, manufacture, or construction may proceed providing submittal complies with the Contract Documents.
Exceptions Noted [] Resubmit for Record [] No Resubmission Required	Fabrication, manufacture, or construction may proceed providing submittal complies with the Contract Documents and the Engineer's notations are complied with.
Revise and Resubmit	The submittal does not comply with the Contract Documents; do not proceed with fabrication, manufacture, or construction. The work and shop drawings are not permitted at the job site. Resubmit appropriate shop drawings.

1.9 PRODUCT DATA

- A. Product Data submittal shall be required from the contractor for all security equipment to be installed regardless whether or not a particular brand product is or is not specified or recommended.
- B. Any system substitution proposed as an equal to what is herein specified shall be proven to be such by the contractor. The contractor shall send a letter stating why the contractors feels the systems are equal along with the name and model numbers of substituted equipment and material together with three copies of specifications and dimensional drawings to the architect no less than ten days prior to the bid date. The contractor shall obtain the architect's approval in writing, by addendum, prior to bid date. No substitutions will be allowed, approved or accepted after bid date. Any substitution submitted without approval may be rejected and may void the complete bid package submitted.

C. Procedures

1. Provide submittals to client's project manager.
2. Submit **electronic color** copies of each submittal.

D. Shop Drawings

1. Submit shop drawings, as specified general shop drawings for the project as described elsewhere.
2. Provide other shop drawings if specifically requested by client's project manager.

E. Manufacturer's Installation and Programming Instructions

1. Provide manufacturers written installation and programming instructions as requested in the various Specification Sections.
2. Spare Parts Data: After approval of the shop drawings, and not later than one month prior to the date of beneficial occupancy, a list of spare parts data for each item of specified materials and equipment shall be submitted. The data shall include a complete list of parts and supplies with current unit prices and source of supply. All spare parts shall be on site prior to commencement of acceptance testing. Depleted spare parts shall be replaced prior to beneficial occupancy.

F. Operating and Maintenance Instructions

1. Operating Instructions: The contractor shall furnish to the client/architect six copies of operating instructions outlining the step-by-step procedures required for system startup, operation, and shutdown at least 30 days prior to acceptance test. The instructions shall include the manufacturer's name, system model number, service manual, parts list, and brief description of all equipment and their operating features.
2. Maintenance Instructions: The contractor shall furnish six complete copies of manufacturers written maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guidelines at least 30 days prior to acceptance test. The instructions shall include simplified diagrams for the systems as installed.
3. Performance Test Reports: Upon Completion and testing of the installed system, test reports shall be submitted in booklet form showing all field tests performed to prove compliance with specified performance criteria. Each test report shall indicate the final position or readings of calibrating controls.

G. Project Record Drawings

1. Definition: Project Record drawings are drawings that completely record and document all aspects and features of the work. (Project Record drawings are also, known as "As-Built" Drawings.)
2. The purpose of Project Record drawings is to provide factual information regarding all aspects of the work, to enable future service, modifications, and additions to the work.
3. Project Record drawings are an important element of this work. Contractor shall accurately maintain Project Record drawings throughout the course of this project. Project Record drawings shall include documentation of all work, including the documentation of existing equipment, wiring, conduits, and raceways that are to be reused in the work.
4. Client project manager shall furnish contractor with two (2) sets of site plans for contractor's use in preparing Project Record Drawings. One set shall be used as a working set; the other shall be used to prepare the final record set.
5. Contractor shall maintain the working set of Project Record drawings at the project site throughout the course of the work. The working set shall be updated on a daily basis as the work progresses.

6. Project Record drawings shall accurately show the physical placement of the following:
 - a. Equipment and devices
 - b. Conduit and raceways
 - c. Junction and pull box locations
 - d. End-of-line resistor locations
 - e. Interfaces to external equipment
 - f. Connections to power and telephone circuits
7. Project Record drawings shall show the physical placement of each device and conduit or aerial centerline, to be accurate to within one foot (1') of the nearest landmark. Where the site plan furnished by client project manager, conflicts with actual conditions, contractor shall amend site plan as required. Indicate exact description of conduit runs (above ground, two foot (2') trench, along outside wall of building, etc.).
8. Project Record drawings shall show wire and cable runs, zone numbers, tamper circuit configuration, panel/circuit breaker numbers from which, equipment is powered and splice points. Such information may be shown on the site plans.
9. Project Record drawings shall be available for inspection by client project manager on a daily basis. Incomplete or inaccurate Project Record drawings may be cause for delay of contractor's payment.
10. Upon completion of work, and prior to Final Acceptance, contractor shall prepare and submit to client project manager a final record set of Project Record Drawings. This set shall consist of all data transferred from the working set, supplemented by Riser Diagrams and other information. The final record set of Project Record drawings shall be drafted by a skilled draftsman, under the supervision of contractor. All final Project Record drawings shall be provided to client.
11. Contractor shall provide **three (3) sets** of Project Record Drawings: one for the Security Department, one for the Facilities Department, and one for the System Designer/Consultant.
12. Each "set" of Project Record drawings shall consist of all sheets plotted on 30x42-inch paper suitable for reproduction and shall provide all drawings on disk (CD-ROM, DVD).

H. System Documentation

1. Definition: System Documentation is a complete collection of all installation, programming, operation, and maintenance manuals and work sheets relating to the equipment provided as part of the work.
2. Contractor shall maintain a file of System Documentation at the project site throughout the course of the work. Such file shall be updated with new information as equipment is received and installed. System Documentation shall be available for inspection by client's project manager on a daily basis.
3. Upon completion of work, and prior to final Acceptance, contractor shall prepare and submit to client's project manager three (3) sets of System Documentation.

I. Closeout Submittals

1. Provide all sets of as-built drawings and manuals to the client project manager as described within these documents:
 - a. As-Built Drawings
 - b. Mounting Details
 - c. Product Data
 - d. Installation Manuals
 - e. Operating Manuals
 - f. Maintenance/Service Manuals

2. Provide the client project manager- with all programming sheets, keys to the equipment cabinets, as-built drawings, operating manuals, maintenance/repair manuals, spare fuses; tools for tamper-resistant enclosures and tools for manual resetting devices.

1.10 QUALITY ASSURANCE

- A. All materials furnished shall be new and unused and free from any defects. All materials shall meet all applicable codes provided a standard has been established for the material in question.
- B. All products and materials are to be clean, free of defects, and free of damage and corrosion.
- C. QUALIFICATIONS OF CONTRACTOR
 1. Contractor shall be an installation and service contractor regularly engaged in the sale, installation, maintenance and service of electronic security systems.
 2. Contractor shall have **five (5) years'** experience with the installation, start-up and programming of systems of a similar size and complexity to the one proposed.
 3. Contractor shall be a factory authorized dealer of the system proposed for at least **two (2) years**.
 4. Contractor shall have permanent offices and factory trained personnel to install and service the security system within twenty-five (25) miles of the jobsite.
 5. The contractor shall be factory certified for the installation, design and programming of the manufacturers equipment to be installed.
- D. Supervision of Work
 1. Contractor shall employ a competent Foreman to be in responsible charge of the work. Foreman shall be on the project site daily during the execution of the work.
 2. Contractor's Foreman shall be a regular employee, principle, or officer of contractor, who is thoroughly experienced in projects of a similar size and type. Contractor shall not use contract employees or Subcontractors as Foremen.
- E. Qualifications of Technicians
 1. All electronic systems work shall be performed by electronic technicians thoroughly trained and certified in the installation and service of specialty low-voltage electronic systems.
 2. Journeyman Wireman electrical workers may be used to install conduit, raceways, wiring, and the like, provided that final termination, hook-up, programming, and testing is performed by a qualified and certified electronic technician. All such work conducted by Journeyman Wireman electrical workers is supervised by the security contractor's Foreman.
 3. All incidental work, such as cutting and patching, lock hardware installation, painting, carpentry, and the like, shall be accomplished by skilled craftsperson's regularly engaged in such type of work. All such work shall comply with the highest standards applicable to the respective industry or craft.
 4. All 120 VAC power wiring and connections are to be performed by a qualified Journeyman Electricians, licensed to perform such work.
- F. Subcontractors
 1. Definition: A Subcontractor is a person or entity that has a direct contract with the contractor to perform any of the work at the site.
 2. Use of any Subcontractor is subject to the approval of client. The contractor shall identify all Subcontractors on the Bid Form. The contractor shall make no substitution for any Subcontractor previously selected without approval from client.

3. Contractor's Foreman shall be on the project site daily during all periods when Subcontractors are performing any work. Contractor's Foreman shall be in responsible charge of all work, including any work being performed by Subcontractors.
4. By an appropriate written agreement, the contractor shall require each Subcontractor, to the extent of the work to be performed by the Subcontractor, to be bound to the contractor by the terms of the drawings and Specifications, and to assume toward the contractor all the obligations and responsibilities which the contractor, by these documents, assumes toward client.
5. Within two (2) months after notice to proceed by the client or client's Representative, or after execution of client/contractor Agreement, submit a complete typed list of all electrical equipment manufacturers and material suppliers for the equipment proposed to be provided on this project, as well as names of all subcontractors.

G. Supervision and Construction Procedures

1. The contractor shall supervise and direct the work, using his best skill and attention. Contractor is solely responsible for all construction means, methods, and techniques.
2. The contractor shall employ a competent foreman who shall be in attendance at the project site during the progress of the work. The foreman shall represent the contractor and all communications given to the foreman shall be as binding as if given to the contractor.

H. Regulatory Requirements

1. All work is to conform to all building, fire, and electrical codes and ordinances applicable in the client. In case of conflict between the Drawings/Specifications and codes, the codes shall govern. Notify client project manager of any such conflicts.
2. Contractor shall secure and pay for all licenses, permits, plan reviews, engineering certifications, and inspections required by regulatory agencies. The contractor shall prepare, at contractor's expense, any documents, including drawings, which may be required by regulatory agencies.

I. Permits

1. The contractor shall make application for and obtain any and all permits required by federal, state, county, city, or other authority having jurisdiction over the work.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Security of contractor's Tools and Equipment

1. Client is not responsible for the care, storage or security of any of the contractor's tools or equipment.

1.12 PROJECT/SITE CONDITIONS

A. Environmental Conditions

1. Power: client will supply electrical power to the extent that the usage is compatible with available facilities in the vicinity of the work.
2. Telephone: contractor may use a telephone designated by client for local and toll-free calls. The costs of long distance calls are the responsibility of the contractor and shall not be charged to client.
3. Restroom Facilities: contractor may use existing Restroom facilities designated by client.
4. Parking: client reserves the right to limit or restrict contractor parking based upon the daily requirements of the other contractors on site.

5. Dust Control: Make provisions to control all dust, dirt, and foreign material caused by the performance of the work.
 6. Use of explosive type fastening equipment is prohibited.
 7. Notify client immediately of any damage or possible damage to any other equipment.
- B. Clean-Up
1. Contractor shall clean up, on a daily basis as the work progresses, all dirt, dust and debris caused by contractor's operations. Clean up shall be completed by the end of each workday to the satisfaction of client's on-site representative.
 2. In the event that contractor fails to clean up, client may elect to have clean up performed by others, with the costs of such clean-up being charged to the contractor.
- C. Construction Aids
1. Definition: Construction Aids are facilities and equipment required by personnel to facilitate the execution of the work. Construction Aids include scaffolds, staging, ladders, platforms, hoists, cranes, lifts, trenchers, core drillers, protective equipment, and other such facilities and equipment.
 2. Contractor shall provide all Construction Aids required in the execution of the work.
 3. Persons authorized to provide such use of requested construction aids shall not use Construction Aids that are the property of client or other contractors without written permission.
 4. Storage of Construction Aids shall be coordinated with client's on-site representative.
- D. Safety
1. The contractor shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the work.
 2. Contractor shall comply with all local, state, and federal regulations and laws for the safety of the work place.
- E. Accident Reports
1. Serious or fatal accidents shall be reported immediately by telephone, radio or in person to the client's project manager.

1.13 COORDINATION OF THE WORK

- A. The Contract Documents establish scope, materials and quality but are not detailed installation instructions. Drawings are diagrammatic.
- B. Coordinate work with other trades and furnish, in writing, any information necessary to permit the work of related trades to be installed satisfactorily and with the least possible conflict or delay.
- C. The Security drawings show the general arrangement of equipment and appurtenances. Follow this drawing as closely as the actual construction and the work of other trades will permit. Provide offsets, fittings, and accessories that may be required but not shown on the Drawings. Investigate the site, review the drawings of other trades to determine conditions affecting the work, and provide such work and accessories as may be required to accommodate such conditions.
- D. The locations of cameras, outlets, panels and other equipment indicated on the drawings are approximately correct, but they are understood to be subject to such revision as may be found necessary or desirable at the time the work is installed in consequence of increase or reduction of the number of devices, or in order to meet field conditions, or to coordinate with

modular requirements of ceilings, or to simplify the work, or for other legitimate causes. Such revisions shall not constitute a change order and no additional funds will be provided for these moves.

- E. Exercise particular caution with reference to the location of panels, cameras, switches, etc., and have precise and definite locations accepted by the Architect before proceeding with the installation.
- F. The drawings show only the general run of raceways and approximate locations of security devices. Any significant changes in location of cameras, panels, etc., necessary in order to meet field conditions shall be brought to the immediate attention of the Architect for review before such alterations are made. Modifications shall be made at no additional cost to the client.
- G. Verify with the Architect the exact location and mounting height of cameras and equipment not dimensionally located on the security Drawings.
- H. Circuit tags in the form of numbers are used where shown to indicate the circuit designation numbers in electrical panels. Show the actual circuit numbers on the as-built Record drawings and on the associated typed panel board directory card. Where circuiting is not indicated, provide required circuiting in accordance with the loading indicated on the drawings and/or as directed.
- I. The drawings generally do not indicate the number of wires in conduit for the branch circuit wiring of fixtures and outlets, or the actual circuiting. Provide the correct wire size and quantity as required by the indicated circuiting and/or circuit numbers indicated, the control intent, referenced wiring diagrams by the manufacturer, the specified voltage drop or maximum distance limitations, and the applicable requirements of the NEC.
- J. Carefully check space requirements with other trades to insure that equipment can be installed in the spaces allotted. This is especially applicable in the telecommunications rooms.
- K. Wherever work interconnects with work of other trades, coordinate with other trades to insure that they have the information necessary so that they may properly install the necessary connections and equipment. Identify items (remote power supplies, pull boxes, etc.) requiring access in order that the other trades will know where to install access doors and panels.
- L. Consult with other trades regarding equipment so that, wherever possible, controls and equipment are of the same manufacturer.
- M. Furnish and set sleeves for passage of risers through structural masonry and concrete walls and floors and elsewhere as required for the proper protection of each security riser passing through building surfaces.
- N. Provide fire stop around all pipes, conduits, ducts, sleeves, etc. which pass through rated walls, partitions and floors per section 280537.
- O. Provide detailed information on openings and holes required in pre-cast members for security work.
- P. Provide required supports and hangers for conduit and equipment, designed so as not to exceed allowable loadings of structures.

- Q. Examine and compare the Contract drawings and Specifications with the drawings and specifications of other trades, and report any discrepancies between them to the Architect and obtain written instructions for changes necessary in the work. Install and coordinate the work in cooperation with other related trades. Before installation, make proper provisions to avoid interferences.
- R. Wherever the work is of sufficient complexity, prepare additional detail drawings to scale to coordinate the work with the work of other trades. Detailed work shall be clearly identified on the drawings as to the area to which it applies. Submit these drawings to the Architect for review. At completion include a set of these drawings with each set of Record Drawings.
- S. Furnish services of an experienced Superintendent, who shall be in constant charge of all work, and who shall coordinate work with the work of other trades. No work shall be installed before coordinating with other trades.
- T. Coordinate with service providers as to their requirements for service connections and provide all necessary metering provisions, grounding, materials, equipment, labor, testing, and appurtenances.
- U. Before commencing work, examine adjoining work on which this work is in any way affected and report conditions, which prevent performance of the work. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.
- V. Adjust location of conduits, panels, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication.
 - 1. Right-of-Way: Lines which pitch has the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
 - 2. Provide offsets, transitions and changes in direction of conduit as required to maintain proper headroom and pitch on sloping lines.
 - 3. In no case shall the maximum bend radius of any conduit exceed 180 degrees before a pull box is required.
- W. In cases of doubt, as to the work intended, or in the event of need for explanation, request supplementary instructions from the Architect/engineer in writing via proper distribution channels.

1.14 SEQUENCING AND SCHEDULING

- A. Description
 - 1. This implementation plan describes the general approach that shall be followed in order to minimize the time before the Security systems are operational.
- B. Approach
 - 1. The contractor shall plan and schedule all work in such a sequence as to minimize the time before the system is operational. The following is a suggested work sequence:
 - a. Order all equipment needed and notify any subcontractors to schedule their participation.
 - b. Perform all system layout work.

- c. Insure there are an adequate number of power receptacles and/or circuits available to operate all security equipment and coordinate with client as to where power is available.
- d. Provide shop drawings to verify location of all equipment, conduit runs, power connections, etc. Submit shop drawings to client project manager.
- e. Coordinate with client to provide space in each building's Communications Room for mounting of equipment.
- f. Provide client training on filling out the programming sheets.
- g. Prepare and pre-test all equipment to the greatest extent possible.
- h. Install all equipment.
- i. Provide client training on selecting the system settings.
- j. Test and inspect all systems.
- k. Perform all other work as required by client.
- l. Provide as-built drawings.
- m. Perform the Acceptance Test
- n. Provide final training.

1.15 INTELLECTUAL PROPERTY

- A. Patents: Should patented articles, methods, materials apparatus, etc., be used in this work, the contractor shall acquire the right to use same. The contractor shall hold client and its agents harmless for any delay, action, suit, or cost growing out of the patent rights for any device on this Project.
- B. Copyrights: Should copyrighted software be used in this work, the contractor shall acquire the right to use it. The contractor shall hold the client and its agents harmless for any delay, action, suit, or cost growing out of the copyrights for any software on this Project.
- C. License to use: All software required for the complete operation of the system as specified herein shall be delivered with either full clientship transferred to the client or a License to use at this site, including the right to make backup copies.

1.16 SCHEDULING

- A. The contractor, within **five (5) days** after being awarded the contract, shall prepare and submit for client's information, an estimated progress schedule for the work. The progress schedule shall be related to the entire project, and shall indicate start and completion dates.

1.17 WARRANTY

- A. Contractor warrants that all work furnished (material and labor) under this Contract will be of good quality, free from faults and defects, and in conformance with the Project drawings and Specifications.
- B. Contractor shall provide a parts and labor guarantee on all work. Unless otherwise specified herein, contractor's guarantee shall be for a period of two (2) years from date of Acceptance, except where any specific guarantees from a supplier or equipment manufacturer extends for a longer time.
- C. Contractor's guarantee shall cover all costs associated with troubleshooting, repair, and replacement of defective work, including costs of labor, transportation, lodging, meals, materials, and equipment.

- D. Guarantee shall not cover any damage to material or equipment caused by accident, misuse, unauthorized modification or repair by client, or acts of god, after the systems acceptance by the client.
- E. Contractor shall promptly respond to client's requests for service during the guarantee period. Contractor shall provide repair service as soon as reasonably possible upon request from client, but in no case shall service response exceed eight (8) hours from time of request. When contractor is unable to meet the 8-hour time frame the client may contact others to repair the system and back charge the contractor for any funds paid and/or charged to repair, replace any component that would normally have been covered under warranty.
- F. Contractor shall provide repair service "after hours" including weekends and holidays during the warranty period at no additional cost for covered system components.
- G. Contractor shall provide repair service charges to client in advance for non-warranty items.

1.18 SERVICE CONTRACT

- A. Contractor shall provide the client an option for a service contract for a period of 18 months with options for extending the service contract for a period requested by the client. The service contract shall be for the period after the 24 month warranty period required by these specifications has expired.

1.19 CLIENT'S INSTRUCTIONS

- A. Coordination with Client
 - 1. Contractor shall closely schedule and coordinate his activities with designated client representatives.
 - 2. Contractor shall provide client's project manager with a work plan on a weekly basis. Such work plan will describe locations of intended activities, types of activities, and potential conflicts to facility operations.
- B. Client's Right to Carry-Out the Work
 - 1. As set forth in Division 1 Specifications
 - 2. If the contractor defaults or neglects to carry out the work in accordance with the Project drawings and Specifications, and fails to respond within seven (7) days after receipt of written notice from client to commence and continue correction of such default or neglect with diligence and promptness. The client may, after seven days following receipt of an additional written notice and without prejudice to any other remedy, the client may have, make good such deficiencies. In such case, an appropriate Change Order shall be issued deducting from the payments then or thereafter due the contractor the cost of correcting such deficiencies.
- C. Minor Changes in the work
 - 1. The Client shall have the authority to order changes in the work not involving an adjustment in the Contract Sum or an extension of the Contract Time and not inconsistent with the intent of the Project Drawing and Specifications. Such changes shall be provided by written order by the client. The contractor shall carry out such work without cost unless additional equipment is required to carry out such work. Any additional equipment shall be discussed with the client prior to commencing work.

1.20 COMMISSIONING

- A. After all work is completed, and prior to requesting the Acceptance test, contractor shall conduct a final inspection, and pre-test all equipment and system features. The contractor shall correct any deficiencies discovered as the result of the inspection and pre-test.
- B. Contractor shall submit a request for the Acceptance test in writing to the client project manager, no less than **fourteen (14) days** prior to the requested test date. The request for Acceptance test shall be accompanied by a certification from contractor that all work is complete and has been pre-tested, and that all corrections have been made.
- C. During Acceptance test, contractor shall demonstrate all equipment and system features to client. Contractor shall remove covers, open wiring connections, operate equipment, and perform other reasonable work as requested by client.
- D. Any portions of the work found to be deficient or not in compliance with the Project Drawing and Specifications will be rejected. The Client's project manager will prepare a list of any such deficiencies observed during the Acceptance test. The Contractor shall promptly correct all deficiencies. Upon correction of deficiencies, contractor shall submit a request in writing to client project manager for another Acceptance Test.
- E. If, at the conclusion of the Acceptance Test, all work is found to be acceptable and in compliance with the Project drawings and Specifications, client project manager will issue a letter of Acceptance to contractor and client.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All products not provided by client shall be new and unused, and shall be of manufacturer's current and standard production.
- B. Where two or more equipment items of the same kind are provided, all shall be identical and provided by the same manufacturer throughout the facility. Multiple manufacturers of any one item will not be permitted, unless specifically noted otherwise.
- C. Any equipment, parts, pieces, boards, relays, and other equipment that is to be connected to, work in conjunction with, be controlled by and/or control any part of the security system is to be manufactured by, for and/or with or approved by the manufacturer to perform the function for which is to be installed.
- D. Any equipment, parts, pieces, boards, relays, and other equipment that is to be connected to, work in conjunction with, be controlled by and/or control any part of the security system is to have been tested and approved for such application by UL, Fire Marshal's Office, FM, FCC, Authority Having Jurisdiction (AHJ) and others.
- E. Drawings and Specifications indicate major system components, and may not show every component, connector, module, accessory and/or option required to support the operation specified. The contractor shall provide all components needed for complete and satisfactory operation.

F. Product Availability

1. The Contractor, prior to submitting a proposal, shall determine product availability and delivery time, and shall include such considerations into his/her proposed Contract Time.
2. Certain products specified may only be available through factory authorized dealers and distributors. Contractor shall verify his ability to procure the products specified through the manufacturer prior to submitting a proposal.
 - a. Third party or non-factory authorized and/or trained contractors will not be acceptable for sale, installation or design of proposed systems.

G. Wire and Cable

1. All wiring, field devices and panels shall be supervised with the use of end-of-line (EOL) resistors. Supervision shall report to its associated panel(s) and to the Security Monitoring Station including but not limited to:
 - a. Alarms
 - b. Opens Circuits
 - c. Fault Conditions
 - d. Grounds Faults
2. General: Provide all wire and cable required to install systems as indicated. Wire and cable shall be sized to provide minimum voltage drop and minimum resistance to the devices being supplied.
3. All cables shall be specifically designed for their intended use (plenum, direct burial, aerial, etc.).
4. Comply with equipment manufacturers recommendations for wire and cable.
5. Comply with all applicable codes and ordinances.

H. If products and materials are specified, or indicated on the drawings, for a specific item or system, use those products or materials. If products and materials are not listed in either the Specification or drawings, use first class products and materials, subject to approval of shop drawings and submittals.

I. Any given item of equipment or material shall be the product of one manufacturer. Multiple manufacturers of any one item will not be permitted, unless otherwise specifically noted.

J. All materials furnished shall bear the UL label, provided that a standard has been established for those materials.

K. No substitutions or alternates will be permitted without the written consent of the Engineer. Substitutions or alternates will be considered only on products where "Or Approved Equivalent" is noted.

L. For products with lists of several acceptable manufacturers, part numbers are provided only for the first manufacturer listed.

2.2 LABELS

A. Labels- Self-adhesive, self- laminating, with white matte finish printing area, clear plastic shield. Pin feed for machine printing. Used for cable identification. Labels shall be provided on both ends of all cables, 1"width for horizontal cabling, 2" width for riser cabling. Length as required for other cable media Labels, White polyester, Laser printable. Used for faceplates:

1-1/2" x 3/8", patch panels: 3/4" x 1/4", cable ladders, racks, frames, etc., as required: 1" x 1/2", 2" X 3/4".

1. Labels - Paper label inserts for 110 blocks. Utilize TIA/EIA-606 compliant colors.
Purple - PBX Terminations
White - Riser cables
Gray - Tie cables
2. Manufacturer: Brady or approved equal

B. CABLE TESTING

1. Test all cables installed under the contract.

C. Pre-installation Inspection

1. Visually inspect all cables, cable reels and shipping cartons for shipping damage. Return visibly damaged items to the manufacturer.
2. Prior to testing, submit for review and approval copies of test report forms proposed for use. Forms shall, at minimum, contain: Project name; contractor's name; Date of test; Media type and description; Make, model and serial number of the test equipment used and date of last calibration.

D. Post Installation Testing

1. Test only completed systems. Partial or statistically sampled testing is not acceptable, except by prior, written approval from the engineer.
2. Paired and multi-conductor metallic cables: perform an end-to-end test for continuity, ground fault, shorts and crossed pairs for each cable pair/conductor.
 - a. Test cable pairs from the work area field device, through all conductors, patches and cross connects, to the equipment room.
 - b. Test horizontal cable pairs not cross-connected to backbone from their furthest termination point to the work area field device.
 - c. Test backbone cable pairs not cross-connected to horizontal cables from their furthest termination point to the equipment room.
3. Optical Fiber Cable
 - a. Multimode fiber: Perform end-to-end attenuation (dB loss) tests for each backbone fiber strand at 850nm and 1300nm wavelengths in accordance with TIA/EIA-526-14A, Method B and with test instrument manufacturer's printed instructions.
 - b. Calculate the total link loss for each fiber in each direction based on the number of mated connector pairs, the connector's published loss per mated pair and the cable's published loss based on distance, minus the system power reference values established at set up. Demonstrate that measured link loss does not exceed calculated link loss by more than 5%.
 - c. Strands with measured attenuation falling outside of the acceptable range by power meter testing shall be subjected to further testing to determine the nature of the fault. Utilize an OTDR to determine the loss factor for each connected pair, the exact length of the fiber and to identify any core damage.
 - d. Correct any faults related to connector and re-test fiber as stated above until acceptable attenuation results are received.
 - e. Where defects cannot be corrected, replace any cable having fewer than the manufacturer's guaranteed number of serviceable fiber strands.
4. The Client and Engineer reserve the right to observe the conduct of any or all portions of the testing process and to conduct, using The contractor's equipment and labor, a

random re-test of up to five (5) percent of the cable plant to confirm documented test results.

5. Document all test results and corrective procedures and submit to the engineer within ten (10) working days of test completion.
6. In addition to the actions specified above, the contractor may be required to be present while client or client's designated representatives conduct performance tests of the transport electronics connected to the cabling system.

E. Test Equipment

1. Optical fiber power meter and light source: Siecor OTS-210 (850/1300nm and 1310/1557nm) and OS-302 light source, FOTEC FM310 and S785 light source, or equivalent.
2. OTDR (if required) Siecor OTDR Plus Multitester, Tektronix TFP2 FiberMaster, Laser Precision TD-2000, or equivalent, with 850nm and 1300nm light emitter modules and hard copy printout.
3. Metallic cable pair tester: Independent Technologies, TEST-ALL IV or 25, Siemon Company Multi-test MT-5000 or equivalent.
4. 4-pair UTP automated cable tester: Tester shall be Level II-compliant with ANSI/TIA/EIA-568-B.3 Draft 10, provide bi-directional testing and be capable of testing to 250 MHz Category 6 Class D standards for both basic links and channels. Test equipment must be approved by Engineer prior to use on the job. Fluke DSP 4100/4300 is pre-approved.

2.3 ACCEPTANCE

- A. Once testing has been completed, as-built and testing documentation delivered to the Engineer, and the engineer is satisfied that all work is in accordance with the contract documents, the Engineer shall notify the contractor in writing of the acceptance of the work performed. The date of this acceptance shall constitute the commencement of the warranty period as defined in Section 1.12 of this Specification.

2.4 CABLE CONNECTOR PROTECTION

- A. All installed connectors shall be protected and insulated by one of the following methods.
1. Any installed connector exposed to construction activities shall be protected with a clear, heat sealed 3 mil plastic bag sealed shut with waterproof tape after installation. The bag must be removable for testing. Any protective bags removed for testing or other installation activities must be replaced immediately after such activities are completed.
 2. Any connector normally shipped with an insulating protective cover over the connector pins shall be left with the cover in place after the connector has been installed on the cable. The protective cover shall be taped in place if easily dislodged.
- B. Any connector fouled or damaged as a result of activities related to the construction process shall be replaced.

2.5 CABLE IDENTIFICATION SYSTEM

- A. Use color-coding in accordance with ANSI/TIA/EIA-606 standards, unless otherwise noted.
- B. Field devices at the user locations, termination blocks, patch panels, equipment racks/enclosures, and individual riser and lateral cables shall be labeled with (at minimum) machine generated black uppercase lettering on a permanent adhesive label stock, covered

with a permanent, water resistant sealer. Labeling stock and/or lettering must be used that provides a high contrast with the color of the terminating equipment, faceplate or cable.

- C. Place labels on both ends of the cable at least 4 inches from the point at which the cable is terminated on the connector or terminal block.
- D. Provide permanent, machine generated cable tags. Temporary tags are acceptable only during construction. Label each tag with the appropriate cable number as shown on the drawings and as indicated on the cable schedules provided by the engineer.
- E. Cable identification numbers shown on the plans are presented in an abbreviated format. All cable ID's shall (at minimum) indicates the floor, the sequential cable number shown on drawings. For example: The first cable pulled to Field device #7 from Closet "A" on the 2nd floor shall be labeled: 2A-07-1, the second cable pulled to Field device #12 out of the "B" closet on that floor shall be labeled: 2B-12-2, and so forth.
- F. If at any time during the job the permanent cable tag becomes illegible or is defaced or removed, immediately replace it with a duplicate pre-printed cable tag.
- G. All equipment shall be assembled and installed as per manufacturers' printed instructions.
- H. Conduit and Raceway Systems
 - 1. Follow Division 26 and 27 requirements/specifications.
 - 2. Conduit is required for all cabling for this project.
 - 3. Conduit shall be used in the following areas without exception:
 - a. Where cabling is below 8 feet
 - b. Any inaccessible area (i.e. inside walls, hard ceilings etc.)
 - c. Locations where Security cabling may come in close association with 120 VAC or above power sources including, transformers, conduits, lights, ballast etc.
 - d. In any area where RF interference may be or become a factor, interfering with the security systems normal operation and functions.
 - e. Other locations directed by other specification divisions and/or sections and/or drawings.
 - 4. General: The placing of surface mounted conduit on the exterior of any building or interior wall shall be approved by client prior to its installation.
 - 5. Interior Conduit:
 - a. EMT
 - 6. Surface Raceways
 - a. Sheet metal channel with fitted cover, suitable for use as surface metal raceway, WIREMOLD or approved equal.
 - b. Provide fittings, elbows, and connectors designed for use with raceway system.
 - 7. Exterior Conduit: (any of the following as determined by local code requirements):
 - a. Rigid Steel Conduit
 - b. Rigid Aluminum Conduit
 - c. Provide rain-tight fittings and connectors as required for installation of exterior conduit.
 - 8. Exterior Flexible Conduit:
 - a. Liquidtight Flexible Conduit: Flexible metal conduit with PVC jacket.
 - b. Provide rain-tight fittings and connectors as required for installation of Liquidtight Flexible Conduit.

9. Junction and Pull Boxes

- a. Interior Boxes: Sheet Metal Outlet Boxes: Sizes to be determined in accordance with code requirements for conductor fill. No box shall be smaller than a single gang 1-1/2 deep. Provide box covers as required.
- b. Exterior Boxes: All exterior boxes shall NEMA 4 or NEMA 3R, watertight and dust-tight
- c. All interior and exterior boxes shall have their covers fastened using security screws.

10. Lighting Protection

- a. The contractor shall provide suitable lightning protection for all electronic security equipment.
- b. All lightning protection equipment shall be UL listed.

2.6 ELECTRICAL PROVISIONING FOR TELECOMMUNICATIONS/SECURITY ROOM

- A. Each security room shall be equipped with a minimum of two 20-amp, 120VAC electrical outlets; each on its own dedicated circuit breaker, for each cabinet or rack.
- B. Security Panels shall each have one dedicated circuit hard-wired into the back-box and connected to the transformer for each panel, controller etc.
- C. There shall be a minimum of two quads Convenience outlets located within the room. These shall be colored orange and identified as Security Technical Power. These outlets shall be used exclusively for security electronic equipment. Do not use Technical Power outlets for general-purpose or utility devices such as electric drills, vacuum cleaners, or coffeepots. These outlets are in addition to and no in replace of power requirements of the security devices, panel, monitors etc.
- D. The Security Technical Power circuits should originate from a dedicated power panel serving the security room. The power panel shall not be used to supply power to sources of electromagnetic interference such as large electric motors, arc welding, or industrial equipment. The power panel must be located in the security equipment room, or in close proximity to the security equipment room.
- E. Some security equipment, such as video surveillance switches are ordered with dual power supplies. The placement of equipment with dual power supplies should be identified and the appropriate racks should have two, separate, dedicated 20-amp 120VAC electrical circuits from the Technical Power panel, terminated in separate duplex outlets and be appropriately marked to identify the separate circuit breakers.
- F. 120VAC Power wired to racks, panels, consoles, monitors etc, shall be direct wired from dedicated circuits and labeled accordingly. Each system's requirements are special and require coordination. The security contractor shall coordinate all power requirements with the electrical contractor to insure enough power, proper power and locations of the power are correct.
- G. Refer to Telecommunications specifications when security shares a room/space with telecom for their requirements. In no case shall these specifications interfere with power required for other systems such as Telecommunications or other convenience power outlets.

PART 3 - EXECUTION

3.1 PREPARATION

- A. The contractor shall order all required parts and equipment upon notification of award of the work as directed by client.
- B. The contractor shall bench test all equipment prior to delivery to the job site.
- C. The contractor shall verify the availability of power where required. If a new source of power is required, a licensed electrician shall be used to install it. Security contractor is responsible for coordinating all power requirements with electrical contractor.
- D. The contractor shall arrange for obtaining all programming information and provide adequate training on the meaning of the programming terms for the client to understand the programming form(s).
- E. The contractor shall arrange for obtaining all programming information including access times, free access times, door groups, operator levels, etc. from the client project manager.

3.2 INSTALLATION

- A. The contractor shall coordinate with the client's Information Systems Department when the security system interfaces with the client's network.
- B. The contractor shall carefully follow the instructions in the manufacturers' Installation Manual to insure all steps have been taken to provide a reliable, easy to operate system.
- C. Materials shall be installed in strict compliance with local building codes and manufacturer's installation guidelines. All work shall be performed in accordance with the manufacturer's printed instructions and in a manner satisfactory to the client's representative
- D. The installer shall be fully qualified, factory trained and certified by each of the product manufacturer's that are to be installed, Certification and training shall include the installation, operation, and programming of all the systems.
- E. Perform all work as indicated in the drawings and Specifications.
- F. The contractor shall install the appropriate cable from the CPU to all field devices (i.e. door contacts, motion detectors), access control and video surveillance panels for alarm monitoring and reporting.
- G. All communications cables shall be kept away from power circuits.
- H. The contractor shall install spare conductors within the cable pairs from the control panels in such quantities that additional devices may be installed in the future without the need to re-pull cable from the controller to the existing door. These spare conductors shall exceed 25% (i.e. when 6 conductors are required an 8 conductor shall be installed) this will allow for growth and replacement of a conductor when/if a conductor is damaged in the future. In no case shall less than one spare pair be installed.
- I. The contractor shall coordinate the installation of the power supply(s) for electric locks in locations where they won't interfere with other operations (see door hardware specifications

and coordinate) and monitor all power supplies for alarms and supervisory signals (i.e. A/C failure, tampering, low battery, short, fault, etc.)

- J. The contractor shall also execute 100% testing of the system to insure proper operation.

3.3 TRAINING

- A. The contractor shall provide training of the security systems to client's personnel insuring adequate understanding of all systems operation and maintenance to prevent errors and/or accidental operation and false alarms.
- B. Adequate training shall consist of not less than 48 hour's system training, scheduled after all systems are installed and accepted by client.
- C. Training of personnel shall be in small groups of not more than 5 individuals and broken down by level of access and responsibilities (i.e. operators, Administrators, Maintenance etc.)
- D. Command Center (Head-end) training shall include but not limited to:
1. Use and control of camera management systems
 2. Use and control of video recording systems
 3. Use and control of video photograph systems
 4. Identification and prediction of potential events
 5. Familiarity with the local area
 6. Knowledge of identified potential trouble spots
 7. Police policy and procedures relating to recording of information, exhibit handling and incident reporting
 8. Emergency response and procedures
 9. Accountability and confidentiality
 10. Privacy
- E. Phone support shall provide ongoing training and assistance in operational, programming and maintenance issues at no additional charge for the first two years after acceptance of the installation by the client.

3.4 WORKMANSHIP

- A. Comply with highest industry standards, except when specified requirements indicate more stringent standards or more precise workmanship.
- B. Perform work with persons experienced and qualified to produce workmanship specified.
- C. Maintain quality control over suppliers and Subcontractors.
- D. Quality of workmanship is considered important. The client's project manager will have the authority to reject work, which does not conform to the drawings and Specifications.

3.5 EQUIPMENT PRE-TEST

- A. All equipment shall be bench tested prior to delivery to job site and prior to installation. Bench test shall be performed per manufacturer's installation instructions.

3.6 WIRE AND CABLE

- A. Design, layout, size, and plan new wire and cable runs as required by the systems complexity.

- B. All wire and cable from the processors to all security devices shall be “home-run” unless otherwise specified.
- C. All wire and cable, including any wire and cable that is existing and will be reused in the work, shall be installed in conduit or surface metal raceway, except as follows:
 - 1. Wire or cable, in lengths of less than ten (10) feet, that is “fished” within ceilings, and doorframes.
 - 2. All wire and cable passing thru metalwork shall be sleeved by an approved grommet or bushing.
- D. Avoid splicing conductors. All splices when necessary shall be made in junction boxes (JB) (except at equipment) with tamper switches installed notifying security when the cover, door or panel has been opened. Splices shall be made with an approved crimp and/or solder connection.
- E. The following shall **not** be used on any security low-voltage wiring:
 - 1. Wire nuts
 - 2. “Beenies”
 - 3. Telecommunications press connectors.
- F. Identify all wire and cable at terminations and at every junction box. Identification shall be made with an approved permanent label, Brady or equal.

3.7 WIRE AND CABLE TERMINATIONS

- A. Identify all inputs and outputs on terminal strips with permanent marking labels (Brady or equal).
- B. Neatly dress and tie all wiring. The length of conductors within enclosures shall be sufficient to neatly train the conductor to the terminal point with no excess. Run all wire and cable parallel or normal to walls, floors and ground.
- C. Install connectors as required by equipment manufacturers written instructions.
- D. Terminations shall be made so that there is no bare conductor at the terminal. The conductor insulation shall bear against the terminal or connector shoulder.
- E. Do not obstruct equipment controls or indicators with wire or cable. Contractor shall route wires and cables away from heat producing components such as resistors, regulators and the like.
- F. Strain relief and service loops shall be included in all pull and/or junction boxes.

3.8 CONDUIT AND RACEWAY INSTALLATION

- A. Design, layout, size and plan new conduit and raceway systems as required.
- B. Indoor Requirements:
 - 1. Route conduit and raceway parallel and perpendicular to walls and adjacent piping
 - 2. Maintain minimum six (6) inch clearance between conduit and piping.
 - 3. Group conduit in parallel runs where practical and use conduit rack constructed of steel channel with conduit straps or clamps.

4. Use conduit bodies to make sharp changes in direction, as around beams. Fasten conduits and raceways to structural steel using approved spring clips or clamps.
5. Where conduit penetrates fire-rated walls and floors, seal opening with UL listed fire rated sealer and/or other fire stop system methods as approved by codes.
6. No exposed conduit, raceway, or junction box shall be installed without written approval of client and/or Architect.
7. Install all boxes straight, plumb and flush.
8. Do not support conduit from mechanical, plumbing, or fire sprinkler systems.
9. Drill or core drill all holes in walls, ceilings, or floors where required for new conduits. Do not cause damage to any structural steel or other structural support member by drilling or cutting.
10. Do not use flexible conduit in lengths longer than six (6) feet.
11. All cables below seven (7) feet shall be installed within conduit.
12. All cables which pass through Fire Rated walls, floor or ceiling shall have the appropriate fire and temperature rating of the wall, floor or ceiling restored to its designed limits.

C. Outdoor Requirements

1. Where conduit penetrates exterior walls contractor shall seal opening around conduit in an approved manner to make watertight.
2. Use galvanized straps and fasteners on all exterior conduits.
3. All exterior boxes will only be used to aid in pulling the cable between points and are not to be used as splice points.

3.9 PENETRATIONS

- A. Do not penetrate any floor, roof, flashing, exterior wall, or parapet without prior approval from client's designated Construction Project representative. (Floor slabs that have radiant heating system installed; penetrations of the slab shall be coordinated to insure heating system is not damaged).

3.10 FIRE RATED DOORS AND FRAMES

- A. Do nothing to modify a U.L. Rated door or frame that may void or alter the UL listing or fire rating.

3.11 GROUNDING

- A. Provide earth grounding of equipment as required by equipment manufacturer. Earth ground shall be connected to ground rod or approved cold water pipe. All systems installed in one or more building shall have a common ground to prevent ground faults.
- B. Electrical or telephone ground connections shall not be used as earth grounds unless approved by electrical engineer, telecommunications engineer and client.
- C. Connections to mounting posts or building structural steel shall not be used as earth grounds.

3.12 POWER TO SECURITY EQUIPMENT

- A. Power all equipment from 120 VAC circuit dedicated for security use, except as noted. Mark all panel circuit breakers with labels worded "Security Equipment - Do Not Operate", or equivalent.

- B. All security systems devices and systems power shall be from UPS with generator back up. See Electrical drawings and specifications for exact requirements.
- C. Provide "Breaker locks" to prevent accidental operation of the breakers.
- D. Avoid using plug-in type transformers. Hardwire 120 VAC to all panels, power supplies, console, racks etc.

3.13 CUTTING AND PATCHING

- A. The contractor shall be responsible for all cutting, fitting or patching that may be required to complete the work.

3.14 PAINTING

- A. Not Applicable

3.15 PLYWOOD BACKING

- A. Install the processor(s), power supplies, and all other related equipment on a plywood backboard. The mounted assemblies will be mounted in the telecommunication, Mechanical Room(s) as shown on drawings.
- B. Fasten the plywood backing to the wall using a hanger bolt at the four corners, which align with pre-drilled holes in the plywood. Secure with flat washers and a nut.
- C. Equipment, which is "rack mountable", shall be installed within "cabinets" designated for security equipment. Cabinets are specified within additional sections of the specifications.

END OF SECTION

SECTION 280537

FIRESTOPPING FOR COMMUNICATION/SECURITY SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Section, apply to work specified in this section.

1.2 DEFINITIONS

- A. Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies.

1.3 GENERAL DESCRIPTION OF THE WORK OF THIS SECTION

- A. Only tested firestop systems shall be used in specific locations as follows: Penetrations for the passage of cables, conduit, and other electrical equipment through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.

1.4 RELATED WORK OF OTHER SECTIONS

- A. Coordinate work of this section with work of other sections as required to properly execute the work and as necessary to maintain satisfactory progress of the work of other sections, including:
 - 1. Section 03 30 00 - Cast-In-Place Concrete
 - 2. Section 04 20 00 - Unit Masonry
 - 3. Section 07 84 00 - Firestopping
 - 4. Section 07 90 00 - Joint Sealants
 - 5. Section 09 20 00 - Plaster and Gypsum Board
 - 6. Section 13 48 00 - Sound, Vibration and Seismic Control
 - 7. Section 21 00 00 - Fire Suppression
 - 8. Section 27 00 00 - Communications
 - 9. Sections 280000-2840000, Security Specifications

1.5 REFERENCES

- A. Test Requirements: ASTM E 814, "Standard Method of Fire Tests of Through Penetration Fire Stops"
- B. Test Requirements: UL 1479, "Fire Tests of Through-Penetration Firestops"
- C. Underwriters Laboratories (UL) of Northbrook, IL publishes tested systems in their "FIRE RESISTANCE DIRECTORY" that is updated annually.
 - 1. UL Fire Resistance Directory:
 - a. Firestop Devices (XHJI)
 - b. Fire Resistance Ratings (BXRH)

- c. Through-Penetration Firestop Systems (XHEZ)
 - d. Fill, Voids, or Cavity Material (XHHW)
 - e. Forming Materials (XHKU)
- D. International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments
- E. Inspection Requirements: ASTM E 2174, "Standard Practice for On-site Inspection of Installed Fire Stops."
- F. Test Requirements: ASTM E 90, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements"
- G. Test Requirements: ASTM E 2178, "Standard Test Method for Air Permeance of Building Materials"
- H. Test Requirements: ASTM E 84, "Standard Test Method for Surface Burning Characteristics of Building Materials."
- I. Test Requirements: ASTM E 2178, "Standard Test Method for Air Permeance of Building Materials"
- J. International Building Code (IBC 2009)
- K. NFPA 101 - Life Safety Code
- L. NFPA 70 - National Electric Code

1.6 QUALITY ASSURANCE

- A. A manufacturer's direct representative (not distributor or agent) to be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.
- B. Firestop System installation must meet requirements of ASTM E 814 or UL 1479 tested assemblies that provide a fire rating equal to that of construction being penetrated.
- C. Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.
- D. Firestop Systems do not reestablish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.
- E. For those firestop applications that exist for which no UL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment drawings must follow requirements set forth by the International Firestop Council.

1.7 SUBMITTALS

- A. Submit Product Data: Manufacturer's specifications and technical data for each material including the composition and limitations, and manufacturer's installation instructions to comply with General Requirements Section.
- B. Submit qualified tested firestop system detail for each firestop application on the project.
- C. Manufacturer's engineering judgment identification number and drawing details when no UL system is available for an application. Engineering judgment must include both project name and contractor's name who will install firestop system as described in drawing.
- D. Submit material safety data sheets provided with product delivered to job-site.

1.8 INSTALLER QUALIFICATIONS

- A. Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install manufacturer's products per specified requirements. A manufacturer's willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and UL label where applicable.
- B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.
- C. Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements, including temperature limitations.
- D. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.
- E. Do not use damaged or expired materials.

1.10 PROJECT CONDITIONS

- A. Do not use materials that contain flammable solvents.
- B. Scheduling
 - 1. Schedule installation of cast-in place firestop devices after completion of floor formwork, metal form deck, or composite deck but before placement of concrete.
 - 2. Schedule installation of other firestopping materials after completion of penetrating item installation but prior to covering or concealing of openings.
- C. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.

- D. Weather conditions: Do not proceed with installation of firestop materials when temperatures exceed the manufacturer's recommended limitations for installation printed on product label and product data sheet.
- E. During installation, provide masking and drop cloths to prevent firestopping materials from contaminating any adjacent surfaces.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.
- B. Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.
- C. Provide a round enclosed fire rated cable management device whenever cable bundles penetrate fire rated walls. The cable management device shall contain integrated intumescent firestop wrap strip materials sufficient to maintain the hourly rating of the barrier being penetrated. The cable management device shall contain a smoke seal fabric membrane or intumescent firestop plugs sufficient to achieve the L-Rating requirements of the barrier type.
- D. Provide non-curing, re-penetrable, intumescent firestop materials around communications cable trays or ladder racks penetrating through a fire rated wall. The firestop system assembly shall be able accessible and re-installed from one side of the wall. The firestop material shall allow up to 12" of unreinforced annular space.
- E. Penetrations in Fire Resistance Rated Walls: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.
 - 1. F-Rating: Not less than the fire-resistance rating of the wall construction being penetrated.
- F. Penetrations in Horizontal Assemblies: Provide fire stopping with ratings determined in accordance with UL 1479 or ASTM E 814.
 - 1. F-Rating: Minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
 - 2. T-Rating: when penetrant is located outside of a wall cavity, minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
 - 3. W-Rating: Class 1 rating in accordance with water leakage test per UL 1479 (if applicable).
- G. Penetrations in Smoke Barriers: Provide fire stopping with ratings determined in accordance with UL 1479 or ASTM E 814.
 - 1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at both ambient and elevated temperatures.

- H. Mold Resistance: Provide penetration fire stopping with mold and mildew resistance rating of 0 as determined by ASTM G21.

2.2 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with through penetration firestop systems (XHEZ) listed in Volume II of the UL Fire Resistance Directory, provide products of the following manufacturers as identified below:
 - 1. Hilti, Inc., Tulsa, Oklahoma
800-879-8000
www.us.hilti.com
 - 2. Provide products from the above acceptable manufacturer; *or approved equal*.

2.3 MATERIALS

- A. Use only firestop products that have been UL 1479 or ASTM E 814 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.
- B. Re-penetrable, round cable management devices for use with new or existing cable bundles penetrating gypsum or masonry walls, the following products are acceptable:
 - 1. Hilti Speed Sleeve (CP 653) with integrated smoke seal fabric membrane.
 - 2. Hilti Firestop Sleeve (CFS-SL SK)
 - 3. Hilti Retrofit Sleeve (CFS-SL RK) for use with existing cable bundles.
 - 4. Hilti Gangplate (CFS-SL GP) for use with multiple cable management devices.
 - 5. Hilti Gangplate Cap (CFS-SL GP CAP) for use at blank openings in gangplate for future penetrations.
- C. Pre-formed, round firestop devices with integrated intumescent strips for use with noncombustible and combustible pipes (closed and open systems), conduit, and/or cable bundles penetrating concrete floors and/or gypsum walls, the following products are acceptable:
 - 1. Hilti Cast-In Place Firestop Device (CP 680-P) for use with combustible penetrants.
 - 2. Hilti Cast-In Place Firestop Device (CP 680-M) for use with noncombustible penetrants.
 - 3. Hilti Speed Sleeve (CP 653) for use with cable penetrations.
 - 4. Hilti Firestop Drop-In Device (CFS-DID) for use with noncombustible and combustible penetrants.
- D. Sealants, foams or caulking materials for use with non-combustible items including rigid steel conduit and electrical metallic tubing (EMT), the following products are acceptable:
 - 1. Hilti Intumescent Firestop Sealant (FS-ONE MAX)
 - 2. Hilti Fire Foam (CP 620)
 - 3. Hilti Flexible Firestop Sealant (CP 606)
 - 4. Hilti Elastomeric Firestop Sealant (CP 601S)
- E. Intumescent sealants, caulking materials for use with combustible items (penetrants consumed by high heat and flame) including PVC jacketed, flexible cable or cable bundles, and plastic pipe, the following products are acceptable:
 - 1. Hilti Intumescent Firestop Sealant (FS-ONE MAX)

- F. Foams, intumescent sealants, or caulking materials for use with flexible cable or cable bundles, the following products are acceptable:
 - 1. Hilti Intumescent Firestop Sealant (FS-ONE MAX)
 - 2. Hilti Fire Foam (CP 620)
 - 3. Hilti Flexible Firestop Sealant (CP 606)
 - 4. Hilti Elastomeric Firestop Sealant (CP 601S)
- G. Non-curing, re-penetrable intumescent putty or foam materials for use with flexible cable or cable bundles, the following products are acceptable:
 - 1. Hilti Firestop Putty Stick (CP 618)
 - 2. Hilti Firestop Plug (CFS-PL)
- H. Wall opening protective materials for use with U.L. listed metallic and specified nonmetallic outlet boxes, the following products are acceptable:
 - 1. Hilti Firestop Putty Pad (CP 617)
 - 2. Hilti Firestop Box Insert
- I. Materials used for large openings and complex penetrations made to accommodate cable trays and bundles, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:
 - 1. Hilti Firestop Mortar (CP 637)
 - 2. Hilti Firestop Block (CFS-BL)
 - 3. Hilti Fire Foam (CP 620)
 - 4. Hilti Firestop Board (CP 675T)
- J. Non curing, re-penetrable materials used for large openings and complex penetrations made to accommodate cable trays and bundles, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:
 - 1. Hilti Firestop Block (CFS-BL)
 - 2. Hilti Firestop Board (CP 675T)
- K. For blank openings made in fire-rated wall or floor assemblies, where future penetration of pipes, conduits, or cables is expected, the following products are acceptable:
 - 1. Hilti Firestop Block (CFS-BL)
 - 2. Hilti Firestop Plug (CFS-PL)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
 - 1. Verify penetrations are properly sized and in suitable condition for application of materials.
 - 2. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.
 - 3. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.

4. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.
5. Do not proceed until unsatisfactory conditions have been corrected.

3.2 COORDINATION

- A. Coordinate location and proper selection of cast-in-place Firestop Devices with trade responsible for the work. Ensure device is installed before placement of concrete.

3.3 INSTALLATION

- A. Regulatory Requirements: Install firestop materials in accordance with UL Fire Resistance Directory.
- B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration materials.
 1. Seal all holes or voids made by penetrations to ensure an air and water resistant seal.
 2. Protect materials from damage on surfaces subjected to traffic.

3.4 FIELD QUALITY CONTROL

- A. Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.
- B. Keep areas of work accessible until inspection by applicable code authorities.
- C. Inspection of through-penetration firestopping shall be performed in accordance with ASTM E 2174, "Standard Practice for On-Site Inspection of Installed Fire Stops" or other recognized standard.
- D. Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.

3.5 ADJUSTING AND CLEANING

- A. Remove equipment, materials and debris, leaving area in undamaged, clean condition.
- B. Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

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SECTION 281300

ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 RELATED SECTIONS

- A. Division 26 Electrical
- B. Division 27 Telecommunications
- C. Division 28, Sections 280000 - 284000

1.3 SUMMARY

- A. The Security Management System (SMS) shall be a powerful, flexible, multi-function and object-oriented security and event management system that features a variety of customizable interfaces for maintaining the system and for monitoring the desired secure sites. The SMS shall provide an option to display these management and monitoring interfaces in the native languages of the people using the system. The security and event management system shall be flexible in order to meet specific requirements and quickly respond to evolving security challenges. The SMS shall be a scalable platform, simple and economical enough to support a single site, yet upgradeable enough to manage a multi-site network. The SMS shall use an open, distributed architecture, where database servers could reside in geographically separate locations.
- B. The SMS shall provide extensive information management capability using Microsoft .NET Framework V4.0. It shall operate in a Client / Server configuration on personal computers with a Windows-based platform. Its distributed client-server architecture shall be capable of supporting up to 100 simultaneous clients, multiple types of controllers, and over 10,000 input devices, including cameras and multiple types of card readers. The SMS shall be constructed to be database independent and shall support at a minimum Microsoft SQL Server 2005 / 2008 (Express, Standard, or Enterprise), for data protection, redundancy and manageability.
- C. The SMS shall have true multi-tasking, multiprocessor and remote client support; allowing independent activities and monitoring to occur simultaneously at different locations. The operator workstation (Client) shall be user friendly, employing icon-based menus and providing a mouse-driven interface for system operation and the creation of color graphic maps. The user interface shall be customizable, capable of delivering a unique look and feel without a unique version release. It shall be an intuitive user interface that is similar to Microsoft's Outlook and Explorer with its easy navigation and tree structures. A practical application layout editor shall let users drag and drop any application onto one screen and create a customized hub for all activities via a single "command and control" center.
- D. Field devices such as card readers, alarm inputs, control points, etc. shall be connected to fully distributed intelligent field controllers or directly through a Software Development Kit or Web Services, and be capable of operating without host computer intervention. All objects

within the SMS, i.e. doors, readers, time intervals, etc. shall be addressed by a unique name as opposed to point numbering or mnemonics. The SMS shall have badge generation tools to create and manage badges using a graphical interface and convenient query features to manage large numbers of badges.

1.4 SUBMITTALS

- A. Reference 280000 for submittal requirements.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications

- 1. The manufacturers of all hardware and software components employed in the SMS shall be established vendors to the access control/security monitoring industry for no less than five (5) years and shall have successfully implemented at least 5 systems of similar size and complexity.

B. Contractor/Integrator Qualifications

- 1. The security system integrator shall have been regularly engaged in the installation and maintenance of integrated access control systems and have a proven track record with similar systems of the same size, scope, and complexity.
- 2. The security system integrator shall supply information attesting to the fact that their firm is an authorized product integrator certified with the SMS. A minimum of one technician shall be a Certified C•CURE 9000 installer.
- 3. The security system integrator shall supply information attesting to the fact that their installation and service technicians are competent factory trained and certified personnel capable of maintaining the system and providing reasonable service time.
- 4. The security system integrator shall provide a minimum of three (3) references whose systems are of similar complexity and have been installed and maintained by the security system integrator in the last five (5) years.
- 5. There shall be a local representative and factory authorized local service organization that shall carry a complete stock of parts and provide maintenance for these systems.

C. Testing Agencies

- 1. The SMS shall be tested and listed by Underwriters Laboratories (UL) for UL/cUL 294 for Access Control System Units (Pending).
- 2. The SMS shall be tested and listed by Underwriters Laboratories (UL) for UL/cUL 1076 for Proprietary Alarm Units (Pending).
- 3. The SMS shall employ a FIPS 197-listed AES 256-bit encryption between C•CURE 9000 Servers, Clients, and iSTAR eX Controllers.
- 4. The SMS shall include full support for FIPS 201 initiative:
 - a. Ability to customize a system-wide Card Holder Unique IDentification number (CHUID).
 - b. Ability to configure custom, extended card formats, including GSA 75-bit Wiegand standard, and to download them to the card access panels.
 - c. Ability to use Hashed Message Authentication Codes (HMAC) for medium assurance profile.
 - d. Enhanced data fields per the FIPS 201 standard, including Agency Code, System Code, Credential Series and Credential Issue Code.
- 5. The SMS hardware shall comply with the following regulatory requirements:
 - a. FCC Class A.
 - b. FCC Class B.

- c. CE.
 - d. Canadian Radio Emissions requirements.
 - e. Restriction of Hazardous Substances Directive (RoHS) 2002/95/EC.
 - f. FIPS 140-2 encryption (certified for the iSTAR eX controller).
- 6. The SMS shall support Americans with Disabilities Act (ADA) compliance in door and access operation.
- D. Licensing
 - 1. Licensing shall be required for the SMS software. The licensing shall include:
 - a. Series (Model).
 - b. Number of online readers.
 - c. Number of online inputs.
 - d. Number of online outputs.
 - e. Number of card holders.
 - f. Number of simultaneous clients.
 - g. Number of simultaneous badging stations.
 - h. Optional Features.

1.6 WARRANTY

- A. The SMS shall be provided with a 14-month product warranty from date of shipment or 1 year from date of registration, whichever is shorter. Software version upgrades shall be available for no charge during this warranty. The software media warranty shall be 90 days per the C•CURE software licensing agreement.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The SMS shall be the Software House C•CURE 9000 system. The Badging Solution shall be Software House C•CURE ID. The hardware manufacturer shall be an ISO 9001:2000 registered company.

2.2 DESCRIPTION

- A. The SMS shall be an integrated system that utilizes a single, industry-standard relational database management system for the storage and manipulation of related data. The SMS shall include a server with operating system and applications software, operator and administrator terminals with appropriate software, hard copy printers and fixed magnetic storage media. The security devices shall communicate with the field panels via a dedicated cable network. The field panels shall communicate to the server via a Fast Ethernet 10/100, TCP/IP network or a serial (RS-232, RS-485) connection.
- B. The SMS shall allow for growth and scalability from a low-end or entry level system to a high end or enterprise system by increasing CPU power, memory and database. The SMS shall be modular in nature, allowing system capacities to be easily expanded without requiring major changes to system operation. All defined system data as well as historical information shall be maintained. Customizable user interfaces shall allow management of system information and activity for administrators and operators. The SMS shall include an intuitive .NET based badging solution with a WYSIWYG badge layout editor and GUI for badge design.

2.3 SMS FUNCTIONALITY

A. Partitioning

1. The SMS shall allow system administrators to separate the creation and viewing of objects into partitions. SMS operators shall be associated with partitions and this shall determine which objects operators have the ability to create and or view. The SMS shall support an unlimited number of partitions.

The SMS partitions shall include but not be limited to the following objects:

- a. Personnel
 - b. Clearances
 - c. Doors
 - d. Controllers with all associated hardware (readers, inputs, outputs, etc)
 - e. Video servers with all associated objects (cameras, tours, views, etc)
 - f. Application layouts
 - g. Events
 - h. Dynamic views
 - i. Maps
 - j. Reports, forms, results
 - k. Holidays
 - l. Badge layouts
 - m. Queries
 - n. Images
2. Through the use of privileges, the SMS System Administrator shall be able to determine which objects are associated with a particular partition. These objects shall then be assigned to System Operators with the appropriate privilege.
 3. The SMS shall support a super-user assigned the 'System All' privilege who shall have full access to all objects in all partitions.
 4. Any operator shall have the ability to be assigned access rights to any partition. Individual Access rights shall be created and have the ability to be assigned to any users of the SMS.
 5. The SMS shall allow objects to be created in any partition. The SMS shall have the ability to grant or remove permission from any object in any partition.
 6. The SMS shall provide the ability to move objects from one partition to another partition without the requirement of deleting and recreating.
 7. The SMS shall provide the ability to import/export any configured object.
 8. The SMS shall support the display of all associated objects contained within a partition.

B. Enterprise Architecture

1. The SMS shall provide an Enterprise Architecture licensable option that allows you to configure multiple Satellite Application Servers (SAS) to communicate with a Master Application Server (MAS). The Master Application Server shall provide a platform for global management of the personnel, video, and access control security objects on two or more Satellite Application Servers (SAS) in an enterprise.
2. The Enterprise Architecture shall work by synchronizing each SAS system's database with the MAS database. The MAS shall contain the global data that is used across every server, such as global personnel records, global clearances, and global schedules. The global data shall be synchronized to each SAS to provide enterprise-wide security. The MAS shall be used to remotely monitor and manage controllers and video servers attached to SAS's in the enterprise, however it shall not support any directly connected controllers or video servers.

3. The MAS shall provide the capability for Central Monitoring of the entire enterprise, using the Monitoring Station application. From a Central Monitoring Station connected to the MAS, the system shall be capable of viewing events, activities, and status of every SAS in the enterprise. Alternatively, you can connect to an individual SAS to monitor that system and its connected hardware. In addition, the MAS shall provide the ability to integrate with external sources via LDAP, XML, CSV or ODBC imports both manually or automatically through scheduled processes.
4. Each SAS shall contain database records for all connected video and access control devices, as well as local personnel, clearances, privileges, and other related data. Each SAS shall synchronize with the MAS so that SAS local data is replicated to the MAS for central management and monitoring. In addition, the MAS shall provide central reporting capability for replicated SAS objects including journal and audit transactional data. [Note, for Connected Program integrations, SAS local data is not replicated to the MAS and central reporting is limited.]
5. All local data shall be synchronized immediately to the MAS or queued if a server is offline. All queued data shall be replicated automatically upon restoration of communication. Global data that is created or changed at the SAS/MAS shall be replicated to all locations. Journal and Audit data shall be synchronized either manually or on a configurable schedule, providing the ability to manage bandwidth usage and load balancing.
6. Operators in the enterprise architecture shall be configured as local or global. Global operators shall be subject to the user privileges as defined on each SAS.
7. The Enterprise Architecture option shall include:
 - a. Support for up to 20 SAS Systems
 - b. Global Administration of Personnel and Clearances, Images, Card formats, CHUID Formats, Holidays, Personnel groups, and Operators and Privileges
 - c. Centralized Reporting
 - d. Central Monitoring of Events and Activities across the Enterprise
 - e. Central Management of Access Card Enrollment
 - f. Central Badging and Image processing
 - g. Global Management of Badge Layouts
 - h. Single Card Access across the Entire Enterprise
 - i. Increased Scalability of Security Hardware and Video
 - j. End-to-End Encryption
 - k. Automated Synchronization of Enterprise Security Databases
 - l. Central Management of Video and Hardware Resources
 - m. Remote Editing of Global and Local Data

C. Graphical User Interface (GUI)

1. The SMS shall employ a standard, Windows 7, Windows 2008 Server or later graphical user interface (GUI). A mouse and keyboard shall be the primary operator interface with the system. Operator screens shall utilize all standard Windows-style functions such as drop-down menus, context menus, radio buttons, and lists, as appropriate. The interface shall utilize a 'tree structure' similar to Windows Explorer.

D. Administration Operator Interface

1. The SMS shall employ an Administration Operator Interface to control the following:
 - a. Hardware (readers, inputs, outputs, video systems, door controls, CCTV, and other systems).
 - b. Configuration of personnel records, operators and operator privileges.
 - c. Graphical Maps.
 - d. Application Layouts.
 - e. Dynamic Views.

- f. Queries.
 - g. Import/Export of objects, including images.
 - h. System Variables.
 - i. Reports (either periodic or one-time).
 - j. System functions (event command and control, actions, schedules).
 - k. Display of a list of objects in a grid that can have their values modified and respond to real-time status changes.
 - l. Scheduling of backups.
 - m. Monitoring of system settings and performance.
 - n. Designing of and printing of badges.
2. The GUI shall be configurable by the system administrator to control the views and access of each Monitoring Station operator.

E. Monitoring Operator Interface / Activity Monitoring

- 1. The SMS shall contain a monitoring component that is capable of, among other things, displaying the current state of any object in the system. Additionally the monitoring station shall be capable of displaying a log of all activity that occurs in the system, from object state changes, to access control information. All text for events (alarms) in the system shall be configurable to be displayed in color based on the user-specified priority of the event.
- 2. The Monitoring Station shall be capable of showing all changes occurring to an object without requiring the associated activity messages for that object to be routed to that monitoring station. The SMS shall require the operator to have appropriate permissions to view and/or control any object.
- 3. The monitoring station interface shall be user-customizable. The SMS shall support the ability of the end user to create a customized application layout for the monitoring station. The monitoring station shall support multiple application layouts that can be assigned to the operators. Each application layout can have multiple panes in the same window. The panes can have multiple tabs so that different objects such as cameras and tours can be displayed in the same pane. The panes shall have the ability to include: General activity; Event (Alarm) activity; Dynamic card swipe information; Video cameras and tours; Maps; Dynamic Views; Reports; and links to external applications. Each pane shall have the ability to be moved to a specific screen.
- 4. The SMS shall provide the Monitoring Operator with following functional capabilities:
 - a. Shall provide a scrolling list of lines or tiles showing current activity on the system.
 - b. Shall display activity in real-time as data is being transmitted by field hardware.
 - c. Shall include icons that indicate the type of activity and textual description of the activity.
 - d. The color of the frames of the tiles, icons, and/or text shall indicate the type or importance of the information contained therein.
 - e. A series of menus, driven by drop-down or trees, shall allow the Monitoring Station operator to perform manual actions, such as "momentary door unlock" for a given door.
 - f. As part of the manual action capability, the system shall provide screens or boxes that query the operator on specifics, such as start and end time, and offer guidance on performing the manual actions.
 - g. A GUI that displays the images of personnel as they enter, as well as the stored images of personnel available in the SMS.
 - h. Ability to view a sortable list of active alarms or events and recently active alarms or activity.
 - i. Ability to view video from DVMS systems within the same GUI. The video screen GUI shall be able to display multiple panes of live or recorded video and have

- on-screen camera controls for each live window, providing PTZ control of individual cameras.
 - j. A GUI that minimizes the number of operator mouse clicks or keyboard strokes.
 - k. Mouse controls include “right-click” pop-ups and highlighted default selections.
 - l. Objects shall be displayed to the operator based on his/her assigned operator privilege. The operator shall only be able to monitor/command those objects for which he or she has been assigned privilege.
 - m. When an operator logs out of a workstation and a new operator logs on, the objects displayed on the workstation screen shall be dynamically updated to display only those objects for which the new operator has privilege.
 - n. Allow the customization of columns as defined by the operator privilege, including:
 - i. Adjusting width (on the fly or pre-programmed).
 - ii. Not displaying Columns (on the fly or pre-programmed).
 - iii. Sorting on selected columns (to follow standard Windows conventions).
 - o. Allow for a “freeze” function. This includes a configurable “freeze time-out” that permits an activity to be selected and temporarily prevents the display of subsequent activities which push the selected activity off the screen. A break-through event disables the freeze function.
 - p. Support multiple panes for the display of events, activities, video, personnel images, and maps.
 - q. Display the number of active causes of an event.
 - r. Support the ability to attach a log message to an event, even after the event has been acknowledged.
 - s. Provide the ability to attach Predefined Log Messages to an event upon acknowledgement.
5. Pre-defined Alarm Acknowledgement Messages
- a. The ACS shall provide the ability to create Predefined Log Messages. Each log message shall have a Name, Description, Label and Message Text. These messages shall be assigned to any event providing the ability to select the appropriate response that resolved the event. The ACS shall provide the ability to group multiple log messages and then assign the group to an event. Each group shall contain up to one hundred messages and each event shall support up to one hundred messages. The ACS shall allow only users with specified operator privileges to add, modify, or delete messages or message groups. Predefined messages shall be editable by an operator with the proper privilege and may be appended as required by the operator.
 - b. Messages shall have the following characteristics:
 - 1) Message Name shall be configured with up to 500 characters
 - 2) Message Description shall be configured with up to 500 characters
 - 3) Message Label shall be configured with up to 100 characters
 - 4) Message Text shall be configured with up to 3000 characters
6. The SMS shall support audible alarm annunciation at operator workstations (operator configurable audio [WAV] files associated with alarms).
7. The activity monitoring screen shall be capable of displaying the following features:
- a. System clock.
 - b. Date/time when the activity actually occurred and the date/time when the activity was received by the server shall be displayed (when they are different).
 - c. Real time event counters.
 - d. Count of the active events.
 - e. Count of the events requiring operator acknowledgment.

- f. Name of operator logged on at the workstation.
- g. Real-time display of the current activity on the system in chronological order.
- h. Manual Action command buttons.
- i. Pre-defined and configurable acknowledgement messages.
- j. Log message.
- k. Clear event.
- l. Clear group of events.
- m. Event action message (automatically display selected message for event).
- n. Dynamic views.

F. Web Client

- 1. The SMS shall support a Thin Client to provide remote access to the SMS Server via a web browser. The Thin Client shall support Microsoft® Internet Explorer 7.0 and Mozilla Firefox® 3.0 or greater. The Thin Client shall support 128-bit AES encryption to the SMS Server.
- 2. The Thin Client shall support Single Sign-on utilizing Windows Authentication. The privileges of the SMS operator shall be propagated to the Thin Client User allowing only access to Security Objects for which the SMS Operator is authorized. The Thin Client shall provide support for Partitioning of the system and utilize the Partitions assigned to the Operator.
- 3. All changes made to the SMS database via the Thin Client shall be recorded in the Audit Trail Database.
- 4. The Thin Client shall provide Personnel Management, allowing the Operator to create and modify Personnel data (includes adding/removing clearances, schedules, and expiration dates). The Operator shall have the ability to enable and disable cards. The Operator shall have the ability to search for, edit, add, and delete Personnel records from the SMS database. The search function shall allow wildcards and shall include First name, Last name, card number, and user defined text 1.
- 5. The Thin Client shall support an Activity Monitor to provide a scrolling display of system activity. Activity shall be restricted based upon the Operator's Privilege and Partition assignments. Display controls shall include page up, page down, and a freeze function.
- 6. The Thin Client shall support Manual Actions to include the Locking/unlocking of doors, and the Activation/deactivation of events.
- 7. The Thin Client shall support the display of Dynamic Views as defined by the SMS. Dynamic Views shall provide a real time view of SMS data including Journal and Audit Trail history. Viewing of Multiple Dynamic Views shall be supported.
- 8. The Thin Client shall support creating, configuring, loading and saving of reports. Reports shall consist of personnel history activity or audit data. The report data shall allow sorting within the thin Client view page by any displayed field in ascending or descending order. The Thin Client shall allow reports to be saved in the following formats: XLS, CSV, XML, TXT or PDF. The operator shall have the option to save the report to a file or send it via email.
- 9. The Thin Client shall support Manual Action Challenges. The Manual Action Challenge shall require an operator to enter their login credentials (User name and password) when executing a manual action, such as a door unlock, from within the Thin client.
- 10. The Thin Client shall support the ability to query on a specific cardholder or a group of cardholders for the purpose of assigning clearances to multiple cardholders at once. Once the query is complete, the operator shall have the ability to assign a single access clearance or a group of clearances to all cardholders.
- 11. The Thin Client shall support the ability to display a door activity report from the web client cardholder record configuration view. In addition, it shall provide the ability to display the Activation / Expiration Date and Time for each credential assigned to a cardholder. The thin client shall display all user-defined personnel fields and the details of each assigned access clearance in a separate window.

12. The Thin Client shall support Auto-Logoff based upon inactivity. The Thin Client shall monitor user activity and shall automatically log a user out of the workstation after a user defined timeout period.

G. Graphic Maps

1. The SMS shall support unlimited graphic maps and icons to be displayed on the operator workstation monitor.
2. The system shall support an operator-programmable, color graphic map display that:
 - a. Shall be capable of showing the floor plan, the location of alarm devices, and alarm instructions for a facility.
 - b. Shall be centralized in the system configuration and displayed on the operators' workstations.
 - c. Shall allow various maps to be associated with different areas to create a hierarchy of maps.
 - d. Shall support graphic maps having a resolution of 1024x768 Pixels or greater.
3. Operators shall be able to use drag-and-drop mouse technique to place dynamic system level object icons of all objects such as: cameras, video servers, inputs/outputs, events, maps, reports, dynamic views, and door/elevator icons. These dynamic object icons shall allow a system operator to perform tasks and issue commands related to the object by double-clicking on the icon.
4. The SMS shall allow the addition of new layers to the drawing (such that if the drawing must ever be reloaded due to an update of the drawing, the layer(s) created within the SMS will be added back automatically without additional reconfiguration).
5. The SMS shall be able to directly import the following file formats for the map:
 - a. AutoCAD (.DWG)
 - b. SVG
 - c. DXF
 - d. DWF
 - e. Windows Meta File (WMF)
 - f. TIFF (.TIF)
 - g. JPEG (.JPG)
 - h. PNG
 - i. Windows Bitmap (.BMP)
 - j. GIF
6. The Maps feature shall include two operational modes: an administrative mode to allow configuring of the facility floor plans or site plans that show exterior features and a runtime mode to allow monitoring and interacting with the configured facility layouts or site plans. The Maps feature shall also include a tracking window, a magnification window, and a coordinates window.

H. Information Storage, Backup and Transfer

1. All programmed information, as well as transactional history, shall be automatically stored in the database for later retrieval and backup. The SMS shall support configurations where the SMS database(s) may be installed on a hard drive on the SMS server, on an independent database server, or in an existing corporate database server.
2. The SMS shall be capable of backing up and restoring all system data and transactional history. The server shall be capable of transferring all programmed data and transactional history to CD-ROM, DVD, or Hard Drive (including networked drives).
3. The SMS shall allow activity history to be written to a database. The system shall have the capacity to store a minimum of 50 million transactions. There shall be a method of backing up the activity history on external media and then restoring and replaying it.

4. The SMS shall support AES 256-bit encrypted communications between server and user client.
5. The SMS shall support AES 256-bit encrypted communications between server and controller. The encryption shall support both local and third-party digital certificates.

I. Communication Ports

1. The SMS shall be able to support multiple serial devices. In addition to COM1 and COM2, up to [8, 16, 32, to 256] additional ports may be configured through the use of a port expander or its equivalent. These serial ports may be used for connection to CCTV matrix switchers, or apC panels.
2. The SMS shall support the use of Ethernet networks as the communications path between the host computer and field devices such as ETHERNET ISC, iSTAR, apC, apC 8/x, ApC Lite controllers, and CCTV matrix switchers. This communications path shall be the same network used for communications between the host server and the operator workstations. The communications between the host computer and the field devices shall be encapsulated in a TCP/IP network/transport layer.

J. Printers

1. The SMS shall support report printing. The report printer(s) may be connected directly to the client PC, or shared over a network. The SMS shall support as report printer(s) any printer for which a printer driver exists within the Windows 7, Windows Server 2003, or Windows Server 2008 operating systems.

K. Software Configuration

1. The SMS configuration tools shall utilize intelligent configuration controls. The system shall be structured so an operator is unable to perform configuration functions that are invalid based on the configuration used. The system shall support the ability to search within browser lists using filtering operators such as "begins with", "ends with", "contains", etc. The system shall also allow an operator to do searches using filtering operators on any class of object in the system, both in the Administration application and the Monitoring Station application.
2. The SMS shall allow text description of all configured objects. The SMS shall allow the renaming of an existing title description without removing the sub-components of that configuration object. The SMS shall automatically remove from the system all configuration references to an object being deleted. The SMS shall automatically provide default names for all inputs, outputs, readers, and extension boards. The SMS shall clearly display which hardware objects (inputs, outputs, readers) on a controller are configured, and which are not.
3. The SMS shall provide for the configuration of templates. Templates of supported objects shall be operator-configurable to provide default values for data fields within an object class's configuration.
4. The SMS shall support an unlimited number of groups for any object type. The SMS shall support unlimited object group definitions. In general, a group shall be usable wherever an individual object is referenced in the SMS. For example, a group may be used instead of an object when configuring a schedule/object pair in a clearance, and a group may be used instead of an object when performing a manual action to unlock a door.
5. The SMS shall generally allow any object in the system to be grouped including personnel, doors, inputs, outputs and clearances.
6. The SMS shall restrict the viewing and controlling of objects in the administration and monitoring stations via operator privileges. The SMS shall support the configuration of operator restrictions on an object class basis, and on an object-by-object basis. The SMS shall maintain a distinction between objects that are being monitored and objects

that are being controlled, preventing operators from issuing object manual actions to objects for which the operator does not have manual action privileges. There shall be different levels of controls within the system for administration privileges versus monitoring privileges.

7. The SMS shall support unlimited operator accounts with unlimited definable privilege levels.
8. The SMS shall allow configuration of controllers using hierarchical tree-based navigation and context menus.
9. The SMS shall support the ability to download firmware updates to the controllers.
10. The SMS shall support Windows single sign-on (SSO) that integrates login credentials with operator permissions to provide seamless user authentication and authorization.
11. The SMS shall provide an automatic client update process for quick distribution of application updates.
12. The SMS shall have context sensitive online help (at the screen level) available at any point requiring operator input.

L. Personnel Records

1. The SMS Personnel records shall provide multiple tabbed pages of personnel data containing default system and user-defined fields. The SMS shall support an unlimited number of tabs allowing an unlimited number of user-defined fields. Labels for user-defined field tabs shall be customizable by the System Administrator with the appropriate privileges. Each user-defined field shall allow a name, description and label. A default language shall be selectable by the System Administrator for the user-defined field labels.
2. User-defined fields shall be definable as Mandatory or Unique and shall support the following field types:
 - a. Character
 - b. Integer
 - c. Logical
 - d. Date/Time
 - e. Date
 - f. Time
 - g. Enumerated List
 - h. Multi Line
 - i. Decimal
3. User-defined fields shall support masking to provide consistency of data entry across all system operators. Custom masks, as well as the following predefined masks, shall be available:
 - a. Alphabetic
 - b. Alphanumeric
 - c. Numeric
 - d. Phone Number – USA
 - e. Zip Code
 - f. Zip Code +4
 - g. Alpha – All Caps
 - h. Alpha – All Lower case
4. The SMS shall provide a "Personnel Record Document Object" option which allows the operator to assign / attach up to two (2) documents (such as URL, PDF, or TXT files) to the personnel record. The document may be applied to the record as a:
 - a. 'Shared' Document - added to the SMS via the Documents Editor.
 - b. 'Private' Document - imported from outside the system, such as a birth certificate or a diploma.

5. The SMS shall include a "Documents" tab to user-defined personnel views as well as the default view "Personnel View with Portrait in Header" to support the association of documents. The documents are available for viewing by operators with appropriate privilege.

M. Personnel Views

1. The SMS shall support user-defined Personnel Views. Personnel Views shall provide the ability to customize the Personnel record by adding and/or removing certain objects from the operator's view. Personnel Views shall be assignable to SMS operators via the operator's assigned privilege and shall be definable for use in the creation and/or editing of the Personnel record. All Personnel Views enabled for an operator shall be selectable from the current view to allow an operator to switch views in real time. Personnel Views shall support the following:
 - a. Adding/Removing Fields (including all user-defined fields)
 - b. Custom Field Labels
 - c. Adding Boxes to group together common fields
 - d. Adding/Removing tabs to organize fields
 - e. Custom Tab Labels
 - f. Customization of Tab display order
 - g. Background/Foreground color control of fields and labels
 - h. Personnel Record Document Object – to associate up to two (2) documents to the record

N. Language Localization

1. The SMS shall be configured so the information presented to system operators is displayed in a language native to the system operator provided that the proper translation files exist.
2. It shall be possible to translate the SMS into any left-to-right or right-to-left language supported by Unicode and by the Microsoft Windows operating system.
3. Languages shall include English, Arabic, Brazilian Portuguese, Dutch, French, German, Italian, Polish, Simplified Chinese, Spanish and Japanese.

O. Inputs

1. The SMS shall monitor both supervised and unsupervised hardware inputs as well as virtual inputs such as predefined system messages. These inputs include door / elevator inputs and monitor points. The SMS shall also monitor controller inputs such as tamper, AC fail, and low battery.
2. The SMS shall have the ability to name and allow for user-defined descriptions for individual inputs, outputs, and readers as well as input and output modules.
3. There shall be three separate and distinct states for inputs, which can be defined on the input configuration screen: Disabled, Enabled / Disarmed and Enabled / Armed.
4. The SMS shall allow configuration to link the state of an input to an output. The system shall allow multiple inputs to activate a single output or group of outputs.

P. Outputs

1. The SMS shall have outputs, also known as Control points that associate an input or event action with a relay output. These output uses include doors / elevators, alarms and industrial control.
2. There shall be three types of outputs available: dry contact / Form C relays, wet or voltage sourced relays and Open Collectors. Outputs shall be configured such that they can be activated, deactivated or pulsed by system actions.

Q. Card and Reader Support

1. The SMS shall be designed to support multiple card formats and card reader types.
2. The SMS shall support the following features for directly connected readers:
 - a. User defined card formats up to 256 bits.
 - b. Unlimited number of SMS card formats.
 - c. The ability to assign up to 10 card formats per reader.
 - d. The ability to show reader status on RM LCD.
 - e. Support Wiegand and 3x4 matrix keypads.
 - f. The enrollment of biometric templates to smartcards.
 - g. Custom CHUID FIPS201-compliant supporting full 256-bit data.
 - h. The SMS shall support readers that provide Wiegand signaling and magnetic signaling to include:
 - 1) Software House RM readers.
 - 2) Software House Multi-technology readers.
 - 3) Wiegand swipe/insert readers.
 - 4) Proximity readers.
 - 5) Biometric readers.
 - 6) Smart card readers.
 - 7) Wireless readers.
 - 8) Magnetic readers.

R. Keypad Commands

1. The SMS shall support keypad commands. Keypad commands shall be up to Nine digits in length. Keypad commands shall be entered at a keypad connected to an iSTAR controller and shall be used to activate system events. The event shall be configurable to activate any allowable event action.
2. Keypad Commands shall support Personnel Permission options to accompany the command and validate the issuer's identity. Keypad Commands shall be configurable to require a valid credential or a valid credential plus a PIN. Keypad Commands shall also be available to all Personnel or only selected Personnel as part of a Personnel Group.
3. The SMS shall support the assignment of certain users as Keypad Command Administrators. These users shall be able to issue all Keypad Commands and shall not be required to be part of a Personnel Group assigned to a Keypad Command.
4. Keypad commands shall have the ability to be limited to specific doors as part of a Door Group within an iSTAR Cluster. In addition, specific readers shall be configured to allow or disallow keypad commands.
5. Keypad Commands shall support segmentation of the nine-digit code in the form of Prompt Codes. Prompt Codes shall allow the user to utilize some digits of the Keypad Command to correspond to a command such as a door unlock, and the remaining digits to correspond to an object such as a door. When using Prompt Codes, the first segment shall be entered and the SMS shall prompt the user on the reader LCD module to enter the remaining digits. The SMS shall support two Prompt Codes per keypad command.

S. RM Reader LCD Messages

1. The SMS shall provide custom LCD messages to be displayed on the LCD screen of RM readers. All messages, as well as date and time formats, shall be downloaded to the controller and will be used on all supported readers configured on that panel. The ability for the System Administrator to change the Language for LCD messages shall

be provided. (The reader LCD supports Western character sets only. No double-byte languages are supported.)

T. Wired or Wireless Handheld IP Device Support

1. The SMS shall support wired or wireless handheld IP devices:
2. The SMS shall support the following features for a ruggedized handheld / portable reader:
 - a. The reader shall store a user-defined list of cardholders locally in its memory for visual validation of personnel.
 - b. The reader shall support a GUI, touch screen, and personnel verification application.
 - c. Support for smartcard contactless (MIFARE, iCLASS, DESFire), barcode and HID proximity cards.
 - d. Wired or wireless communication to the SMS server.
 - e. Communicate to the SMS Server via a SSL connection.
 - f. User-defined personnel query to define records stored at reader.
 - g. Live-to-server or standalone operation mode.
 - h. Ability to manually accept or reject cardholder at reader.
 - i. Ability to show the expiration date of a cardholder.
 - j. A report of personnel who have not presented their card to the reader.
 - k. Upload of transactions to the SMS server for reporting purposes.
 - l. Scheduled database refresh by Time Specification.
 - m. Encrypted database on reader.
 - n. Application security mode based on personnel credential.
 - o. Pre-defined personnel fields to download to reader.
 - p. Unit shall be ruggedized.
 - q. Unit shall support a full duty cycle on a single battery charge.
 - r. Unit shall Support up to 16 GB RAM.

U. Door Configurations / Elevator Control

1. The SMS shall allow doors to be configured to operate in any of the following access control modes:
 - a. Unlocked
 - b. No Access (Secure mode)
 - c. Any combination of the following, as defined by schedule, event: card only, PIN only, Card + PIN, Card entry through keypad.
2. The SMS shall allow a door to be configured to operate using the following functions:
 - a. Readers shall read cards while the door is in the open position.
 - b. Door lock relay shall automatically lock upon the door being opened.
 - c. Allow for a user-defined delay relock time period.
 - d. Allow for a user-defined door unlock time and door held open time.
 - e. A separate (alternate) shunt timer for ADA flagged cardholders
 - f. The operator shall be able to specify a shunt expiration output to be triggered for a configurable time (in hh:mm:ss) before the expiration of the door open or alternate shunt. Can be enabled for ADA only, or all the time.
 - g. Allow for a user-defined door unlock and door held time, in seconds.
 - h. PIN-only access (keypad).
 - i. PIN-entry on the reader keypad shall be required during a specified schedule after a card access (unless a manual action or event has disabled PIN).
 - j. Card entry through keypad.

3. The SMS shall allow each door to be configured to cause a variety of events such as alarms to occur based on activity at that door.
4. The SMS shall support configuration of unlimited elevators.
5. The SMS shall support an extended unlock function initiated via two valid card presentations to a single reader or a 'double swipe'. The double swipe feature provides the ability to designate doors at which cardholders with double swipe privileges may perform an extended lock or unlock of the door. The double swipe feature shall support the following:
 - a. Modified reader beeper pattern to reflect the extended unlock mode.
 - b. Individual card access privileges to perform double swipe action.
 - c. Unique parameters assignable to any door.
 - d. Reset of a double swipe unlock (relock) via scheduled event.
 - e. Event activation to reflect double swipe state (Lock, Unlock).

V. Area Control and Antipassback

1. The SMS shall support the ability to define Area configurations. Areas are defined as physical regions bounded by doors. An area shall consist of a room, a specific location(s) within a building, or an entire building.
2. All configured areas shall have in/out access doors providing the ability to run reports showing all present cardholders in each area. There shall be no way to leave an area without presenting a credential to a reader/door.
3. The SMS shall provide the ability to run a Roll Call report. The host shall maintain a current area for each personnel record, and the time at which the area was entered (AreaAccessTime). The current area shall represent the last area entered by the cardholder based on a valid admit.
4. The SMS shall support Area control to provide the ability for tracking personnel. With this function, an operator shall obtain the current location of cardholders. Dynamic views and or reports can be generated to show specific cardholders who are present in each defined area.
5. Each cardholder's record shall provide easy access to view and maintain their current area location. This card record property will be updated as a person moves from one area to another using a valid credential.
6. The local controller shall provide the ability to manage and control the Area configuration in the event that it loses communication with the SMS system server.
7. The SMS Area configuration shall have three modes of operations: None, Antipassback, and Timed Antipassback.
8. Antipassback shall control access based on the cardholder's location. The SMS shall deny access to cardholders who are in violation of antipassback rules. In the event that a cardholder leaves an area without presenting their credential to the out access reader/door and then tries to enter back into the area by swiping the In access reader/door, a denial of access will occur. The SMS system shall provide the ability to grace individual cardholders who have violated antipassback rules. The Grace option shall also provide the ability to grace all cardholders.
9. Antipassback shall continue to be enforced during communications failure. SMS controllers shall have the ability to be clusters in a group. The master controller in the group and all other controllers within that group shall have full access to the existing antipassback information. The cluster can be configured for 'No Access' Communications Failure mode or for 'Local' Communications Failure mode.
10. Clustered controllers configured in 'Local' mode that are disconnected from the master controller shall grace all cardholders from antipassback violations. The disconnected controller shall then follow antipassback rules specific to the areas defined on that controller. If the controller does not know if a cardholder is in antipassback violation based on areas that are configured between controllers, access will be granted.

11. Clustered controllers configured in 'No Access' mode that are disconnected from the master controller mode shall not grace all cardholders from antipassback violations. All cardholders will receive a denial of access until communications is restored.
12. The SMS shall support Timed Antipassback. Areas configured for Timed Antipassback shall require a cardholder use an exit reader to exit an area. Cardholders who do not exit properly shall be required to wait for a predetermined period of time before re-entering the area.
13. The SMS shall provide occupancy restrictions for areas. Restrictions shall be applied to individual cardholders (personnel) or user defined groups of cardholders. Areas shall be configurable to provide limits for the maximum and minimum number of personnel who can access an area at one time. It shall be possible to trigger an event based upon a violation of either of these rules. Events shall be configurable based upon the following criteria:
 - a. Maximum occupancy status
 - b. Minimum occupancy status
 - c. Group Maximum occupancy status
 - d. Group Minimum occupancy status
 - e. Personnel Count (user-defined)
 - f. Violation status (Antipassback entry/exit violation etc.)
14. The SMS shall support Soft occupancy restrictions for both maximum and minimum occupancy to allow reporting of violations while still allowing access to the area.

W. Escorted Access

1. The ACS shall provide an Escorted Access feature that gives the ability to control, track, and report on the movements of Personnel designated as Escorted Visitors. An Escorted Visitor shall be a visitor who can only move around a facility in tandem with an employee designated as an Escort.
2. There shall be two Escort Visitor modes: Companion mode and Remote Escort Mode. In Companion mode the system shall allow multiple Escorted Visitors to be accompanied by one escort. In Remote Escort mode the system shall allow Escorted Visitors and the Escort to present their credentials on opposite sides of a door to gain access.
3. The ACS shall have the ability to configure a designated Area to allow an Escorted Visitor to enter/exit the area without an Escort.

X. Intrusion Zones

1. The SMS shall support the configuration of Intrusion Zones. An Intrusion Zone is a user-defined group of Doors and Inputs on the same local Controller that delineates a physical area. This area shall be monitored and produce an alarm during any violation of the objects associated with the Zone.
2. The local controller shall provide the ability to manage and control the Intrusion Zone in the event that it loses communication with the SMS system server.
3. The Intrusion Zone shall have 2 modes of operations: Armed or Disarmed. When an Intrusion Zone is in an armed mode, the state of the Intrusion Zone shall either be Violated or Not Violated based on the state of the inputs and doors associated with the Zone. If the Zone is violated the SMS shall provide the ability to execute any defined event(s) within the SMS.
4. The SMS shall provide the ability to display the "Ready to Arm State" of any configured Zone. The "Ready to Arm State" shall be able to be displayed from any SMS monitoring application or from a local reader with an LCD display. All off-normal points/doors shall be able to be displayed from both locations. If any point or door associated with a Zone is not in a normal state, the Zone shall show a "Not Ready to Arm State".

5. When a door is placed in a Zone, the operation of the door shall be configured based on the state of the Zone (unlocked, locked, secure). Specific doors assigned to the Intrusion Zone shall be configured as entrance or exit points for the Zone. When the Zone is being armed or disarmed, a user-definable time shall be set for exit or disarm operations. Specific readers/doors shall have the ability to be defined as arm/disarming stations.
6. The Intrusion Zone shall be configured such that when an input configured in a Zone is active, the Zone cannot be armed without executing a force arm. When a Zone is force armed, the input(s) that were in an active state shall not function as part of the Zone until they are placed back in a normal state and the Zone is disarmed and rearmed.
7. Inputs configured in a Zone shall have the ability to be configured as Controlled Inputs or Monitored Inputs. A Controlled Input shall follow the state of the Zone. If the Zone is disarmed, the Controlled Input shall be disarmed as well. A Monitored Input shall have the ability to cause a Zone violation even if the Zone is in a disarmed state.

Y. Schedules

1. The SMS shall support unlimited operator configurable schedules. Each schedule shall allow unlimited individual time intervals.
2. Each system controller shall support a minimum of 128 schedules and a minimum of 18 time intervals per schedule.
3. Each schedule shall consist of operator-defined time segments. Each time segment shall be day(s) of the week and include holidays and starting and ending times. The system shall provide grouping of days.

Z. Holidays

1. The SMS shall support unlimited holidays.
2. The SMS shall support holiday type designations as Recurring Day of Month, Recurring Relative Monthly, Non-Recurring or Day of Week. The SMS shall allow assignment of duration to each holiday.
3. Holiday groups can be assigned to a Schedule.

AA. Time Zones

1. The SMS shall maintain time zones to be used when configuring certain system objects. A time zone shall adhere to standard international Time Zone behavior, and the system shall support all time zones supported by the Windows OS.
2. The SMS shall allow time zones to be assigned to IP devices, controllers, CCTV matrix switchers, DVRs, and scheduled Manual Actions.

BB. Clearances

1. The SMS shall support configuration of unlimited Clearances.
2. The iSTAR controllers shall support up to 150 clearances per person.
3. The SMS shall support clearance activation and expiration date and time.
4. The SMS shall support the ability to select multiple personnel from a Dynamic View and assign clearance(s) to the selected personnel.
5. The SMS shall support the ability to select multiple personnel from a Dynamic View and remove clearance(s) from the selected personnel.

CC. Clearance Filters

1. The SMS shall support Clearance Filters. Clearance Filters shall provide the ability to dynamically change the access rights of personnel (cardholders) or groups of personnel. Personnel with a lower Clearance Filter level than that assigned to a card reader shall be denied access to that card reader (door). Clearance Filter levels shall

be assignable to card readers either manually or automatically via event logic or a time schedule.

DD. Events

1. The SMS shall support unlimited operator configurable events, including the scheduling of events, and action-based trigger of events.
2. The system shall provide 8 configurable event priority levels with a total of 200 numbered event priorities. The system shall allow the operator to define custom colors and labels per individual priority level.
3. The system shall allow an event to be configured to:
 - a. Be sortable by event name, date/time, priority, state, and any other displayable information.
 - b. Be routed to operators by operator privileges, including support for the routing by time of day feature.
 - c. Require or not require operator acknowledgment.
 - d. Require or not require a log message to be entered by the system operator responding to the event.
 - e. Display or not display the event activation.
 - f. Require the object(s) causing the event activation to reset before the operator may acknowledge the event.
 - g. Display an operator-defined text message upon event activation.
 - h. Display an operator-defined text message when the event is deactivated.
 - i. Be associated with a map so the map opens automatically on the monitoring station when the event activates.
 - j. Activate a second event when the first event activates and is unacknowledged for a specified period of time.
 - k. Allow the operator to associate an audio wave file with the event.
 - l. Allow for minimum activation time and delayed activation time for events.
 - m. Download events to the iSTAR controllers.
 - n. Run imports and exports.
 - o. Run reports and remove report results.
4. Event Assessment Feature
 - a. The SMS shall provide an Event Assess Feature which allows an operator to quickly view all objects associated with an event in a user defined Event Assess Application Layout.
 - b. The SMS shall not require the operator to navigate away from the event assessment window to review objects associated with the event.
 - c. The SMS shall provide an Event Editor "Assess Configuration" to allow an operator to configure the objects available during the assessment of an event in the Monitoring Station.
 - d. The Assess Event Application Layout shall have the following capabilities:
 - 1) View any documents associated with the Event.
 - 2) View live video associated with the Event.
 - 3) View recorded video associated with the Event.
 - 4) View Event details.
 - 5) View a Map associated with the Event.
 - 6) View a Journal Replay of the event, based on a query associated with the Event.
 - 7) Use an Event Details Viewer with additional quick action buttons to process the Event.
 - e. Each event shall provide the ability to show the entire Event Assessment with a single mouse click via an icon.

- f. The event assessment layout shall only be available for viewing by operators with appropriate privilege.

EE. Manual Action Challenge

1. The SMS shall support Manual Action Challenges. The Manual Action Challenge shall require a SMS operator to enter their login credentials (User name and password) when executing a manual action from within the SMS. The Manual Action Challenge shall be available from both the Administration and Monitoring Applications. The Manual Action Challenge shall be assigned to a Privilege and the Privilege shall be assigned to the SMS operator.

FF. Document Editor

1. The SMS shall support the ability to import multiple types of document objects to include:

PDF, TXT, XML, DOC, XLS, JPG, GIF, PNG, TIF

2. The SMS shall have the ability to attach these object types to the following areas:
 - a. Personnel records to provide additional information.
 - b. Events as part of the Events Assessment Feature.

GG. Integrated E-mail

1. The e-mail system shall have the ability to interface directly to an SMTP-compliant e-mail system supplied and configured by the user.

HH. Import/Export

1. The SMS shall provide a means for manually importing and exporting selected data in XML format. This mechanism shall support the import and export of any and all classes or types of data in the system. Specific data validation and logging requirements shall be met.
2. The system shall also support importing from CSV files.
3. The SMS shall provide an automated import mechanism (preferably XML-based). This mechanism shall support the import of most classes or types of data into the system. Specific data validation and logging requirements shall be met.
4. The SMS shall have the capability to perform automated imports from an Open Database Connectivity (ODBC) data source allowing the import of personnel data directly into the system database.
5. The system shall have the ability to connect to a directory service source via the Lightweight Directory Application Protocol (LDAP). The connection to the LDAP source shall be user-configurable directly from the SMS and shall not require custom code. The LDAP interface shall also support the automatic assignment of SMS clearances based on data contained in the LDAP record. The LDAP feature shall support the following features:
 - a. LDAP server name and user-defined port number.
 - b. A base distinguished name for the root of searches.
 - c. A user-definable LDAP search filter to refine object search.
 - d. User-defined mapping of attributes to SMS personnel fields.
 - e. The use of a Distinguished Name (DN) entry for the SMS to authenticate to LDAP.
 - f. Option to search all sub-levels of the directory from the base DN.
 - g. Preview sample-data based on SMS LDAP import settings.
 - h. Automatic roles-based SMS clearance(s) based on two fields of source data.

- i. Automatic import of directory entries from the LDAP source.
 - j. Authentication via a user-definable LDAP user account and SSL.
 - k. Automatic SMS clearance assignment.
6. The SMS shall provide a Data Mapping feature that provides field mapping information using the XSLT file based on the input data or an external XSLT file.

II. Objects

- 1. Each object within the SMS shall be addressed by a unique operator-defined name. Object names shall be unique within object types.
- 2. The SMS shall provide the ability to add description text to each object definition.

JJ. Reports

- 1. The SMS shall provide configurable data reports for database configuration, historical activity (Journal) and audit tracking. Pre-defined reports shall be available for download and import into the system.
- 2. The SMS report function shall perform the following:
 - a. Create reports about any object.
 - b. Create report templates to simplify report design.
 - c. Run reports on demand.
 - d. Save report results for sharing between different users of the application.
 - e. Export reports into formats such as PDF, RTF, TXT, TIFF, Excel (XLS), and MHTML.
 - f. Specify a query to select and filter the records on which to report.
 - g. Specify the data fields to be included in a report.
 - h. Specify a design for the report layout.
 - i. Design a report form to be used as a layout for headers / footers for multiple reports.
 - j. Access and use system pre-defined report forms.
 - k. Select tabular, multi-line, or free form report layouts.
 - l. Report on objects linked together with parent / child relations.
 - m. Schedule reports to run automatically on a customized schedule.
 - n. Send exported report files to the printer or to external recipients via e-mail.
- 3. The SMS shall support integration to The Business Intelligence Reporting Suite (BIRS). The suite shall offer web-based reporting as well as data warehousing of SMS historical and system data. The suite shall include multiple pre-written reports such as 24 Hour Journal Messages, 24 Hour Trouble Messages, Graphical Usage and Count of Door Group. The open system procedures shall allow the reports to be written and saved for repeat use.
- 4. The reporting suite shall provide an interactive user experience via any standard web browser, allowing the user to scrutinize the information without needing to print or review hard copies.
- 5. The reporting suite shall support connecting to one or more SMS systems. This shall provide data and reports across an enterprise solution to allow segregated reports that reflect both satellite application server data as well as master application server data.
- 6. The reporting suite shall allow an enterprise to share and blend data from other sources such as ERP and Time and Attendance systems to yield critical business information and reporting.
- 7. The reporting suite shall provide information delivery options such as email, CSV export, PDF export, XML data transfer, or database pool offerings. The suite shall also be a critical resource in system review and audit procedures such as system maintenance and performance.

8. The Reporting Suite shall:

- a. Provide Intuitive user interface and web-based reporting for SMS customers
- b. Share and blend data from other sources to yield critical business information
- c. Leverage Microsoft® Business Intelligence (BI) tools
- d. Include Reporting Service for report delivery and presentation
- e. Perform Reporting and processing from the SMS host
- f. Include Subscription options for automated delivery of reports
- g. Include Dashboard, graphical, and statistical reports, and reports customized by user
- h. Generate Reports on any PC with compatible Web browser without SMS Client software
- i. Offer and secure Data via Active Directory and SQL permissions
- j. Include Optional front end or other application integration including SharePoint

KK. Dynamic Views

1. The system shall support a grid format displayable report that will be usable to display homogeneous lists of objects within the system. This display shall be configurable both at configuration time and also at run time.
2. The Dynamic views shall have the following features:
 - a. Real-time updating and display of property values.
 - b. The display shall be sortable.
 - c. Groupable by any number of columns.
 - d. Filterable based on user selectable criteria.
 - e. Printable.
 - f. Exportable in either XML or CSV file formats.
 - g. The export file shall be viewable in Excel (Excel must be installed separately).
 - h. The export file shall be able to be emailed.
 - i. The user shall be able to add and remove columns from the grid at runtime to enhance the user experience even if displaying a preconfigured view.
 - j. The view shall be capable of pre-configuration so that repeatable displays of objects are possible.
 - k. The view shall support in-place editing of properties of the object.
 - l. Bulk operations shall be performed via multi-selection. The operations shall consist of (but are not limited to) setting a property to a value and deletion.

LL. Query

1. The SMS shall provide a Query engine to be useful for users without any knowledge of SQL or any other specific query language. It shall allow users to make requests against data sets with preconfigured relations between tables. The relations shall reflect the actual relations between database objects and the user shall be able to put conditions on any available field in the selected object type and its subordinate objects.
2. The users shall be able to construct a proper query expression selecting all available operations, column names, and table names from prompted lists. It shall eliminate the necessity to memorize any particular expression syntax. References to existing configuration objects shall also be prompted through a list of existing objects where applicable, eliminating the necessity of memorizing names. The Query feature also shall support complex logic, such as AND/OR.

MM. CCTV Integration / Digital Video

1. The SMS shall provide extensive integration with American Dynamics Intellex digital and VideoEdge video recorder/NVR solutions.

2. The SMS shall provide extensive integration with Nextiva 5.1 digital video recorder/NVR solutions.
3. The SMS server shall be connected to the DVR/NVR during the configuration process enabling the SMS to query the DVR/NVR for setup information.
4. The SMS shall use tree controls to drag and drop video servers or cameras directly into the interface for intuitive and instantly active video integration.
5. The SMS shall provide live camera display during configuration.
6. The SMS shall provide the ability to drag cameras into tours.
7. The SMS shall provide the ability to identify and automatically configure all cameras on a controller.
8. The SMS shall provide the ability to interface with IP cameras.

NN. Intercom Integration

1. The SMS shall provide integration to an Intercom system. The integration shall include the ability to monitor multiple intercom states. In addition, the SMS shall provide the ability to monitor and control intercom functions both manually and through configured events based on system activity.
 - a. Email one or more recipients the details of the Intercom activity
 - b. Call up video camera, video tour, video view and recorded video
 - c. Call up a map
 - d. Highlight associated Intercom Call Station icons on a map
 - e. Run a report
 - f. Lock down a group of doors
 - g. Trigger any configured system event
2. In addition, the following functionality shall be provided:
 - a. Clicking on an icon configured as a Call Station on a map shall provide the ability to initiate a call.
 - b. Manually executing an event that controls Call Station communication.
 - c. Triggering an Intercom action event based on any system activity: e.g. door forced, door held, panic button, etc.
 - d. When an intercom icon is configured, an appropriate design JPG shall be assigned. The icon shall have the ability to be customized based on customer requirements.
3. If the Intercom Server loses communication with a remote station the Intercom Server shall notify the SMS. The notification trigger shall provide the ability to trigger any SMS event. When Call Station communication is resolved the SMS shall be updated with the real time status. If communication is resolved the SMS shall provide the ability to update the system event based on its real time status.
4. If the Intercom Server loses communication with the SMS, the SMS shall have the ability to generate a detailed event. If communication is resolved the SMS shall provide the ability to update the system event based on real time status.
5. All calls that are placed by the Central Master Control Station and/or a Field Intercom point shall update the SMS with a complete audit trail. The data shall be logged in the SMS Journal database. Any changes to configured intercom controls within the SMS shall be recorded in the Audit database.

OO. ID Badging Subsystem

1. The SMS shall include an embedded ID Badging Subsystem. The ID Badging subsystem shall utilize a common database with and be an integral part of the SMS. The ID Badging Subsystem shall provide the ability to capture cardholder images and design and print user-defined badge layouts. The Badging Subsystem shall support the following capabilities:

2. The SMS shall provide the ability to trigger Push-to-Call intercom station control. Intercom Call Station activity shall be able to generate SMS events. Event generation shall provide the ability to configure the following actions to automatically occur based on Call Station status.
 - a. Unlimited number of badge design layouts.
 - b. WYSIWYG badge designer.
 - c. Background color detection in the portrait image.
 - d. Threshold level selection to apply to background detection.
 - e. User-defined selection of background color.
 - f. User-defined selection of replacement color or transparency setting.
 - g. Edge-detection setting, to aid in replacing only the selected background and not any matching color within the portrait image.
 - h. Capture, import, and display portraits.
 - i. Capture, import, and display signatures.
 - j. Capture and display fingerprints.
 - k. Insert, import, and display foreground and background images.
 - l. Print two-sided badges.
 - m. Encode magnetic data onto personnel badges.
 - n. Insert 1D or 2D bar codes.
 - o. Insert or replace color and transparent effects for image and background display.
 - p. Support a variety of image formats including .bmp, .jpg, .tif, and .wmf.
 - q. Custom functions using the Expression builder.
 - r. Multiple images per cardholder.
 - s. Diagonal and Square borders. Each type of border shall support a user-defined width and height setting, and individual color settings for each border side.
 - t. Proper Case (first letter in string is set to uppercase, all other characters set to lowercase).
 - u. Year display (four- or two-digit).
 - v. Month display (full or abbreviated name, or numeric).
 - w. Day display (full or abbreviated name, or week/month numeric).
 - x. Hour display (12 or 24 hour format).
 - y. Minute display.
 - z. Second display.

PP. Smart Card / Proximity Card Enrollment

1. The SMS shall provide a smart card enrollment feature as part of the ID Badging Subsystem. The smart card enrollment feature shall allow a user to enroll MIFARE, iCLASS or DESFire cards utilizing a USB wedge reader or a Manufacturer-approved badge printer.
2. The SMS shall provide a proximity card enrollment feature as part of the ID Badging Subsystem. The proximity enrollment feature shall allow a user to enroll the card number of proximity cards on a Fargo HDP 5000 printer that is equipped with an OMINKEY CardMan 5x25 encoder.
3. The ID Badging Subsystem shall support the creation of Smart Card Templates to define the smart card configuration. Templates shall be used to define the data transfer between the physical card and the Personnel Record. Templates shall define the card type as MIFARE, iCLASS or DESFire. When programming a card, the system shall be able to read and write to all relevant data such as personnel fields, card fields or card formats. The Badging Subsystem shall provide the ability to Enroll MIFARE, iCLASS or DESFire. The Badging Subsystem shall provide the ability to Program and Enroll MIFARE.
4. Templates shall also be utilized to define the Security Keys needed to access the data on the smart card. Templates shall be assignable to the enrollment device (wedge reader or printer).

5. The ID Badging Subsystem shall support both the enrollment (reading of data from the card) and programming (writing of data to the card) for MIFARE cards. The ID Badging Subsystem shall support the enrollment of DESFire cards and shall support Card Serial Number data only. The ID Badging Subsystem shall support the enrollment of iCLASS cards and shall support Card Serial Number data only.
6. The ID Badging Subsystem shall support the creation of Custom read/write Keys. Custom Keys are private keys supplied by a third party. Custom Keys shall be assigned to Software House Readers via Program Cards supplied by the Manufacturer.

QQ. System Parameters

1. The Security Management System (SMS) shall have a minimum capacity of:
 - a. 16 online readers
 - b. 64 online inputs
 - c. 64 online outputs
 - d. 7,000 credentials
 - e. 6 simultaneous Clients
 - f. 1 Badging Client
2. The SMS shall have a maximum capacity of:
 - a. 2,500+ online readers
 - b. 10,000+ online inputs
 - c. 10,000+ online outputs
 - d. 500,000 credentials
 - e. 10 Simultaneous Clients (Additional clients may be added to the license up to 256)
 - f. 2 Badging Clients (Additional clients may be added to the license)
3. The SMS shall support a Master Application Server (Enterprise Architecture) with maximum capacity of:
 - a. 250,000 Global Personnel Records
 - b. 10 Simultaneous Clients (Additional clients may be added to the license)
 - c. 2 Badging Clients (Additional clients may be added to the license)
4. The SMS shall support both application and web client connections. The system shall allow the user to define the number of administration/monitoring client connections. This prevents web clients from using these reserved connections.

2.4 OPERATION

- A. The SMS shall provide the following operational functionality:
 1. The system shall control access to a designated area.
 2. The system shall validate cardholder credentials by use of downloaded personnel records, card formats, PINs, biometric enrollment and multiple active cards. The system shall compare the time, location, and unique credential number of an attempted entry with information stored in memory.
 3. Access to a designated area will be validated only when a user's credential has a valid number for its facility and the number is valid for the current time and for the reader where it is used.
 4. The system shall access the hardware that validates the person and monitor the security of a building by use of controllers, doors, readers, elevators, inputs and outputs. When access has been validated, a signal to the door locking device shall be activated to enable alarm-free access at that location.

5. The system shall configure itself as required by use of an Administrative application, and shall provide Configuration templates.
6. The system shall monitor access control activities by use of Monitor Station, Alarm configuration, NetVue, CCTV, and dynamic Graphical Maps display of alarm, door, and event activity (Maps based on CAD data).
7. The system shall restrict administrative and Monitoring Station activity by use of Privileges and Authentication (User Password) using Microsoft Windows OS Password Function.
8. The system shall report on various aspects of the system by use of Reports (canned and configurable). Reports shall be able to export to a printer.
9. The system shall have the capability to report off-normal security device conditions both audibly and visually.
10. The system shall control hardware from the monitoring station by use of Manual actions, Events, and cause lists.
11. The system shall provide Record and Data Management by use of Historical Journal (archive and replay), Full Audit Trail and automated and manual import and export (data and images).
12. The system shall allow for data to be imported from other products by use of database Migration tools (Card Holder data and configuration data) from iSecure, C-CURE 800/8000 and 3rd party applications via XML formatted data exchange.

2.5 EQUIPMENT

A. Server Requirements

1. The SMS server shall meet the following minimum requirements:
2. The server shall have a Processor of
 - a. Series L-N: Intel Pentium Dual Core or Greater (2.5GHz or Greater) 64 bit CPU
 - b. Series P-S: Quad-Core Intel Xeon (2.4GHz or Greater). Xeon 5500 Series or Greater 64 bit CPU
 - c. M1 – M6: Quad-Core Intel Xeon (2.4GHz or Greater) Xeon 5500 Series or Greater 64 bit CPU
3. The server shall have Hard Disk Drives of
 - a. Series L-N: Dual drives: primary drive = 80 GB -9000 Runtime; secondary drive = 80 GB – Data Backups, Drive Speed: 7200 RPM or greater.
 - b. Series P-S: Dual drives: primary drive = 250 GB -9000 Runtime, secondary drive = 250GB – Data Backups, Drive Speed: 10,000 RPM or greater.
 - c. M1 – M6: Dual drives: primary drive = 250 GB -9000 Runtime, secondary drive = 250 GB – Data Backups, Drive Speed 15,000 RPM.
4. The server shall have Memory of
 - a. Series L-N: 4GB RAM
 - b. Series P-S: 4GB RAM – (For Windows Server 2008 R2 64-bit, 8GB RAM or more is recommended)
 - c. M1 – M6: 8 GB RAM or Greater (12GB RAM is recommended)
5. The server shall have Network Adapter Card: 100/1000 MB/sec
6. The server shall have DVD Drive
7. The server shall have an Operating System of:
 - a. Standalone or Satellite Application Server

- b. Windows XP Professional SP3, 32 bit
Windows 2003 Standard SP2 or Enterprise SP2 32 bit
Windows 2008 Standard or Enterprise, 32 bit
Windows 2008 R2 Standard or Enterprise, 64 bit
Windows 7 Professional or Enterprise 32/64 bit Series P-S M1 – M6
 - c. Windows 2008 R2 Standard or Enterprise 64 bit
- 8. The server shall have Web Server IIS v6.0 or higher
- 9. The server shall have a Database of:
 - a. Standalone or Satellite Application Server
 - b. SQL 2005 SP3 Express, Standard, or Enterprise 32 bit
 - c. SQL 2008 R2 SP1 Express, Standard, or Enterprise, 32bit/64bit
 - d. Master Application Server
 - e. SQL 2008 R2 SP1 Standard or Enterprise, 64bit only
- 10. The server shall have a dedicated 256 MB SVGA accelerated Video Card
- 11. The server shall have a 17" or larger SVGA (1024 x 768) monitor with true color support.
- 12. The server shall have a PS/2 or USB style mouse.
- 13. The server shall have an appropriate backup device

B. Client Workstation Requirements

- 1. The SMS client workstations shall meet the following minimum requirements:
 - a. The client workstation shall have an Intel Pentium Dual Core or Greater (2.5GHz or Greater) 64 bit Processor
 - b. The client workstation shall have a Hard Disk Drive of 100 GB, Drive Speed: 7200 RPM or greater
 - c. The client workstation shall have Memory of 2GB RAM [4 GB RAM recommended]
 - d. The client workstation shall have a Network Adapter Card of 100/1000 MB/sec
 - e. The client workstation shall have a DVD Drive
 - f. The client workstation shall have an Operating System of:
 - g. Windows 7 Professional or Enterprise 32 bit or later version
 - h. The client workstation shall have a 17" or larger SVGA (1024 x 768) monitor with true color support.
 - i. The client workstation shall have a dedicated 256 MB SVGA accelerated video card.
 - j. The client workstation shall have a 1 GB NIC or greater network card, rated at 100/1000 MB/sec.
 - k. The client workstation shall have a keyboard and a PS/2 or USB style mouse.

C. Badging Station Requirements

- 1. The SMS badging stations shall meet the following minimum requirements:
 - a. The client workstation shall have an Intel Pentium Dual Core or Greater (2.5GHz or Greater) 64 bit Processor
 - b. The client workstation shall have 2 GB RAM.
 - c. The client workstation shall have a 100 GB hard disk drive at 7200 RPM.
 - d. The client workstation shall have a DVD Drive
 - e. The client workstation shall have Operating System
 - f. Windows 7 Professional or Enterprise 32 bit or later version
 - g. The client workstation shall have a 17" or larger SVGA (1024 x 768) monitor with true color support.

- h. The client workstation shall have a dedicated 256 MB SVGA accelerated video card.
- i. The client workstation shall have a 1 GB NIC or larger network card, rated at 100/1000 MB/sec.
- j. The client workstation shall have a keyboard and a PS/2 or USB style mouse.
- k. The badging station shall have a USB camera that supports TWAIN protocol for photos.
- l. The badging station shall have a PVC printer.

D. Controllers

- 1. The SMS shall support the following controller hardware:
 - a. Software House iSTAR Classic
 - b. Software House iSTAR Pro
 - c. Software House iSTAR eX
 - d. Software House iSTAR EDGE
 - e. Software House apC, apC/8X, apC/L
 - f. SimplexGrinnell Ethernet ISC

E. Clustering

- 1. The SMS shall support a user-defined grouping of iSTAR controllers defined as a cluster. iSTAR controllers within a cluster shall be able to communicate in a peer-to-peer scheme should the SMS server lose communication with the cluster.
- 2. Clustering shall support the following features:
 - a. Assignment of Master and alternate master controllers for cluster communication to the SMS server
 - b. Primary and backup communication paths to the SMS server
 - c. Encrypted communications
 - d. Up to 16 controllers per cluster
 - e. Logical event linking between controllers in a cluster independent of SMS server communication
 - f. Asynchronous communication via TCP/IP (Polled devices shall not be acceptable)

PART 3 - EXECUTION

3.1 TESTING

- A. The software shall be entered into the SMS computer systems and debugged. The Contractor shall be responsible for documenting and entering the initial database into the system. The Contractor shall provide the necessary blank forms with instructions to fill in all the required data information that will make up the database. The database shall then be reviewed by the Contractor and entered into the system. Prior to full operation, a complete demonstration of the computer real-time functions shall be performed. A printed validation log shall be provided as proof of operation for each software application package. In addition, a point utilization report shall be furnished listing each point, the associated programs utilizing that point as an input or output and the programs which that point initiates.
- B. Upon satisfactory on-line operation of the system software, the entire installation including all subsystems shall be inspected. The Contractor shall perform all tests, furnish all test equipment and consumable supplies necessary and perform any work as required to establish performance levels for the system in accordance with the specifications. Each

device shall be tested as a working component of the completed system. All system controls shall be inspected for proper operation and response.

- C. Tests shall demonstrate the response time and display format of each different type of input sensor and output control device. Response time shall be measured with the system functioning at full capacity. Computer operation shall be tested with the complete data file.
- D. The Contractor shall maintain a complete log of all inspections and tests. Upon final completion of system tests, a copy of the log records shall be submitted as part of the as-built documentation.

3.2 TRAINING

- A. The Contractor shall provide a competent trainer who has extensive experience on the installed systems and in delivering training to provide the instruction. As an alternative, the Contractor may propose the use of factory training personnel and coordinate the number of personnel to be trained.

3.3 MAINTENANCE

- A. The Contractor shall offer a Software House Software Support Agreement (SSA) in order for Software House Technical Support Specialists to reactively troubleshoot system problems.
- B. As part of the agreement, 5x9 telephone support (Standard and Enhanced SSA) will be provided to the Contractor by Certified Technicians. An option of 7x24 Standby telephone support (Enhanced SSA) shall be offered.
- C. As part of the agreement, Flashable and Non-Flashable (Chips) firmware and documentation shall be provided.
- D. As part of the agreement, access to C•CURE patches and software release updates shall be provided.
- E. The SSA shall cover the current C•CURE 9000 release one full version back, and associated controller hardware.

END OF SECTION

SECTION 281301

ACCESS CONTROL AND INTRUSION DETECTION DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and Division 0-Contracting Requirements of the contract apply to this section.

1.2 RELATED SECTIONS

- A. DIVISION 8, 080671, Door Hardware Schedule
- B. DIVISION 26, Electrical
- C. DIVISION 28, Sections 280000-284000

1.3 SUMMARY

- A. This section documents the type of card readers and peripheral intrusion detection equipment which shall be installed and provided to the Client.
- B. This Section includes furnishing of equipment and installation of Access Control Readers for the Access Control System Installation.
- C. Readers and the necessary communications/control wiring shall be located from the readers to the access control panels in designated security equipment/telecom rooms.
- D. The access control readers shall be capable of all described functions and communication with the control panels.

1.1 DEFINITIONS

- E. As referenced in Section 280000.

PART 2 - PRODUCTS

2.1 GENERAL

- A. An existing Access Control System will be used to integrate new card readers.
- B. The card readers shall be a multi-technology card, HID multiCLASS SE® 40RP readers Reader.
- C. The card readers shall read the encoded data from the access card and/or transponder and transmit the data back to the host panel, giving an audible and visual indication of a properly read card.
- D. The card reader shall be no larger than 3x3" x 4x8" x 1.0"

- E. The card readers shall have a typical read range of 1-5" to 4.25" when used with a proximity technology.
- F. Card readers shall be sealed units and shall be constructed of high impact plastic, narrow enough to be mounted onto a mullion. The color of the card readers shall be black.
- G. The card reader shall be listed under UL 294 as an access control system unit accessory, and shall have the following certifications: UL 294, FCC, Scheme Electrical Safety.
- H. Card readers shall provide for both power and data connections via multi-conductor cable. Cable runs between readers and field panels shall be sized in accordance with the manufacturer's recommendations.
- I. Card readers shall incorporate a multi-color LED which shall serve to indicate a successful card read and an invalid card read. The LED shall function as follows:
 - 1. Steady Red: Card reader functioning with door locked.
 - 2. Blinking Red: Card presented and rejected.
 - 3. Steady Green: Valid card presented, door unlocking.
 - 4. Alternating Red/Green: Door in alarm reporting a forced open or held open condition.
 - 5. LED not lit: Reader not working or turned off.
- J. The card reader shall have a lifetime warranty.
- K. The card reader shall transmit at a 125 kHz and 13.56 MHz frequency.
- L. Cable to the reader shall have sufficient number of conductor allowing the reader to be configured now or in the future to any combination available without requiring and additional cable installation (10 conductor min. required).
- M. The cable requirements of the card reader shall use a minimum five (5) conductor, 22 AWG, stranded cable with overall shield (for a Wiegand protocol interface).
- N. The card reader shall communicate in a Wiegand protocol interface, and be compatible with all standard access control systems.
- O. The voltage requirements of the card reader shall be 5 to 16 VDC.

2.2 DOOR POSITION SWITCHES

- A. Door switches are to be provided to the door hardware supplier and installed and wired by security contractor. Door hardware contractor is to provide door switches of such type as to meet the needs of each door type. Door hardware contractor is to prepare the doors and frames to accept the recessed switch and magnet.
- B. Coordination with door hardware contractor is required. Contact the project manager with any coordination issues as they arise.
- C. Device housing shall be of cast non-ferrous durable material. Provide reasonable protection against moisture and dust.
- D. Mechanism shall be adjustable so that the operating gap between faces of the switch housing and the magnet housing may be adjusted up to 1/2 in. to accommodate installation variances.

- E. Install door position switches for doors. All wire shall be concealed or in conduit.
- F. Generator Door Switches will be Magnasphere HSS, Model L2C-101-A, no substitutions.
- G. Interior Door Switches will be GE Interlogix 1078C or approved equal.

PART 3 - EXECUTION

3.1 PREPARATION

- A. The Contractor shall order all required parts and equipment upon notification of award of the Work.
- B. The Contractor shall bench test all equipment prior to delivery to the job site.
- C. The Contractor shall verify the availability of power where required. If a new source of power is required, a licensed electrician shall be used to install it.
- D. The Contractor shall arrange for obtaining all programming information including access times, free access times, door groups, operator levels, etc. from the Client's Project Manager.

3.2 INSTALLATION

- A. The Contractor shall coordinate with other disciplines (e.g., architectural, structural and electrical) to ensure proper location and ancillary requirements are met.
- B. The Contractor shall carefully follow the instructions in the manufacturers' Installation Manual to insure all steps have been taken to provide a reliable, easy to operate system.
- C. The Contractor shall coordinate with the Client's/Architect door hardware contractor/consultant for determining the electric locking and RTE hardware compatibility. Perform all Work as indicated in the Drawings and Specifications.
- D. The Contractor shall install the appropriate cable from the control panels to readers, door contacts, request-to-exit devices, and electric locks at each door.
- E. The Contractor shall install the maximum number of cable conductors to a reader. This will allow the reader to be configured in any of the possible combinations available to the Client at the time of installation or for future needs and desired changes. Spare conductors shall be installed per other specification documents.
- F. All communications cables shall be kept away from power circuits.
- G. The Contractor shall also execute adequate testing of the system to insure proper operation.
- H. The Contractor shall provide adequate training of the system users to insure adequate understanding to prevent operating errors.

END OF SECTION

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SECTION 282321

VIDEO SURVEILLANCE CAMERAS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 RELATED SECTIONS

- A. Division 26 Electrical Provisions
- B. Division 27 Communications
- C. Division 280000 – 284000 Security Specifications

1.3 QUALIFICATIONS

- A. Provide manufacturer's certificate with bid response proving that the contractors have successfully attended factory sponsored Digital Products and Network training program and they are authorized and certified to purchase, install, program and service the Digital networked video surveillance equipment is to be installed.

1.4 SUMMARY

- A. This Section includes furnishing of video surveillance cameras and associated equipment for the existing video surveillance system for the project. The existing system shall have the ability to view the new cameras full screen on any selected monitor. Security monitoring locations will have full control over all cameras functions.
- B. Cameras, mounts, housings (both environmental and Indoor/outdoor) interconnections, cabling, pathways and any other equipment that allows the newly installed cameras to be a part of the existing complete and functional system are to be furnished and installed under this contract.
- C. This contract is for the installation of all Cameras, mounts, housings, communications/control wiring and other equipment installed and the necessary conduit and cable from the camera mounting locations to the Data room(s).
- D. All Cameras' power supplies (as required) are to be mounted within the Data room(s). The Video from the cameras shall be home-run to the associated head-end components not to exceed the maximum distance of 90m (300 feet including all patch cables). If the cable distance exceeds the maximum allowable cable distance, amplifiers signal extenders shall be installed to boost the signal to meet the quality standards.
- E. The cable from each camera will terminate on a cabinet mounted in the Data room(s). The security contractor will use existing cabinets, but will supply additional patch panels, switch(es), video/data Modules, rack mount, power supplies and associated equipment as specified.

- F. There shall be a demark location determined by the owner where security contractor's conduit ends and others begins. Regardless of where the conduit demark is located it is the security contractors responsibility to complete the connections without splices.
- G. The security contractor shall coordinate the communication protocols between the systems and insure the communications between the installed head-end systems and the cameras.
- H. In no case shall any systems (or components) be installed that is not pre-approved by the owner, architect and engineer, or any systems that are incompatible with new or existing equipment.
- I. The security contractor shall provide all systems parts, pieces, mounts, power supplies, conduit, cable, wire, modules, cabinets, patch panels, servers, switches and other systems components necessary to provide a complete system as called for in these specifications, directions and drawings. All equipment shall be commercial grade and intended for the purpose to be used or installed.

1.5 CAMERA HOUSING COLORS

- A. All colors shall be selected and approved by architect.
- B. Camera mounted to the exterior of the building shall be color matched to the concrete color of the building.
- C. Surface mounted cameras in cellar shall be black
- D. Trim rings of recessed/flush mount cameras shall be matched to the ceiling installed.
- E. In no case shall any camera be installed at any location without housing or trim rings color approved by the architect.

1.6 DEFINITIONS

- A. Video Surveillance System also known as CCTV Closed-Circuit Television
- B. NVR Network Video Recorder

1.7 SUBMITTALS

- A. As referenced in Section 284000.
- B. Warranties:
 - 1. Special warranties specified in this Section.
- C. Calculations and Parameters;
 - 1. Contractor shall submit for approval by Owner's project manager/engineer, the calculations used and plans and diagrams for the Field of View calculations for the Video Surveillance cameras. Submission as a minimum shall include and address Low Level Lighting. Backlight compensation, and Lens conformance with this Specification.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. This project requires an experienced installer with a minimum of five (5) years' experience installing Video Surveillance equipment and possesses manufacturer's certification, for both installation and maintenance of equipment required for this Project; to supervise installation of the system.

B. Product:

1. Drawings shall indicate size, profiles, and dimensional requirements of surveillance equipment and are based on the specific system indicated. Other manufacturers' products complying with requirements may be considered. Refer to Division I Section "Substitutions."

C. Electrical Components

1. Devices, and Accessories; Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Comply with NFPA 70.
3. Comply with 47 CFR 15, 17, and 76.

1.9 PROJECT CONDITIONS

A. Environmental Limitations:

1. System components shall be equipped and rated for the environments where installed
2. Service Conditions for Outdoor Equipment: Rate equipment for continuous operation under the following environmental conditions, unless otherwise indicated:
 - a. Temperature: Minus 40 deg F to plus 122 deg F.
 - b. Relative Humidity: 5 to 100 percent.
 - c. Weather:
 - 1) Enclosure housings to prevent entry of moisture due to melting ice build-up or driven rain or snow.
3. Service Conditions for Indoor Equipment:
 - a. Rate equipment for continuous operation under the following environmental conditions, unless otherwise indicated:
 - b. Temperature: 32 deg F to 122 deg F.
 - c. Relative Humidity: 0 to 95 percent.

1.10 SYSTEM DESIGN

- A. Scope of work is to install Video Surveillance Cameras that integrate with the existing Video Surveillance security system.
- B. The monitoring location will have the ability to control the cameras. Monitoring locations will be able to change the viewing screen from a multiplexed view to a single image, if more detail is required. This will be accomplished using the controller at the security desk.

1.11 COORDINATION

- A. Coordinate layout and installation of Video Surveillance cameras/equipment and suspension system components with hardware installed and in place, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate all systems head-end equipment prior to installation to insure compatibility. All system components must be pre-approved by engineer and owner.

1.12 INTELLECTUAL PROPERTY

- A. Patents: Should patented articles, methods, materials apparatus, etc., be used in this Work, the Contractor shall acquire the right to use same. The Contractor shall hold Owner and its agents harmless for any delay, action, suit, or cost growing out of the patent rights for any device on this Project.
- B. Copyrights: Should copyrighted software be used in this Work, the Contractor shall acquire the right to use same. The Contractor shall hold the Owner and its agents harmless for any delay, action, suit, or cost growing out of the copyrights for any software on this Project.
- C. License to use: All software required for the complete operation of the system as specified herein shall be delivered with either full ownership transferred to the Owner or a License to use at this site, including the right to make backup copies.

1.13 WARRANTY

- A. Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
 - 1. Special Warranty for Surveillance System and Components: Written warranty, provided by manufacturer and Installer agreeing to correct system deficiencies and replace components that fail in materials or workmanship within specified warranty period when installed and used according to manufacturer's written instructions. This warranty shall be in addition to, and not limiting, other rights Owner may have under other provisions of the Contract Documents.
 - 2. Special Warranty Period:
 - a. Fixed cameras shall have a two year warranty
 - b. Pan/tilt/zoom units shall have a two year warranty under constant operation
 - c. All other Video Surveillance equipment shall have a minimum of two year warranty from date of Substantial Completion or acceptance by the owner.
 - d. This section is not to deprive the owner of product warranties that extend beyond the periods listed, as in the case with lifetime warranties for some products.
 - 3. Technical Assistance: Video Surveillance equipment manufacturer shall provide a 24-hour technical telephone assistance program, including a live person answering the phone and connection to a technical support person specializing in the product.
 - 4. Repairs: Manufacturer shall provide 24-hour repair turn around service on all CCTV equipment.

PART 2 - PRODUCTS

2.1 VIDEO SURVEILLANCE SYSTEM COMPONENTS

- A. Components: Modular plug-in, heavy-duty, industrial, or commercial-grade units.
- B. Equipment; Silicon-based, solid-state, integrated circuit devices
- C. Power Supply Characteristics: Devices shall be within specified parameters for supply voltages within the range of 105 to 130 VAC.
- D. Protect signal cables and connected components against transient-voltage surges by suppressors and absorbers designed specifically for the purpose.
- E. RF and Video Impedance Matching: Signal-handling components, including connecting cable, shall have end-to-end impedance-matched signal paths. Match and balance devices used at connections where it is impossible to avoid impedance mismatch or mismatch of balanced circuits to unbalanced circuits.

2.2 VIDEO SURVEILLANCE EQUIPMENT

- A. Description: Video cameras, camera outlets, camera controls, signal-processing equipment, distribution components, and accessories to generate video images, process them, and distribute them. System shall display images on monitors and provide for remote control of video-camera equipment.
- B. It is the Contractors responsibility to submit for approval the complete designed system configuration and layout showing all devices, wiring, conduct, and locations along with other required Information as specified herein for the completely integrated system proposed for installation.

2.3 VIDEO SURVEILLANCE COMPONENTS

- A. Color high resolution integrated cameras shall provide for video coverage of areas shown on the drawings. The cameras shall allow for mounting in an exterior or interior environment and shall meet or exceed the following specifications:
- B. FIXED NETWORK CAMERA SPECIFICATIONS
 - 1. MANUFACTURERS
 - a. Arecont Vision or approved equivalent
 - b. Axis or approved equivalent
- C. FIXED DOME MULTI-SENSOR 4K IP CAMERA – AXIS Q3790-PV
 - 1. The fixed dome multi-sensor network camera shall meet or exceed the following design specifications:
 - a. The camera shall operate on an open source; Linux-based platform, and including a built-in web server.
 - b. The camera shall be equipped with an IR-sensitive progressive scan megapixel sensor.
 - c. The camera shall provide a removable IR-cut filter, providing day/night functionality.

- d. The camera shall be manufactured with an IP66- and NEMA 4X-rated, IK10 impact-resistant aluminum casing fitted with a repaintable weather shield.
 - e. The camera shall be equipped with factory-focused lenses in order to eliminate the need for manual focusing.
 - f. The camera shall provide a manual 3-axis (pan/tilt/rotation) positioning to allow adjustment for optimum camera rotation and placement.
 - g. The camera shall provide a 180° panoramic overview provided by three sensors.
2. The fixed dome multi-sensor network camera shall meet or exceed the following performance specifications:
- a. Illumination
 - 1) The camera shall meet or exceed the following illumination specifications:
 - a) 2 lux in color
 - b) 0.4 lux B/W
 - c) Resolution
 - 2) Be designed to provide video streams in:
 - b. 3 x 4K Ultra HD: Up to 25/30 fps with power line frequency 50/60 Hz
 - c. 3 x 11 MP: Up to 16/20 fps with power line frequency 50/60 Hz
 - 1) The camera shall support video resolutions including:
 - a) 3840x2880
 - b) 3840x2160
 - c) 1920x1080 (HDTV 1080p)
 - d) 1280x720 (HDTV 720p)
 - e) 800x600
 - f) Encoding
 - 2) The camera shall support the following video encoding algorithms:
 - d. Motion JPEG encoding in a selectable range from 1 up to 25/30 frames per second in all resolutions.
 - e. Baseline Profile H.264 encoding with motion estimation in up to 25/30 frames per second.
 - f. Main Profile H.264 encoding with motion estimation and context-adaptive binary arithmetic coding (CABAC) in up to 25/30 frames per second.
 - g. Support High Profile H.264 encoding with motion estimation up to 50/60 frames per second.
 - 1) The camera shall provide independently configured simultaneous H.264 and Motion JPEG streams.
 - 2) The camera shall in H.264 support Variable Bit Rate (VBR) for video quality adapted to scene content. To protect the network from unexpected bit rate spikes the camera shall support Constant Bit Rate (CBR) or Maximum Bit Rate (MBR).
 - 3) The camera shall provide configurable compression levels.
 - 4) Support motion estimation in H.264/MPEG-4 Part 10/AVC.
 - a) Transmission
 - 5) The camera shall allow for video to be transported over:
 - a) HTTP (Unicast)
 - b) HTTPS (Unicast)
 - c) RTP (Unicast & Multicast)
 - d) RTP over RTSP (Unicast)
 - e) RTP over RTSP over HTTP (Unicast)

- 6) The camera shall support Quality of Service (QoS) to be able to prioritize traffic.
 - a) Image
- 7) The camera shall incorporate Automatic and Manual White Balance.
- 8) The camera shall incorporate an electronic shutter operating in the range of 1/23250 s to 2/5 s.
- 9) The camera shall incorporate Wide Dynamic Range – Dynamic contrast.
- 10) The camera shall provide backlight compensation functionality.
- 11) The camera shall support manually defined values for:
 - a) Color level
 - b) Brightness
 - c) Sharpness
 - d) Contrast
- 12) The camera shall incorporate a function for optimization of low light behavior.
 - a) User Interface
- 13) Web server
 - a) The camera shall contain a built-in web server making video and configuration available to multiple clients in a standard operating system and browser environment using HTTP, without the need for additional software.
 - b) Optional components downloaded from the camera for specific tasks, e.g. Active X, shall be signed by an organization providing digital trust services, such as Verisign, Inc.
- 14) Language Specification
 - a) The camera shall provide a function for altering the language of the user interface, and shall include support for at least 10 different languages.
- 15) IP addresses
 - a) The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.
 - b) The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.
 - c) The camera shall provide support for both IPv4 and IPv6.
 - d) PTZ functionality
- 16) The camera shall:
 - a) Provide Digital PTZ functionality.
 - b) Provide Preset positions functionality
 - c) Provide Guard tour functionality
 - d) Event functionality
- 17) The camera shall be equipped with an integrated event functionality, which can be triggered by:
 - a) Video Motion Detection
 - b) Live Stream Accessed
 - c) Camera tampering

- d) Fan malfunctioning
 - e) Temperature
 - f) Manual Trigger/Virtual Inputs
 - g) PTZ functionality
 - h) Embedded third party applications
 - i) Edge storage disruption detection
- 18) Response to triggers shall include:
- a) Send notification, using HTTP, HTTPS, TCP or email
 - b) Send images, using FTP, HTTP, HTTPS, network share or email
 - c) Send video clip, using FTP, HTTP, HTTPS, network share or email
 - d) Send SNMP trap message
 - e) Recording to local storage and/or network attached storage
 - f) PTZ control functionality
 - g) Day/Night Vision Mode
 - h) Overlay Text
- 19) The camera shall provide memory for pre & post alarm recordings.
- a) Edge storage
- 20) The camera shall support continuous and event controlled recording to:
- a) Local memory added to the cameras SD-card slot
 - b) Network attached storage, located on the local network
- 21) The camera shall be able to detect and notify Edge storage disruptions.
- a) Protocol
- 22) The camera shall incorporate support for at least IPv4/v6, HTTP, HTTPS, SSL/TLS, QoS Layer 3 DiffServ, TCP, ICMP, SNMPv1/v2c/v3 (MIB-II), RTSP, RTP, UDP, IGMP, RTCP, SMTP, FTP, DHCP, UPnP, ARP, DNS, DynDNS, SOCKS, SSH, NTP, CIFS/SMB, Bonjour.
- 23) The SMTP implementation shall include support for SMTP authentication.
- a) Text overlay
- 24) The camera shall:
- a) Provide embedded on-screen text with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.
 - b) Provide the ability to apply privacy masks to the image.
 - c) Allow for the overlay of a graphical image, such as a logotype, into the image.
 - d) Security
- 25) The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.
- 26) The camera shall provide centralized certificate management, with both pre-installed CA certificates and the ability to upload additional CA certificates. The certificates shall be signed by an organization providing digital trust services.
- 27) The camera shall support IEEE 802.1X authentication.
- 28) The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.
- 29) The camera shall restrict access to the built-in web server by usernames and passwords at three different levels.

- a) API support
 - 30) The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.
 - 31) The camera shall support relevant ONVIF profiles as defined by the ONVIF Organization.
- a) Embedded applications
 - 32) The camera shall provide a platform allowing the upload of third party applications into the camera.
- a) Installation and maintenance
 - 33) The camera shall be supplied with Windows-based management software which allows the assignment of IP addresses, upgrade of firmware and backup of the cameras' configuration.
 - 34) The camera shall support the use of SNMP-based management tools according to SNMP v1, 2c & 3 / MIB-II.
 - 35) The camera shall allow updates of the software (firmware) over the network, using FTP or HTTP.
 - 36) The camera shall provide the ability to apply a rectangle of customer-defined number of pixels to the image, which can be used as a pixel counter identifying the size of objects in number of pixels.
 - 37) The camera shall accept external time synchronization from an NTP (Network Time Protocol) server.
 - 38) The camera shall store all customer-specific settings in a non-volatile memory that shall not be lost during power cuts or soft reset.
- a) Access log
 - 39) The camera shall provide a log file, containing information about the 250 latest connections and access attempts since the unit's latest restart. The file shall include information about the connecting IP addresses and the time of connecting.
 - 40) Provide a connection list of all currently connected viewers. The file shall include information about connecting IP address, time of connecting and the type of stream accessed.
- a) Camera diagnostics
 - 41) The camera shall be equipped with LEDs, capable of providing visible status information. LEDs shall indicate the camera's operational status and provide information about power, communication with receiver, the network status and the camera status.
 - 42) The camera shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.
 - 43) The camera shall send a notification when the unit has re-booted and all services are initialized.
- a) Hardware interfaces
 - 44) Network interface
 - h. The camera shall be equipped with one 100BASE-TX Fast Ethernet-port, using a standard male RJ45 connector and shall support auto negotiation of network speed (100 MBit/s and 10 MBit/s) and transfer mode (full and half duplex).
 - i. Enclosure

- 1) The camera shall:
 - a) Be manufactured with an IP66- and NEMA 4X-rated, IK10 impact-resistant aluminum casing.
 - b) Be fitted with a dehumidifying membrane.
 - c) Be fitted with a repaintable weather shield.
 - d) Power
- 2) Power over Ethernet Plus (PoE+) IEEE 802.3at Type 2 Class 4
 - a) Environmental
- 3) Operate in a temperature range of -40 °C to +55 °C (-40 °F to 131 °F).
- 4) Operate in a humidity range of 10–100% RH (condensing).

D. Fixed Dome Network Camera

1. The camera shall be manufactured with a tamper-resistant casing and metal encapsulated electronics.
2. The camera shall be manufactured with a vandal-resistant metal casing and metal encapsulated electronics.
3. The camera shall be manufactured with an outdoor ready, IP66 and NEMA 4X-rated vandal-resistant metal casing, metal encapsulated electronics and shall operate between -40 to +55°C (-40 to +131°F), also when powered using Power over Ethernet.
4. The camera shall be equipped with a progressive scan megapixel sensor, a vari-focal lens with automated iris functionality and remote zoom and focus abilities, Wide Dynamic Range, so called Day/Night functionality and shall provide images down to 0.5 lux in day mode and 0.08 lux in night mode.
5. The camera shall be equipped with a 10BASE-T/100BASE-TX Ethernet-port, and shall include support for Power over Ethernet according to IEEE 802.3af.
6. The camera shall provide individually configured simultaneous Motion JPEG and H.264 video streams, and shall support video of HDTV 1080p (1920x1080) resolution in 30 frames per second.
7. The H.264 implementation shall include both unicast and multicast functionality and support Constant Bit Rate (CBR) as well as Variable Bit Rate (VBR).
8. The camera shall be fitted with a built-in microphone, Line In and Line Out, provide full duplex audio, and shall support AAC, G.711 or G.726 compression.
9. The camera shall be fitted with Line In and Line Out, provides full duplex audio, and shall support AAC, G.711 or G.726 compression.
10. The camera shall be equipped with one digital (alarm) input and one digital output and shall be able to trigger its embedded event functionality based on camera tampering alarm, detection of video motion or audio, or when the local storage is full. Possible response to a triggered event shall include remote notification, incl. image upload, and activation of output and recording to local storage. The camera shall be equipped with a video buffer for saving pre- and post-alarm images and shall have a SD/SDHC card slot to support local storage of video.
11. The camera shall feature overlay text, that includes date and time synchronized using an NTP server. Furthermore, it shall apply a graphical image as an overlay and a privacy mask in the video stream.
12. The camera shall provide both static IP addresses and addresses from a DHCP-server, and shall support both IPv4 and IPv6. The camera shall incorporate support for Quality of Service (QoS).
13. For secure access to the camera as well as provided content, the camera shall provide HTTPS, SSL/TLS and IEEE802.1X authentication. The camera shall also support IP address filtering and include at least three different levels of password security.
14. The camera shall contain a built-in web server making video and configuration available in a standard browser environment using HTTP and shall also be fully supported by an

open and published API (Application Programmers Interface) providing necessary information for integration of functionality into third party applications.

15. The camera shall:
 - a. Include pixel counter functionality, providing a tool to calculate the size of objects in number of pixels
 - b. Be equipped with one digital (alarm) input and one digital output
 - c. Include embedded event functionality, which may be triggered by:
 - 1) Alarm input
 - 2) Camera tampering alarm
 - 3) Video motion detection
 - 4) Audio detection
 - 5) Local storage full
 - d. Event actions supported by the camera shall include:
 - 1) remote notification, including video upload
 - 2) activation of output
 - 3) recording to local storage
 - e. Be equipped with a built-in web server
 - f. Be supported by an open and published API

E. WDR OMNI-DIRECTIONAL (180-DEGREE) 12MP IP CAMERA - ARECONT VISION AV12176N

1. Hardware
 - a. The camera shall have three configurations: AV20175DN-28 (4x 2.8mm M12 lenses), AV20175DN-08 (4x 8.0mm M12 lenses), AV20175DN-NL (no lenses, ordered separately).
 - b. Lens options shall include the following IR corrected, F1.6, M12 lenses: 2.8mm, 4.0mm, 6.0mm, 8.0mm, 12.0mm, 16.0mm.
 - c. The camera shall utilize four high sensitivity 5-Megapixel CMOS sensors with 1/2.5" optical format, progressive scan and Active Pixel Count: 2560(H) x 1920(V) pixel array
 - d. The camera shall integrate four 2.8mm M12 megapixel IR corrected lenses, 1/2.5", F1.6, Horizontal Field of View of 114°. (AV20175DN-28)
 - e. The camera shall integrate four 8.0mm M12 megapixel IR corrected lenses, 1/2.5", F1.6, Horizontal Field of View of 43°. (AV20175DN-08)
 - f. The camera shall have die-cast aluminum chassis with IK-10 vandal resistant dome. Entire enclosure to be rated minimum IP66 for water and dust protection.
 - g. The camera shall have four individually adjustable 2-axis camera gimbals with 360° pan and 90° tilt for easy and accurate positioning.
2. Imaging
 - a. The camera shall combine four image sensors for a user configurable field of view.
 - b. The camera shall allow for multiple lens options for a user configurable field of view.
 - c. The camera shall have dual standard compression support with simultaneous streaming of both H.264 and MJPEG formats.
 - d. Each sensor of the camera shall feature automatic exposure, automatic multi-matrix white balance; shutter speed control to minimize motion blur, programmable resolution, brightness, saturation, gamma, sharpness and tint.
 - e. The camera's shutter speed shall be 1ms - 500ms.
 - f. The camera shall feature selectable 50/60 Hz flicker control, windowing, simultaneous delivery of full-field view and zoomed images at video frame rate,

- instantaneous electronic zoom, pan and tilt, and electronic image rotation by 180 degrees
 - g. The camera shall have multi-streaming support of up to 8 non-identical concurrent streams (different frame rate, bit rate, resolution, quality, and compression format).
 - h. The camera shall have wide dynamic range up to 100 dB and a maximum SNR of 51 dB
 - i. The camera shall have privacy masking, the ability to select multiple regions of an arbitrary shape to block the video. The camera shall have extended motion detection grid, a higher granularity grid of 1024 distinct motion detection zones. User can select between 64 zone based motion detection and extended motion detection to provide backward compatibility with the existing Video Management System (VMS) integration. This feature shall support RTP, HTTP and TFTP protocols, as well as the on-camera web interface.
 - j. The camera shall feature streaming of the full field of view (FOV) and simultaneous multiple regions of interest (ROI) for forensic zooming.
 - k. The camera shall provide 21 levels of compression quality for optimal viewing and archiving.
 - l. It shall be possible to program the camera in binning mode to output lower resolution images: i.e. 5120(H) x 960(V) pixels (1/4 full resolution) at 13 FPS.
 - m. The camera shall provide flexible cropping (Resolution windowing down to 1x1 pixels for JPEG and 2x2 pixels for H.264)
 - n. The camera shall be able to save bandwidth & storage by running at 1/4 full resolution
 - o. The camera shall feature MoonLight™ mode - extended exposure and noise cancellation
 - p. The camera shall be able to support Picture-in-Picture: simultaneous delivery of full field of view and zoomed images
3. Video
- a. Video frame rate (up to):
 - 1) 3.5FPS @ 10240x1920
 - 2) 11 FPS @ 2560x1920
 - b. Video frame rate in binning mode up to:
 - 1) 13 FPS @ 5120x960
4. Protocols
- a. The camera shall have Real Time Streaming Protocol (RTSP) support allowing for compatibility with media players such as Apple QuickTime, VLC Player and others.
 - b. The camera shall support both unicast and multicast communication protocol.
 - c. The camera shall support RTSP, RTP over TCP, RTP over UDP (Unicast/Multicast), HTTP1.0, HTTP1.1, TFTP
 - d. 100 Base-T Ethernet Network Interface
 - e. Multi-streaming: 8 non-identical streams (2 active connections to each sensor)
5. Electrical
- a. General purpose opto-coupled input and output
 - b. Power over Ethernet (PoE): PoE 802.3af
 - c. Auxiliary Power 12-48V DC, 24VAC
 - d. Power consumption: PoE – Class 3; auxiliary- 14W max
6. Networking
- a. The camera shall be equipped with a 100 Mbps LAN connector

7. Environmental
 - a. Operating temperature -40°C (-40 °F) to +50°C (122 °F)
 - b. Stable image temperature 0°C (32 °F) to +50°C (122 °F)
 - c. Storage temperature -40°C (-40 °F) to +60°C (140 °F)
 - d. Humidity 0% to 90% (non-condensing)
 8. Illumination
 - a. Color (non-binning): 0.5 Lux @ F2.0
 - b. Color (binning): 0.25 Lux @ F2.0
 - c. B/W: 0 Lux, IR sensitive (with additional IR light source)
- F. WDR OMNI-DIRECTIONAL (360-DEGREE) 20MP IP CAMERA - ARECONT VISION AV12175N
1. Hardware
 - a. The camera shall have three configurations: AV20175DN-28 (4x 2.8mm M12 lenses), AV20175DN-08 (4x 8.0mm M12 lenses), AV20175DN-NL (no lenses, ordered separately).
 - b. Lens options shall include the following IR corrected, F1.6, M12 lenses: 2.8mm, 4.0mm, 6.0mm, 8.0mm, 12.0mm, 16.0mm.
 - c. The camera shall utilize four high sensitivity 5-Megapixel CMOS sensors with 1/2.5" optical format, progressive scan and Active Pixel Count: 2560(H) x 1920(V) pixel array
 - d. The camera shall integrate four 2.8mm M20 megapixel IR corrected lenses, 1/2.5", F1.6, Horizontal Field of View of 114°. (AV20175DN-28)
 - e. The camera shall integrate four 8.0mm M20 megapixel IR corrected lenses, 1/2.5", F1.6, Horizontal Field of View of 43°. (AV20175DN-08)
 - f. The camera shall have die-cast aluminum chassis with IK-10 vandal resistant dome. Entire enclosure to be rated minimum IP66 for water and dust protection.
 - g. The camera shall have four individually adjustable 2-axis camera gimbals with 360° pan and 90° tilt for easy and accurate positioning.
 2. Imaging
 - a. The camera shall combine four image sensors for a user configurable field of view.
 - b. The camera shall allow for multiple lens options for a user configurable field of view.
 - c. The camera shall have dual standard compression support with simultaneous streaming of both H.264 and MJPEG formats.
 - d. Each sensor of the camera shall feature automatic exposure, automatic multi-matrix white balance; shutter speed control to minimize motion blur, programmable resolution, brightness, saturation, gamma, sharpness and tint.
 - e. The camera's shutter speed shall be 1ms - 500ms.
 - f. The camera shall feature selectable 50/60 Hz flicker control, windowing, simultaneous delivery of full-field view and zoomed images at video frame rate, instantaneous electronic zoom, pan and tilt, and electronic image rotation by 180 degrees
 - g. The camera shall have multi-streaming support of up to 8 non-identical concurrent streams (different frame rate, bit rate, resolution, quality, and compression format).
 - h. The camera shall have wide dynamic range up to 100 dB and a maximum SNR of 51 dB
 - i. The camera shall have privacy masking, the ability to select multiple regions of an arbitrary shape to block the video. The camera shall have extended motion

detection grid, a higher granularity grid of 1024 distinct motion detection zones. User can select between 64 zone based motion detection and extended motion detection to provide backward compatibility with the existing Video Management System (VMS) integration. This feature shall support RTP, HTTP and TFTP protocols, as well as the on-camera web interface.

- j. The camera shall feature streaming of the full field of view (FOV) and simultaneous multiple regions of interest (ROI) for forensic zooming.
- k. The camera shall provide 21 levels of compression quality for optimal viewing and archiving.
- l. It shall be possible to program the camera in binning mode to output lower resolution images: i.e. 5120(H) x 960(V) pixels (1/4 full resolution) at 13 FPS.
- m. The camera shall provide flexible cropping (Resolution windowing down to 1x1 pixels for JPEG and 2x2 pixels for H.264)
- n. The camera shall be able to save bandwidth & storage by running at 1/4 full resolution
- o. The camera shall feature MoonLight™ mode - extended exposure and noise cancellation
- p. The camera shall be able to support Picture-in-Picture: simultaneous delivery of full field of view and zoomed images

3. Video

- a. Video frame rate (up to):
 - 1) 3.5FPS @ 10240x1920
 - 2) 11 FPS @ 2560x1920
- b. Video frame rate in binning mode up to:
 - 1) 13 FPS @ 5120x960

4. Protocols

- a. The camera shall have Real Time Streaming Protocol (RTSP) support allowing for compatibility with media players such as Apple QuickTime, VLC Player and others.
- b. The camera shall support both unicast and multicast communication protocol.
- c. The camera shall support RTSP, RTP over TCP, RTP over UDP (Unicast/Multicast), HTTP1.0, HTTP1.1, TFTP
- d. 100 Base-T Ethernet Network Interface
- e. Multi-streaming: 8 non-identical streams (2 active connections to each sensor)

5. Electrical

- a. General purpose opto-coupled input and output
- b. Power over Ethernet (PoE): PoE 802.3af
- c. Auxiliary Power 12-48V DC, 24VAC
- d. Power consumption: PoE – Class 3; auxiliary- 14W max

6. Networking

- a. The camera shall be equipped with a 100 Mbps LAN connector

7. Environmental

- a. Operating temperature -40°C (-40 °F) to +50°C (122 °F)
- b. Stable image temperature 0°C (32 °F) to +50°C (122 °F)
- c. Storage temperature -40°C (-40 °F) to +60°C (140 °F)
- d. Humidity 0% to 90% (non-condensing)

8. Illumination

- a. Color (non-binning): 0.5 Lux @ F2.0

- b. Color (binning): 0.25 Lux @ F2.0
- c. B/W: 0 Lux, IR sensitive (with additional IR light source)

2.4 ETHERNET-FIBER MEDIA CONVERTER

- A. An Ethernet to Fiber Media Converter that supports two (2) cameras (the existing exterior camera and a new camera for the transformer area) is required.
- B. The media converter shall be commercial grade for use outdoors in inclement weather, typical of the area that it will be utilized.
- C. The media converter should be able to transmit video over 4,000 ft minimal.
- D. The media converter will utilize existing fiber optic cables and be supported by an existing AC power supply in the NEMA enclosure where it will be installed.
- E. The media converter will be Black Box, Hardened Media Converter Switch, 10/-100-Mbps Copper to 100-Mbps Fiber, Multimode, 100–240-VAC, ST, Model #LBH100A-H-ST or approved equal.

2.5 VIDEO NETWORK EQUIPMENT

- A. All security cameras shall be power by POE layer 3 switch located within the telecom/security equipment room unless otherwise noted.
- B. The POE Switch shall support surveillance video bandwidth and provide power to each camera as indicated on drawings.
- C. The POE switch shall have appropriate Layer 3 equipment with security features to provide secure internet access and prevent the system from being hacked into.
- D. Each POE switch port shall support a gigabit of data.
- E. Catalyst layer 3 POE switch shall be Cisco Model number 3750X 24 and 48 Port 10/100/1000 base-T PoE+ switch by Cisco Model Number WS-C3750-24PL and WS-CS3750-48PL or approved equal as determined by owner.

2.6 RACKMOUNT UNINTERRUPTIBLE POWER SUPPLY (UPS)

- A. Rackmount Uninterruptible Power Supply (UPS) shall be Middle Atlantic Products model number determined by contractor.
- B. UPS shall be line interactive with AVR.
- C. Unit shall measure 19.00" W x 3.50" H x 19.00" D and occupy 2U rack spaces.
- D. UPS shall have a rear mounting range of 19" to 32" and not require more than one person to mount.
- E. Unit shall operate on 120 VAC/60Hz current. Unit shall have a nominal output of 120V.
- F. Unit shall have a capacity to support all security system active electronics for a minimum of 30 minutes at 50% of load, until emergency generators start. Units shall protect the systems from any surges or voltage drops. Units shall prevent the electronics from re-booting.

- G. Unit shall have (8) NEMA receptacles on the rear of the unit.
- H. Unit shall have a priority outlet bank consisting of 4 outlets dedicated to ensure maximum run time of critical components. Unit shall have a non-critical outlet bank consisting of 4 outlets dedicated to load shedding, and individual outlet control.
- I. Unit shall be IP enabled, when used with IP Expansion card UPS-IPCARD.
- J. Rack mount UPS shall include a 9' SignalSafe™ power cord with NEMA plug.
- K. UPS shall have surge suppression that utilizes a clean line-to-neutral design that does not pass noise contamination to ground.
- L. Rack mount UPS shall have a hot swappable battery that allows for a 15 minute run time at half load and a 15 minute run time at full load.
- M. Rear of unit shall have inputs that allow for the installation of up to 10 additional hot swappable batteries.
- N. Rack mount UPS shall be RoHS EU Directive 2002/95/EC compliant.
- O. Rack mount UPS shall utilize Middle Atlantic Power Manager™ software.
- P. Rack mount UPS shall be warrantied to be free from defects in materials and workmanship under normal use and conditions for a period of 3 years; battery shall be warrantied for a period of 2 years.
- Q. Rack mount UPS shall be UL listed in US and Canada.
- R. UPS-IPCARD
 - 1. Web based control shall be enabled on non-internet enabled Middle Atlantic Products UPS by UPS-IPCARD, which shall be installed into the Expansion Port on the rear of the UPS. This shall be compatible with UPS firmware v1.65 or greater, and provide full functionality when used on models with firmware v1.75 or greater.
- S. Expansion Battery
 - 1. Rack mount expansion battery pack shall be Middle Atlantic Products.
 - 2. Expansion battery pack shall be suitable for use with the UPS system.
 - 3. UPS shall measure 19.00" W x 3.50" H x 19.29" D and occupy 2 rack spaces.
 - 4. UPS-EBPR shall require 22.66" useable depth. With hot swappable batteries connected to the unit, there is a 30-minute run time at half load and a 15 minute run time at full load.
 - 5. Rack mount expansion battery pack shall be warrantied for a period of 2 years.
- T. Replacement Battery
 - 1. Replacement Battery Pack for the UPS shall be Middle Atlantic Products. Replacement battery pack shall be suitable for use with the UPS system.
 - 2. Replacement battery shall be warrantied to be free from defects in materials and workmanship under normal use and conditions for a period of 2 years.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cable. Check raceways, cables trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- B. Examine walls and locations for suitably conditions where CCTV equipment is to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. The Contractor shall carefully follow instructions in documentation provided by the manufacturer to insure all steps have been taken to provide a reliable, easy-to-operate system.
- B. All equipment shall be tested and configured in accordance with instructions provided by the manufacturer prior to installation.
- C. All firmware found in products shall be the latest and most up-to-date provided by the manufacturer, or of a version as specified by the provider of the Video Management Application (VMA) or Network Video Recorder (NVR).
- D. All equipment requiring users to log on using a password shall be configured with user/site-specific password/passwords. No system/product default passwords shall be allowed.
- E. It is the intent of the owner to utilize the cabling and wiring installed for this project, testing is required prior to the installation of any equipment for proper cable structure and functionality. All testing must be recorded and provided to the Owner's project manager for approval of wire usage.
- F. Outdoor Installation: Comply with ANSI C2, "National Electrical Safety Code."
- G. Install surge suppressors where integral surge suppressors specified in UL 1449 do not protect ac-power-operated devices against voltage transients. Install surge suppressors at the devices' power-line terminals.
- H. No product shall be installed, provided, submitted, or designed into the system that is nearing its end of life (EOL). Only the most current products shall be provided, installed or submitted at time of installation that meets the specifications, regardless of the specified products.
- I. Wiring Method:
 - 1. Install all wiring in conduit as otherwise indicated. No Cable splices will be permitted.
- J. Wiring within Enclosures:
 - 1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

K. Pulling Cable:

1. Do not exceed manufacturers recommended pulling tensions. Do not install bruised, kinked, scored, deformed, or abraded cable.
2. Do not splice cable between termination, tap, or junction points.
3. Remove and discard cable if damaged during installation and replace it with new cable.

L. Exposed Cable:

1. Install parallel to building lines, follow surface contours, and support the cable according to manufacturer's written instructions.
2. Do not run adjacent and parallel to power or data cables.
3. All Cable is to be protected in Raceway, cabinets and boxes exposed cabling is not allowed.

M. Equalizing Video Signals:

1. Where system performance may be degraded in certain operating modes, revise component connections and install video distribution amplifiers and attenuators as required providing a balanced signal across the system.

N. Splices, Taps, and Attenuations:

1. For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
2. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

O. Grounding: Provide independent signal circuit grounding recommended by manufacturer.

3.3 CCTV SYSTEM INSTALLATION

- A. Install cameras at locations and heights as indicated on the drawing. Change type of mounting to achieve required clearance.
- B. Install power supplies and other auxiliary components in rooms as shown on drawings. Do not install such items near the devices they serve, unless otherwise indicated.
- C. Contractor shall determine in the field exact cable requirements needed to meet cable length and voltage drop requirements. Voltage drop shall not exceed manufacturer's recommendations.

3.4 CABLING REQUIREMENTS

- A. Requirements shall meet the printed documentation of the manufacturer for power and video distribution.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminal; according to Division 26.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service:
 - 1. Engage a factory-authorized service representative to inspect field-assembled components and equipment installation and supervise pre-testing, testing, and adjusting of television equipment.
- B. Inspection:
 - 1. Verify that units and controls are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.
- C. Pre-testing:
 - 1. Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Replace malfunctioning or damaged items. Retest until satisfactory performance and conditions are achieved. Prepare television equipment for acceptance and operational testing as follows:
 - a. CCTV Sources: Connect the receiver to the output of each CCTV signal source or the distribution amplifier associated with it.
- D. Test Schedule:
 - 1. Schedule tests after pre-testing has successfully been completed and system has been in normal functional operation for at least 14 days. Provide a minimum of (11) days' notice of test schedule.
- E. Operational Tests;
 - 1. Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.
- F. CCTV Camera Location Test:
 - 1. Temporarily support each camera at the indicated location and connect to monitor. Adjust camera location and mounting and substitute fixed lenses to provide required performance at monitor. Adjust locations within 15 feet of those indicated.
- G. Record test results.
- H. Retest; Correct deficiencies identified by tests and observations and retest until specified requirements are met.

3.7 CLEANING

- A. Clean installed items using methods and materials recommended by manufacturer.
- B. Clean CCTV system components, including camera-housing windows, lenses, and monitor screens.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain television equipment.
 - 1. Train Owner's maintenance personnel on procedures and schedules for troubleshooting, servicing, and maintaining equipment.
 - 2. Demonstrate methods of determining optimum alignment and adjustment of components and settings for system controls.
 - 3. Review data in maintenance manuals. Refer to Division 1 Section 'Contract Closeout.'
 - 4. Scheduled training with Owner, through Architect, with at least seven days advance notice. Contractor shall provide a minimum of 8 hours of in-service training with this system. These sessions shall be broken into segments, which will facilitate the training of individuals in the operation of this system. Operators' Manual and Users Guides shall be provided at the time of this training.

3.9 ON-SITE ASSISTANCE

- A. Occupancy Adjustments: When requested by Owner within one year of date of Substantial Completion, provide on-site assistance in tuning and adjusting the system to suit actual occupied conditions and to optimize performance. Provide up to two adjustments at Project site for this purpose, without additional cost.

END OF SECTION

SECTION 310000

EARTHWORK

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Work governed by this section, as shown or specified shall be in accordance with the requirements of the Contract Documents and the New York City Building Code (2014 edition).
- B. Work of this Section, as shown or specified, shall be in accordance with the Sediment and Erosion Control Plan, where applicable.

1.2 SECTION INCLUDES

- A. Work of this Section includes, but is not limited to the following:
 - 1. Removal of existing foundations, pavements, curbs, tanks, abandoned pipes, utilities, and other structures encountered which require removal for successful completion of the work.
 - 2. General excavation of soil to levels established within the Contract Drawings and as described herein.
 - 3. Local excavation of soil for the pile caps, slabs, walls, and other foundation elements indicated on the Contract Drawings and as directed by the Owner's Engineer.
 - 4. Excavation, fill placement, grading and compaction to required elevations for appurtenances and general site work as shown on the Contract Drawings or as described herein.
 - 5. Excavation and trenching for mechanical trades, including but not limited to plumbing, heating, water, steam, gas, and electric within and outside the transformer yard as shown on the Contract Drawings or as required to make the work complete; backfilling same with suitable fill materials as described herein; and thoroughly compacting said materials to "Rough Grading" elevations.
 - 6. Excavation and trenching for temporary works as shown or as required; backfilling same with approved fill; compaction, and rough grading.
 - 7. Removal of unsuitable subgrade soils, replacement with approved fill materials, and compaction of such materials as dictated by site conditions or as directed by the Owner's Engineer.
 - 8. Scarifying, compacting, controlling the moisture content of soils, and removal of unsuitable material to ensure proper preparation of areas to receive fill or proposed improvements.
 - 9. Furnishing approved material for filling and rough grading, as required.
 - 10. Legal off-site disposal of surplus excavated materials, and materials not suitable for re-use as fill or backfill.
 - 11. Subgrade preparation for pile caps, footings, foundations, and slabs.
 - 12. Protection of adjacent structures, utilities, and pavements.
 - 13. Temporary groundwater control as required for execution of the work of this Section and for all other related foundation work in accordance with Section 312315 – Groundwater Control.

14. All professional engineering and consulting required for the design and execution of the work of this Section.
15. All other labor, equipment, and materials as may be reasonably inferred to be required to make the work under this Section complete.

1.3 RELATED SECTIONS

- A. Related Documents and Sections: Examine Contract Documents for requirements that directly affect or are affected by Work of this Section. A list of those Documents and Sections include, but is not limited to the following:
 1. Cast-in-Place Concrete – Section 033000
 2. Monitoring of Structures and Utilities – Section 310901
 3. Groundwater Control – Section 312315
 4. Erosion and Sediment Control – Section 312500
 5. Excavation Support and Protection – Section 315000
 6. Drilled Caissons – Section 316326

1.4 STANDARDS AND REFERENCES

- A. American Society for Testing and Materials (ASTM) standards, latest edition.
 1. ASTM C 33 Standard Specifications for Concrete Aggregates.
 2. ASTM D 422 Standard Test Method for Particle Size Analysis of Soils (sieve only).
 3. ASTM D 1557 Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.
 4. ASTM D 2216 Test Method for Laboratory Determination of Water (Moisture) Content of Rock and Soil.
 5. ASTM D 2487 Test Method for Classification of Soils for Engineering Purposes.
 6. ASTM D 2922 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
 7. ASTM D 3017 Test for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
 8. ASTM D 4318 Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- B. ACI-318 latest edition – Building Code Requirements for Structural Concrete, latest edition
- C. ACI-299R – Controlled Low Strength Materials, latest edition
- D. Geotechnical Memorandum: The Geotechnical Engineer engaged by the Owner, has prepared a memorandum entitled Geotechnical Engineering Evaluation – Jacob Javits Convention Center – Transformer Yard Relocation, dated 1 April 2016. Copies of this document shall be available to the Contractor, upon request. Boring and other in situ test logs are made available to the Contractor for information only. Conditions are not intended as representations or warranties of accuracy or continuity between borings. The Owner will not be responsible for interpretation conclusions drawn from this data by the Contractor.
- E. All work shall comply with requirements of the New York City Building Code, New York State Department of Labor, Occupational Safety and Health Administration (OSHA), New York State Department of Health (NYSDOH), New York State Department of Environmental Conservation (NYSDEC), New York City Department of Environmental Protection (NYCDEP), New York State Department of Transportation (NYSDOT), New York City

Department of Transportation (NYCDOT), and with applicable requirements of all other authorities having jurisdiction.

F. Regulatory Requirements and Reference Standards

1. The Contractor shall comply with all the laws, ordinances, codes, rules and regulations of the Federal, State and Local authorities having jurisdiction over any of the work specified herein. The Contractor shall meet NYCDEP Limitations for Effluent, NYSDEC and EPA limitations for discharge into any surface water bodies, federal EPA and State Department of Transportation regulations for shipping of regulated substances to off-site disposal facilities, and meet all regulatory requirements imposed by the Treatment, Storage and Disposal Facility. Regulations pertaining to the handling, transport and disposal of regulated substances/materials include, but are not limited to the following:
 - a. USEPA Regulation 40 CFR Part 280, Underground Storage Tanks: Technical Requirements Final Rule and Office of Emergency and Remedial Response, Standard Safety Guides, PB92-983414.
 - b. New York City Fire Department, FP Directive 3-73 Division of Fire Protection, NYCAC Title 27, New York City Fire Prevention Code, Chapter 4 et seq., and Rule 21-02 of the City of New York. NYS Uniform Fire Prevention and Building Code (UFPBC) 1164.5.
 - c. NYS Department of Environmental Conservation (DEC)-Subdivision 6 NYCRR Part 613.9 (b) (DEC's Petroleum Bulk Storage (PBS) Regulation.
 - d. NYSDEC Petroleum Bulk Storage Regulations 6 NYCRR Part 613.9(b).
 - e. 6 NYCRR Part 360, Solid Waste Management Facilities, July 14, 1985.
 - f. 6 NYCRR Part 364, Waster Transporter Permits, January 10, 1985.
 - g. 6 NYCRR Part 371, Identification and List of Hazardous Waste, July 1, 1986.
 - h. 6 NYCRR Part 375 Environmental Remedial Programs, December 14, 2006.
 - i. NYSDEC, Ambient Water Quality Standards and Guidance Values.
 - j. NYSDEC Site Assessment at Bulk Storage Facilities, August 1, 1994, SPOTS Memo No 14.
 - k. NYSDEC Petroleum-Contaminated Soil Guidance Policy, August 1992, STARS Memo No. 1.
 - l. Rule 21-02 of the City of New York.
 - m. The New York City Building Code
 - n. 29 CFR 1910 – Federal Occupational Safety and Health Administration (OSHA) standards.
 - o. NIOSH Occupational Safety and Health Guidance manual for Hazardous Waste Site Activities.
 - p. 29 CFR 1926 – Federal Construction Standards.
 - q. Resource Conservation and Recovery Act, 40 CFR Parts 260-265, Safe Entry and Cleaning of Petroleum Storage Tanks.
 - r. National Fire Prevention Association, Volume 30, "Flammable and Combustible Liquids Code."
 - s. National Fire Prevention Association, Volume 327, "Cleaning or Safeguarding Small Tanks and Containers without Entry."
 - t. US Department of Transportation (US DOT) 49 CFR Section 172.500 et seq.
 - u. American Petroleum Institute, API-2015A, "A Guide for Controlling the Lead Hazard Associated with Tank Entry and Cleaning."
 - v. American Petroleum Institute, API-2217A, "Guidelines for Work in Inert Confined Spaces in the Petroleum Industry."

- w. American Petroleum Institute, API-2015, "Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks."
 - x. American Petroleum Institute, API-2016, "Guidelines and Procedures for Entering and Cleaning Petroleum Storage Tanks."
 - y. American Petroleum Institute, API-1604, "Closure of Underground Petroleum Storage Tanks."
 - z. American National Standard Institute, ANSI Z288.2, "Standard Practice for Respiratory Protection."
 - aa. American Society of Testing Materials, ASTM D 5088 (1990), Decontamination of Field Equipment Used at Non-radioactive Waste Sites.
 - bb. National Institute for Occupational Safety and Health, NIOSH, "Working in Confined Space."
 - cc. Department of Transportation 49 CFR 172 through 179
 - dd. Department of Transportation 49 CFR 387 (46 FR 30974)
 - ee. Department of Transportation DOT-E 8876
 - ff. Environmental Protection Agency 40 CFR 136 (41 FR 52779)
 - gg. Environmental Protection Agency 40 CFR 262 and 761
 - hh. Resource Conservation and Recovery Act (RCRA)
 - ii. NYCDEC, Rules of the City of New York (RCNY), Title 15, Chapter 19, Use of the Public Sewers.
 - jj. NYCDEP, Limitations for Effluent to Sanitary or Combined Sewers.
 - kk. NYCDEP, Dewatering Sampling and Testing Requirements.
- 2. Any transporter of contaminated/hazardous materials shall be licensed in the state in which handling and transportation shall take place in accordance with all applicable regulations.
 - 3. Comply with OSHA (Occupational Safety and Health Administration) Standards and Regulations contained in Title 29 CFR Part 1910.120 "Hazardous Waste Operations and Emergency Response."
 - 4. Where reference is made to one of the above standards, the revision in effect at the time of the bid opening shall apply.
- G. In case of conflict between regulations and specifications, the Contractor shall comply with the most stringent requirements outlined in the applicable codes, regulations, and specifications.
- H. Nothing in clause 1.4 shall relieve Subcontractor of his responsibility of providing higher standard than the relevant Code or Standard, in order to comply with this Specification.

1.5 SUBMITTALS

- A. Unless otherwise indicated, transmit all submittals to the Construction Manager for review. Review of submittals by the Construction Manager, Owner's Architect, and Owner's Engineers is required before proceeding with ordering, fabricating, or any work of this Section. Submittal review will be of concept only and shall not in any way diminish or limit Contractor's responsibility for the quality and performance of his work. All material orders shall be the sole responsibility of the Contractor.
- B. Test Reports: Submit the following information for each source of each material submitted for review and approval of the Owner's Engineer:

1. Test reports for all proposed fill materials (either from borrow sources or on-site) as follows:
 - a. Particle size analysis in accordance with ASTM D 422 (sieve only).
 - b. Atterberg Limits in accordance with ASTM D 4318
 - c. Soil classification in accordance with ASTM D 2487
 - d. Moisture content in accordance with ASTM D 2216
 - e. Modified Compaction Curve in accordance with ASTM D 1557.
 2. Include data for all samples indicating the exact location and methods of transportation and placement of all materials.
- C. Samples:
1. Where requested, the Contractor shall submit samples of materials proposed for use as fill, including, but not limited to general fill, drainage fill, structural fill, pavement subbase course, etc. Samples shall be submitted at least 1 week prior to proposed use on site. Test reports as required under Section 1.5.B shall accompany each sample.
- D. Submit mix designs, vendor information, materials test data and reports and any other pertinent product data for all proposed concrete fill including but not limited to: structural concrete, lean concrete, and controlled low strength materials (CLSM). All concrete fill mix designs shall be prepared by a Professional Engineer, licensed in New York State.
- E. Shop Drawings: Submit detailed shop drawings and calculations to be reviewed by the Owner's Engineer. The drawings and calculations shall be prepared by a Professional Engineer registered in the State of New York. The submittals shall include, but not be limited to following:
1. Earth excavation procedures.
 2. Fill materials, equipment, and procedures for placement and methods of compaction, where required.
- F. Catalog Cuts: Submit catalog cuts and manufacturer's literature for excavation and compaction equipment, and all geotextile and drainage materials.
- G. All required certifications and permits pertaining to the work of this Section.
- H. Monitoring Program: Submit the proposed monitoring program as specified herein and in accordance with Section 310901 at least 2 weeks before proceeding with the work, including locations of all monitoring points, proposed methods, responsible personnel, etc.
- I. Certification for Examination of Site and Records: Before proceeding with the work, submit certification in an acceptable form, signed by the Contractor, stating that careful examination has been made of the site, existing structures, existing adjacent structures, records of utility lines, test boring records, soil samples, subsurface exploration reports, the Contract Drawings, and all other Contract Documents.
- J. Substitutions: Should the Contractor desire a substitution from the Contract Drawings or specifications, or both, Contractor shall submit the specific substitution in writing prior to submittal of Shop Drawings. Requests for substitutions shall be submitted on the Contractor's letterhead. Approval of the Contractor's request for substitutions shall be at the

discretion of the Owner and Owner's Structural and Geotechnical Engineers. Rejection of substitutions shall not be grounds for an adjustment to the Contract price.

1.6 DEFINITIONS

- A. Wherever the word "excavating", "excavate", "excavation", "carried down", "remove", etc., are used, they shall be taken to include the removal of all existing work, including rubble, former foundation remnants, rubbish, earth, as well as rock, boulders, concrete and all other materials and obstructions encountered; they shall also be taken to include all temporary excavation support, bracing, groundwater control, and all other operations and items needed for the proper execution of the work. Excavation is considered unclassified.
- B. Where the words "finished grades", "finished grade lines", or "future finished grades", appear in these specifications, they shall be taken to mean the finished elevations as indicated on the Contract Drawings.
- C. Rough grading consists of cutting or filling to the elevation herein established with a permissible tolerance of plus or minus 1 inch. This tolerance shall be so used within any area of 100 ft that it will not be necessary to remove excess or bring in additional fill to meet the required elevations.

1.7 PROTECTION

- A. The work shall be executed so that no damage or injury will occur to the existing public and adjoining or adjacent structures, streets, paving, sewers, gas, water, electric or any other pipes. Should any damage or injury be caused by the Contractor, or anyone in Contractor's employ, or by the work under this Contract occur, the Contractor shall repair such damage and shall assume all responsibility for such injury.
- B. The above shall include the protection of all existing utilities (including sewers, water lines, electrical lines and telecommunication lines) to remain in use within and adjacent to the area affected by the work of this project.
- C. Monuments, bench marks and other reference features shall be protected. Should these be disturbed in any manner, the Contractor shall have them replaced at no additional cost to the owner.
- D. Excavation sides and adjacent structures and foundations shall be protected by means of adequate bracing, shoring and anchoring at all times. Excavation shall not proceed until adequate support for excavation sides is provided. Contractor is solely responsible for the stability, safety and protection of excavation sides.
- E. Provide barricades and warning lights, barriers, to prevent accidents, to avoid all necessary hazards and protect the public, the work and property at all times, including Saturdays, Sundays and Holidays.
- F. Provide protection to sidewalks and pedestrians as required.
- G. Erosion and sediment control and dust control shall be in accordance with Section 312500.
- H. Support of Excavation shall be in accordance with Section 315000

- I. Monitoring shall be in accordance with Section 310901.
- J. The Contractor shall maintain the cleanliness of paved streets immediately adjacent to the site through regular sweeping and moistening as required to remove any excess mud, dirt, or rocks tracked from the site. Trucks hauling material from the site are to be covered with a tarpaulin during transport offsite.

1.8 ERRORS IN DEPTH

- A. In the event that any part of the excavation be carried, through error, beyond the depth and the dimensions indicated on the Contract Drawings or called for in the specifications, then the Contractor, at his own expense, shall furnish and install fill material, suitable to the Owner's Geotechnical Engineer, for re-establishing proposed grades. The specific type of fill to be implemented shall be per the direction of the Owner's Engineer based on the intended final loading and/or end-use conditions.

1.9 QUALITY ASSURANCE

- A. Contractor Qualifications:
 - 1. The Contractor performing the work of this Section shall be a qualified excavation contractor with at least 10 years of relevant field experience on projects of similar size, scope, and complexity.
- B. All work shall comply with the Owner's Construction Waste Management Plan.
- C. All work shall comply with the requirements of the project's Sediment and Erosion Control Plan.

1.10 QUALITY CONTROL - INSPECTION AND TESTING

- A. Special Inspection:
 - 1. The Owner will engage, under the requirements of Section 1704.1 of the Building Code, one or more Special Inspection Agencies to observe and provide all necessary material testing related to the work of this Section. All inspections and all materials testing shall be performed by Special Inspectors meeting the minimum qualifications outlined in RCNY 101-06.
 - 1. The Special Inspector shall be present on a full-time basis during all earthwork activities.
 - 2. The Special Inspector shall prepare and submit daily reports summarizing the construction and/or material testing activities.
 - 3. The Special Inspector shall submit all logs and test reports necessary to facilitate any corrective design requirements by the Engineer of Record.
 - 4. Where work is observed to be non-conforming, the Special Inspector shall immediately inform the Construction Manager and Owner's Engineer(s) of such conditions in writing. A summary of the observed non-conformance shall be issued within 24-hrs. The Special Inspector shall maintain a tracking log of all non-conformances and shall update the tracking log on a daily basis such that corrective measures, if required, can be facilitated in timely fashion. The tracking log shall include such information as ID number, date opened, description of non-conformance, actions required, actions taken, and date closed.

5. The Special Inspector shall provide all necessary certifications of the work in compliance with Building Code requirements.
- B. The Special Inspector(s) shall be provided with reasonable office space (heating, cooling, electric) on-site by the Construction Manager to conveniently prepare and maintain all necessary project records pertinent to their duties and to store equipment. At a minimum the Special Inspector shall be provided with a minimum of one desk, a locking cabinet or closet, and wireless internet access.
- C. The Contractor shall have the sole responsibility for coordinating his work with the Construction Manager to assure that all tests and inspection procedures required by the Contract Documents and the governing Building Codes are properly provided by the Special Inspector. The Contractor shall cooperate fully with the Special Inspector in the performance of his work.
- D. Materials and installed work may require testing at any time as work progresses. Allow free access to material stockpiles and facilities. Tests not specifically indicated herein may be performed at Owner's expense, as required by the Special Inspector.
- E. Retesting of rejected materials and installed work shall be Contractor's responsibility and shall be performed at his expense.
- F. The Contractor shall notify the Construction Manager, and all other necessary parties at least 72 hours prior to each day of caisson drilling to allow for the appropriate personnel to be on the site.
- G. The role of the Special Inspector(s) shall not relieve the Contractor from any responsibility with respect to conformance to the proper workmanship, management of materials and waste, or any other requirements of the Contract Documents.

1.11 PROJECT CONDITIONS

- A. Subsurface Conditions - The subsurface conditions within the development area are generally characterized by uncontrolled fill underlain by consecutive layers of slightly organic silty clay, glacial till, and finally bedrock; a thin mantle of decomposed rock may be present above competent bedrock at some locations. Groundwater is anticipated to be tidally influenced within the project site, and is estimated to fluctuate between elevations el +2 and el -3 ft. Additional details pertaining to the subsurface conditions are presented in the memorandum entitle Geotechnical Engineering Evaluation – Jacob Javits Convention Center – Transformer Yard Relocation, prepared by Langan Engineering, Environmental, Surveying and Landscape Architecture, D.P.C., dated 1 April 2016. This information is provided for Contractor's information only.
- B. The project site is underlain by three vehicular tunnels, referenced as the Lincoln Tunnel North Tube, Lincoln Tunnel Center Tube, and Lincoln Tunnel South Tube. All Lincoln Tunnel facilities are operated by the Port Authority of New York and New Jersey (PANYNJ).
- C. Boring logs are available for the Contractor's review. The Owner makes no predictions or representations regarding the character or extent of soil, rock, or other subsurface conditions to be encountered during the work. The Contractor shall make his own deductions of the subsurface conditions which may affect the methods or cost of construction of the work

hereunder, and he agrees that he will make no claims for damages or compensations, except as are provided under the agreement, should he find conditions during the progress of the work different from those as calculated or anticipated by him. Additional borings and other exploratory operations, not included in the Contract Documents, may be performed by Contractor, at the Contractor's option and following the Owner's approval. No reimbursement or change in the Contract Sum will be authorized for such additional exploration undertaken by the Contractor.

- D. The Contractor, by careful examination, shall inform himself as to the nature and location of the work; the conformation of the ground, the nature of the subsurface conditions; the locations of the groundwater table; the character, quality and quantity of the materials to be encountered; the character of the equipment and facilities needed prior to and during the execution of the work; and all other matters which can be in any way effect the work.
- E. The Contractor shall be held to have visited the site and to have familiarized himself with the existing conditions of adjoining properties, utilities, and buildings.
- F. The Contractor shall investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to, ingress and egress of the site of the work. The Contractor shall conform to all New York City and State, and Federal regulations in regard to the transportation of materials to and from and at the job site and shall secure in advance such permits as may be required.

1.12 LINCOLN TUNNEL

- A. Earthwork activities, including excavation and installation of support of excavation systems, shall be subject to the review and observation of PANYNJ representatives. The Contractor shall cooperate with the PANYNJ's representatives and shall follow all protocols set forth in the Contract Documents. The Contractor shall be prepared to develop and submit a Work Plan where required by PANYNJ.
- B. The Lincoln Tunnel (North and Center Tube) and other structures shall be monitored during construction activities as specified in Section 310901.
- C. Per Section 310901, the Contractor shall photograph and map all cracks in the Lincoln Tunnel and other structures to remain that are within 100 ft of the construction prior to execution of any excavation activities.

1.13 EXISTING UTILITIES

- A. Existing Utilities: Locate existing underground utilities within and beyond the areas of work. If utilities are indicated to remain in place, provide adequate means of support and protection during the work. Utilities scheduled for relocation are identified in the Contract Documents.
 - 1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
 - 2. Do not interrupt existing utilities serving facilities occupied by Owner or others, during occupied hours, except when permitted in writing by the Construction Manager and then only after acceptable temporary utility services have been provided. Provide

- minimum of 48-hour notice to the Construction Manager, and receive written notice to proceed before interrupting any utility.
3. Where necessary, demolish and completely remove existing underground utilities indicated to be removed from the site. Coordinate with utility companies for shutoff of services if lines are active.
 4. Examine drawings to determine sequence of operations, and relation to work of other trades. Start of work will signify acceptance of field conditions and will acknowledge coordination with other trades.

1.14 PRECONSTRUCTION MEETING

- A. Prior to work on site, the Construction Manager will arrange a series of meetings to discuss coordination and scheduling. Parties to be present: Structural Engineer, Geotechnical Engineer, Environmental Engineer, Architect, Testing Laboratory, Construction Manager, Excavation Contractor and his Engineer, PANYNJ, the Special Inspector, and the Owner. Review the earthwork procedures and responsibilities including testing and inspection procedures and requirements. Notify participants at least 3 working days prior to convening conference. Record discussions and agreements and furnish a copy to each participant.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS:

- A. Structural Fill: Well graded granular soil containing not more than 10 percent by weight of materials finer than No. 200 mesh sieve and not more than 20 percent retained on a ¾-inch sieve with a maximum particle size of 2-inches.
- B. Drainage Fill: Clean ¾-inch gravel meeting the requirements of NYSDOT Item No. 605.0901, Underdrain Filter, Type I.
- C. General Fill: Shall have no more than 20 percent by weight of stones, brick, or other masonry debris, shall contain no stones or other materials greater than 4 inches in any dimension and shall contain less than 20 percent by weight of materials finer than No. 200 mesh sieve.
- D. Pavement Subbase Fill: Subbase materials below asphalt and concrete pavements shall consist of clean granular soils, crushed stone, or recycled concrete aggregate conforming to the requirements of NYSDOT Item No. 304.14, Subbase Course, Type 4.
- E. Fill for utility trenches shall meet the criteria given for structural fill and shall not contain sharp, angular pieces and pieces larger than 2 inches in any dimension.
- F. Before import any fill to the site, the Contractor shall submit the source for approval by the Owner's Engineer(s).
- G. All fill materials shall be free from wood, debris, combustible materials, vegetation matter or any material subject to decay or disintegration.
- H. The use of recycled concrete aggregate as structural or general fill shall be permitted provided it meets the gradation requirements above and is acceptable to the Environmental Engineer.

- I. The use of mole rock shall not be permitted.

2.2 IMPORT SOIL AND FILL:

- A. Import Soil and Fill: Fill shall meet the requirements of 6 NYCRR Part 360. Import soil used in the top two feet of landscaped areas (not anticipated) shall meet a minimum of NYSDEC Subpart 375-6 Restricted Residential SCOs. In landscaped areas with the two-foot clean soil layer, a demarcation layer (i.e., orange snow fencing) shall be placed between the residual site material and the new two-foot clean fill. The Contractor will be responsible for the sampling and laboratory analysis of backfill materials at a rate of one sample per 250 cubic yards.

2.3 CONCRETE MATERIALS:

- A. Lean Concrete shall conform to ACI 301 and as specified in Section 033000.
- B. Controlled low strength material (CLSM) shall conform to ACI 299R.

PART 3 - EXECUTION

3.1 GENERAL SITE PREPARATION

- A. The Contractor shall furnish all labor, equipment and materials required to prepare the site and to excavate all materials of whatever type encountered to the lines and grades shown on the Contract Drawings and as specified.
- B. The Contractor shall give 72 hours advance notice to the Owner's Engineer of the impending excavations so as to allow the Owner's Engineer to inspect the condition of the exposed surface for footings, pile caps, slabs and pads and review the ground water conditions in accordance with the NYC Building Code requirements for Special Inspection.
- C. The Contractor is to obtain and pay for all necessary permits to perform the work from the appropriate authorities and agencies prior to start of such work. Obey all applicable local and federal work safety rules and regulations.
- D. Install all necessary protection equipment, including structures such as fences, signs, scaffolding, etc. prior to start of work.
- E. Remove all existing structures, utilities, pavement in accordance with the Contract Documents.
- F. Protect all utility lines which are to remain. The Contractor shall be responsible for any damage to utilities resulting from the Contractor's actions.
- G. Stockpile on-site materials anticipated for re-use. Care shall be taken to avoid blending with the deleterious materials. Stockpiling shall comply with the requirements of Sections 026113 – Handling, Transport and Disposal of Contaminated Soil, and 312500 – Soil Erosion and Sediment Control.
- H. Provide all necessary erosion and sediment control in accordance with Section 312500.

3.2 GROUNDWATER AND SURFACE WATER CONTROL

- A. Groundwater control shall be in accordance with Section 312315, and as specified herein.
- B. The Contractor's groundwater control system shall be capable of maintaining dry, stable subgrade conditions.
- C. Groundwater control systems shall be capable of operating on a continuous basis throughout excavation and foundation construction. The Contractor shall provide adequate backup systems in the event of equipment failure or malfunction.
- D. The Contractor's groundwater control system shall consider methods and measures necessary to reduce inflow through soils including but not limited to grouting and installation of sumps or pumping wells in an effort to minimize daily discharge quantities.
- E. The Contractor's work shall not result in damage to adjacent property. Protect adjacent property from the effects of groundwater lowering, as required.
- F. The Contractor shall monitor and record groundwater levels prior to and during any pumping.
- G. The Contractor shall be responsible for maintaining groundwater levels at least 2 ft below the levels of any excavation.
- H. Where required, the Contractor shall be responsible for obtaining all necessary discharge permits.
- I. All pumping and dewatering shall be performed in such a manner as to avoid the movement of fines or loss of ground from below the bearing level and shall not influence the stability of surrounding areas.
- J. The Contractor shall be responsible for controlling surface water on-site. Excavations shall be protected from deleterious effects of surface water accumulation. The Contractor shall grade accordingly to minimize run-off from entering and accumulating within excavations.

3.3 GENERAL EXCAVATION

- A. General
 - 1. The excavation shall be unclassified and shall comprise and include the satisfactory removal and legal disposal of all materials encountered regardless of the nature of the materials and shall be understood to include boulders, earth, hardpan, miscellaneous fill, foundations, structures, slabs, walls, utilities, pavements, curbs, piping and debris.
 - 2. All excavation shall be properly sized and shall extend to the depth required for the installation of the work indicated on the Contract Drawings. When excavations for foundations have reached the required depths, the Special Inspector shall make an inspection of the conditions.
 - 3. Excavation shall be made to a depth that will allow installation of foundations and slabs, including allowances for sub-base materials, mud-mats and waterproofing shown on the Contract Drawings, and within a one-inch tolerance. Excavation lines shall provide sufficient clearance for the proper execution of all concrete work including allowances for form work, shoring and inspection.

4. Materials that, in the opinion of the Owner's Engineer or Special Inspector, are not suitable for backfill, any surplus earth and all rock shall be removed from the site and legally disposed of.
5. The bottom of excavations shall be leveled off, free of standing water, snow, ice and loose materials and graded to receive foundations, slabs, pits, pile caps, trenches, grade beams, etc.
6. Where required, waterproofing shall be installed in accordance with the Contract Drawings and Specifications.
7. Subgrades of pile caps, slabs, and other foundation elements shall be level and free of loose soil, standing water and frost prior to acceptance for concrete placement. Hand-excavate to achieve final subgrade elevation as directed by the Owner's Engineer or Special Inspector.
8. Approved subgrades for pile caps, slabs and footings shall be sealed with a minimum 3-inch-cover of lean concrete to provide stabilization of the subgrade and provide a suitable substrate for installation of waterproofing membranes.

B. Excavation for Slabs, Pile Caps and Other Structural Members

1. Subgrades of slabs, pile caps and other structural members including framed slabs and grade beams shall be approved by the Special Inspector before proceeding with their construction. Subgrades shall consist of material that meets the allowable bearing pressure requirements indicated in the Contract Documents. Subgrades resulting from excavation shall be free of unsuitable material (fill, loose materials, organics, debris, etc.) as judged by the Owner's Engineer or Special Inspector.
2. Unauthorized Excavation: Excavations performed below the elevations shown or specified, shall be filled and compacted as hereinafter specified, at no additional cost.
3. Authorized Additional Excavation: Where the Owner's Engineer or Special Inspector determines that the bearing material encountered is unsuitable, remove the unsuitable bearing material as directed. The removed material shall be replaced with structural fill or concrete as directed by the Owner's Engineer or Special Inspector.

3.4 SOIL SUBGRADE PREPARATION

- A. Proofrolling shall be performed for all subgrades located within and outside the limits of the proposed work, including all adjacent site work and pavements.
- B. Proofrolling of subgrades shall conform to the following requirements:
 1. All subgrades shall be proofrolled in the presence of the Special Inspector.
 2. Proofrolling shall be accomplished with a minimum of six overlapping cross-rolled coverages of a smooth drum roller having a static weight of at least 6-tons in open areas. A vibratory trench roller having a static weight of at least 1.5 tons may be used in confined areas as approved by the Owner's Engineer or Special Inspector. Areas inaccessible to the heavy equipment shall be compacted using a vibratory plate or jumping jack compactor as directed by the Owner's Engineer or Special Inspector. The maximum travel speed of rollers should not exceed 1.5 mph.
 3. Vibratory or impact compaction shall not be performed on soils which are not within 2 percent of the optimum moisture content as determined by ASTM D1557. Disking, harrowing, or other methods of drying the soils should be performed as necessary to facilitate drying and subsequent proofrolling.
 4. Fill shall not be placed until the subgrade is approved by the Special Inspector.

5. Soft Areas during Compaction: Areas deemed unsatisfactory due to “pumping, rutting, or heaving” shall be undercut within the limits and extent ordered by the Owner’s Engineer or Special Inspector. These areas shall be replaced with an approved fill, and compacted to the requirements of this Section or as directed by the Owner’s Engineer or Special Inspector.

3.5 FILL PLACEMENT, GRADING, AND COMPACTION

- A. Filling and backfilling shall not be performed until related work has been inspected by the Special Inspector.
- B. All subgrades shall be free of water, snow, ice, wood, organics, or other deleterious materials prior to placement of any fill.
- C. Fill shall be placed such that there are no void spaces below floors, bottoms of pits, trenches, pipe haunches, pavements, etc.
- D. Fill shall not be placed against concrete elements until the concrete has obtained its specified compressive strength, unless otherwise directed by the Owner’s Engineer. Where fill is required on both sides of a wall, said fill shall be brought up simultaneously and evenly on both sides.
- E. Fill voids caused by the removal of boulders, and/or below grade improvements, with lean concrete, CLSM, or structural fill.
- F. The Contractor shall supply and install all fill materials necessary to bring the ground surfaces to the required levels as shown on the Contract Drawings and as necessary to make the work complete.
- G. All surplus materials shall be removed from site and legally disposed of. Should additional material be required for the placing of backfill, other than material obtained from the site, the Contractor shall obtain, deliver, and place accepted backfill material as required.
- H. Fill Placement:
 1. Begin placement of fill and backfill at the lowest section of the area. Spread material evenly by mechanical equipment or by manual means above the approved compacted subgrade in lifts not exceeding 10-inches for material compacted by heavy machinery and 4-inches for material compacted by with light machinery or by hand tamping.
 2. Build layers as horizontally as practical to prevent thickness of lift from exceeding that specified but provide with sufficient longitudinal and transverse slope to provide for runoff of surface water from every point.
- I. Moisture Control: The moisture-density curve for the fill used shall be supplied by the Contractor as a guide in controlling moisture to achieve the required degree of compaction. If, in the opinion of the Special Inspector, fill material becomes too wet for the required compaction, the fill shall be dried by a method approved by the Owner’s Engineer prior to commencing or continuing compaction operations. Likewise, if, in the opinion of the Special Inspector, the fill material becomes too dry for the required compaction, the fill shall be moistened by a method approved by the Owner’s Engineer prior to commencing or continuing compaction operations.

- J. Compaction:
 - 1. Pile Supported Structures:
 - a. Compact each lift to at least 92 percent of the soil's maximum dry laboratory density as determined by ASTM D1557.
 - 2. Pressure slabs, pavement, and utilities:
 - a. Compact each lift to at least 95 percent of the soil's maximum dry laboratory density as determined by ASTM D1557.
 - 3. The degree of compaction shall be checked by the Special Inspector and each successive lift shall not be placed or compacted until the previous lift is inspected and approved by the Special Inspector. Compact all fill to elevations and limits shown on Contract Drawings.
- K. Frost: Do not place fill materials when either the fill materials or the previous lift (or subgrade) on which it is placed is frozen. In the event that any fill which has already been placed on the surface shall become frozen, it shall be scarified and recompact, or removed, to the approval of the Special Inspector before the next lift is placed. Remove or recompact any soft spots resulting from frost to the satisfaction of the Engineer before new fill is placed.

3.6 MAINTENANCE

- A. Finished subgrades shall be verified to ensure proper elevation and conditions for construction above subgrade.
- B. Protect subgrade from excessive wheel loading during construction, including concrete trucks and dump trucks.
- C. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
- D. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.
- E. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.
- F. Where settling is measurable or observable at excavated areas during general project warrantee period, remove surface (pavement, or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.7 MONITORING

- 1. Monitoring shall be in accordance with Section 310901.

3.8 FIELD QUALITY CONTROL

- A. The Owner will employ, at his own expense, an Engineer to review all laboratory test results and submitted reports specified in this Section.

- B. The Owner's Engineer will interpret the tests, state in each report whether or not the test specimens and results comply with all requirements of the Contract Documents and note any deviations.
- C. The Owner's Engineer will identify when and where samples are to be obtained for the use of on-site materials. The Contractor shall collect samples, provide all necessary laboratory testing, and shall submit the following laboratory test reports to the Owner's Engineer for review:
 - 1. Gradation Analysis - ASTM D 422.
 - 2. Atterberg limits - ASTM D 4318.
 - 3. Modified Moisture-density curve determination - ASTM D1557.
- D. The Owner's Engineer will determine the conformance of materials to be used for fills.
- E. Backfilling and Compaction: Backfilling and compaction below foundations, slabs, behind foundation walls, and any other backfilling and compaction work shall be inspected by the Special Inspector. No fill shall be placed unless the previous lift is approved by the Special Inspector. The Special Inspector shall take field density tests of the subgrade for every 2,000 sq- ft, but not less than 3 tests in each compacted fill layer. Field density tests shall be performed in accordance with ASTM D2922.
- F. The Contractor shall cooperate with the Special Inspector in the performance of the required tests and inspections.

3.9 CLEAN-UP

- A. All excess material, including earth, rock and fill, shall be removed from site and legally disposed of. Material handling and disposal shall be in accordance with Section 022730 – Soils Management.
- B. All lumber, forms and metal work shall be removed immediately after completion of local areas. The Contractor shall be responsible for removal of all debris produced by work to this section from the site.
- C. Sidewalk and streets adjoining the property shall be broom cleaned and free of debris, rubbish, trash and obstructions of any kind caused by the work of this Section.

3.10 CLOSEOUT

- A. Substantial Completion Requirements:
 - 1. Provide final cleaning immediately prior to Substantial Completion inspection.
 - 2. Corrective Work:
 - a. Remove, repair and reinstall, or restore in place damaged items.
 - b. Replace damaged materials or items with New if repair not acceptable to Architect.
 - 3. Provide product data to complete Operation & Maintenance Manuals.
 - 4. Submit executed Warranties.

3.11 WASTE MANAGEMENT

- A. Separate and dispose of waste in accordance with the Project's Waste Management Plan.

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SECTION 310901

MONITORING OF STRUCTURES AND UTILITIES

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Work governed by this section, as shown or specified shall be in accordance with the requirements of the Contract Documents and the New York City Building Code (2014 edition).

1.2 SECTION INCLUDES

- A. Work of this Section includes, but is not limited to the following:
 - 1. All labor, equipment, and materials to execute the work of this Section as specified herein.
 - 2. Collection, cataloging, and compilation of existing buildings, tunnels, infrastructure, and other structures to remain within 100 ft (horizontally) of the site boundary limits (i.e. Pre-Construction Conditions Documentation).
 - 3. Furnish and install optical survey targets, surveying marks, inclinometers, seismographs, benchmarks, and settlement monitoring points as required and as outlined herein.
 - 4. Furnish all equipment and labor to provide continuous vibration and strain monitoring within adjacent tunnels and structures.
 - 5. Provide all surveying services required for performing optical survey monitoring as outlined herein.
 - 6. Provide all labor necessary for the periodic measurement of any installed crack gauges installed under this Section.
 - 7. Compilation and transmittal of monitoring data during construction.
 - 8. Provide all other labor, equipment, and materials as can reasonably be inferred to make the work of this Section complete.

1.3 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Documents and Sections: Examine Contract Documents for requirements that directly affect or are affected by Work of this Section. A list of those Documents and Sections include, but is not limited to the following:
 - 1. Earthwork – Section 310000
 - 2. Groundwater Control – Section 312315
 - 3. Erosion and Sediment Control – Section 312500
 - 4. Excavation Support and Protection – Section 315000
 - 5. Drilled Caissons – Section 316326

1.4 QUALITY ASSURANCE

- A. The Contractor shall retain the services of a Land Surveyor, licensed in the State of New

York, to perform all survey monitoring during construction. The Contractor's surveyor shall have at least three years of professional experience or as approved by the Owner's Engineer.

- B. The Contractor shall retain the services of a qualified Engineer, licensed in the State of New York, to evaluate and report all monitoring data during construction. The Contractor's Engineer shall have at least three years of professional experience or as approved by the Owner's Engineer.

1.5 SUBMITTALS

- A. Unless otherwise indicated, transmit all submittals to the Construction Manager for review by the Owner's Engineers before proceeding with ordering, fabricating, or any other work of this Section.
- B. Submit method statement describing the type of equipment to be implemented for optical surveying, inclinometers, crack gages, and any other instrumentation proposed. Describe installation, location, operation, and maintenance of equipment, as necessary.
- C. Submit work plan detailing the installation, operation, and maintenance of all equipment.
- D. Submit product cut-sheets and calibration data and identify the allowable tolerances of all proposed equipment.
- E. The Contractor shall submit resumes for all personnel performing the work of this Section.
- F. Submit Pre-Construction and Post-construction Documentation Reports to the Construction Manager for distribution to the Owner, Owner's Architect and Engineers, and PANYNJ. Documentation shall include all applicable plans, sketches, notes, and photographs logging the conditions of all tunnels, structures and thoroughfares located within 100 ft of the site boundary.
- G. Submit plan showing location of all instrumentation and crack gages installed to document movement during construction activities.
- H. Monitoring Plans:
 - 1. The Contractor shall submit drawings showing proposed monitoring points. The drawings shall include a plan view layout with appropriate elevation and section views necessary to accurately convey the plan and vertical locations of monitoring points. The plan shall graphically identify the type of monitoring point (i.e., optical survey, surface points, seismographs, crack gages, borehole instruments, benchmarks, etc.), with each monitoring point bearing a unique identification number. Where required, provide elevation and section drawings (i.e. excavation faces, building facades, tunnel walls, etc.) and identify the elevations (North American Vertical of 1988 Datum NAVD88) at which monitoring points have been or will be installed.
 - 2. The drawings shall be updated and resubmitted in the event that monitoring points are abandoned, relocated, or additional monitoring points are added.
- I. Submit sample survey monitoring report.
- J. Submit all monitoring data directly to the Construction Manager for distribution to the Owner's Architect and Engineers and PANYNJ. Measurement data shall be submitted within 24 hours of taking each reading. All data shall be transmitted in electronic format suitable to the

Owner's Architect and Engineers and PANYNJ. Transmitted data shall show all cumulative measurements recorded as a function of time. Requisite notes shall be included to document construction activities performed during the monitoring increment.

1.6 SCHEDULING OF WORK

- A. Obtain all necessary permits and access agreements necessary prior to performance of the work.
- B. Pre-Construction Conditions Documentation of all tunnels, below grade structures, and other adjacent structures shall be completed at least 10 days, but no more than 60 days, prior to commencing earthwork and foundation construction, including but not limited to general earthwork, caisson drilling, or ground improvement.
- C. Crack gauges shall be installed during performance of the Pre-Construction Conditions Documentation as required to catalog and record the conditions of existing cracks.
- D. Seismographs shall be installed during or following performance of Pre-Construction Conditions Documentation. Seismographs shall be installed to allow for sufficient time to evaluate background vibration levels resulting from vehicular traffic.
- E. Additional crack gauges or seismographs shall be installed as required by earthwork and foundation construction activities.
- F. Survey targets, benchmarks, and settlement monitoring points shall be installed at least 10 days prior to commencing with earthwork and foundation construction, including but not limited to general earthwork, caisson drilling, or ground improvement.
- G. Additional monitoring points shall be established as required during construction.

1.7 VIBRATION, STRAIN, AND CRACK MONITORING

- A. Monitoring shall include construction vibrations, strain measurements, and periodic measurement of existing cracks, where present. Monitoring shall be performed prior to and during earthwork and foundation construction to evaluate the performance of the Contractor's activities.
- B. The field locations of seismographs and strain gages shall be coordinated with the Owner and Owner's Engineers, PANYNJ, and all other agencies having jurisdiction.
- C. The Contractor shall be responsible for all maintenance of equipment as required to maintain monitoring on a continuous basis throughout the duration of construction activities on-site.
- D. Crack monitoring data shall be transmitted to the Construction Manager for distribution to Owner, and the Owner's Architect and Engineers, PANYNJ, and all other agencies having jurisdiction.
- E. Vibration monitoring data shall be transmitted to the Construction Manager for distribution to Owner, and the Owner's Architect and Engineers, PANYNJ, and all other agencies having jurisdictions.

1.8 SURVEY MONITORING

- A. Survey monitoring shall include installation of survey monitoring points and periodic measurement of horizontal and vertical movements. The final location of survey monitoring points shall be established by the Contractor, but at a minimum shall include all areas identified on the Contract Drawings.

1.9 ADDITIONS

- A. The Contractor may elect to provide additional types of monitoring not specifically outlined herein, but shall at a minimum conform to the requirements of this Section. Where additional types of monitoring are proposed, the Contractor shall inform the Construction Manager in writing, and shall provide all information as requested by the Construction Manager and the Owner's Architect and Engineers, PANYNJ, and all other agencies having jurisdiction.
- B. The Contractor shall be solely responsible for all means and methods not specifically addressed herein.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Contractor shall submit all details and other supporting data for materials proposed for use in performing the work of this Section.
 - 1. Optical Survey Targets: Survey targets shall consist of self-adhesive reflective sheet targets suitable for adherence to wood, steel, brick, concrete, etc.
 - 2. Surface Marker 1 (SM1): A ¼-inch by 2-inch PK nail set in paved streets or sidewalks with a 1-½" diameter hub identification tag (or approved equal).
 - 3. Surface Marker 2 (SM 2): Scribe surface of monitoring point as required to maintain permanent demarcation of the location. Scribed locations shall be identified on all drawings.
 - 4. Crack Gauges: Grid crack gauges shall be as manufactured by Avongard Products Ltd (or approved equal) and shall be permanently affixed to monitoring surfaces using bolts or adhesive.
 - 5. Strain Gages: Strain gages shall be vibrating wire, Model 4000 as manufactured by Geokon Inc. (or approved equal). The Contractor shall provide all necessary power, cabling, read outs, dataloggers, mounting, protective covers, and all other ancillary equipment necessary for providing uninterrupted operation, collection, and compilation of strain gage data.
 - 6. Borehole Instruments: All borehole instruments shall be subject to approval of the Owner's Engineer(s), PANYNJ, and all other agencies having jurisdiction.

2.2 EQUIPMENT

- A. Seismographs: Blastmate Series III portable seismograph as manufactured by Instatel Inc. (or approved equal). Seismographs shall include a cellular modem (Verizon) or other means to allow for continuous real-time monitoring and alert via email and internet. Geophones and cases shall be affixed to the liner walls or other structures by means of concrete anchor bolts as manufactured by Hilti, Redhead, or equal. Portable units, mounted directly on the ground, shall be installed in accordance with manufacturers requirements.
- B. Crack Gages: Grid crack cages shall be as manufactured by Avongard Products (USA) Ltd. (or approved equal). Anchors, bolts, screws and quick setting epoxy shall be as provided by Avongard Products (or approved equal). A minimum of 100 gauges shall be procured prior to

execution of Preconstruction Conditions Documentation.

- C. Optical Survey Equipment: Optical surveying equipment shall be suitable for achieving the following accuracies and repeatability:
 - 1. Vertical: at least plus or minus 0.005 ft
 - 2. Horizontal: at least plus or minus 0.005 ft
- D. Strain Gages: Strain gages shall be vibrating wire, Model 4000 as manufactured by Geokon Inc. (or approved equal). The Contractor shall provide all necessary power, cabling, read outs, dataloggers, mounting, protective covers, and all other ancillary equipment necessary for providing uninterrupted operation, collection, and compilation of strain gage data.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Install monitoring systems prior to commencing construction activities.
- B. Install all equipment in accordance with manufacturer's recommendations.
- C. Submit drawings showing the as-built locations for all monitoring points installed, listing unique identifiers for each point, and the type of monitoring.
- D. Install additional monitoring points as required as the work progresses. Replace all locations that are lost, damaged or vandalized.
- E. Monitoring equipment shall be installed in accordance with the manufacturers recommendation and the Contractors work plan.

3.2 INSTALLATION OF CRACK GAUGES

- A. Cracks shall be photographed and mapped prior to installation of crack gages. The location of crack gages shall be made in consultation with the Owner's Engineer, PANYNJ, and all other agencies having jurisdiction.
- B. Installation shall be in accordance with the manufacturer's recommendations.
- C. Write ID # on gauge with permanent marker.
- D. After completion of installation, check that gauge parts are free to move over each other by passing a feeler gauge or thin plastic card between the two sections.
- E. After completion of installation, the as-built location and initial movement (if any) shall be recorded.
- F. Photograph crack gauge following installation and all subsequent readings.

3.3 MONITORING LOCATIONS

- A. The minimum number of locations and approximate orientation of all monitoring points shall be as outlined below:

1. Lincoln Tunnel North and Center Tubes
 - a. Survey Targets or Survey Marks: N/A
 - b. Crack Gauges: Monitoring points shall be installed at cracks observed during execution of Preconstruction Conditions Documentation and as required as the work progresses, as determined by the Contractor, and as directed the Construction Manager and Owner's Consultants, PANYNJ, and all other agencies having jurisdiction.
 - c. Strain Gauges: Strain gage arrays shall be provided per the direction of the Owner's Consultants, PANYNJ, and all other agencies having jurisdiction.
2. Other Buildings and Structures within 100 ft of proposed construction:
 - a. Survey Targets or Survey Marks: Monitoring locations shall be evenly spaced at 25 ft centers at the base and roofline of adjacent structures to determine movement in critical areas such as cracked facades, etc.
 - b. Crack Gauges: Monitoring points shall be installed at cracks observed during execution of Preconstruction Conditions Documentation and as required as the work progresses, as determined by the Contractor, and as directed the Construction Manager and Owner's Consultants, PANYNJ, and all other agencies having jurisdiction.
3. Support of Excavation Systems and Temporarily Shored Existing Below Grade Walls:
 - a. Survey Targets and Survey Marks: Install monitoring points at 30 ft centers or as indicated on the Contract Drawings. Survey targets and survey marks shall be positioned as close as possible to the ground surface and where possible should be affixed to steel bracing members or concrete faces. Additional targets or marks shall be installed for each 15 ft of exposed vertical height.
 - b. Inclinerometers: Install inclinometers as shown on the Contract Drawings.

3.4 BASELINE MEASUREMENTS

- A. Baseline measurements for all monitoring shall be established prior to execution of construction activities on-site.
- B. Establishment of trigger values for vibration monitoring shall consider background vibration levels. Background levels shall be recorded prior to commencing construction activities to determine ambient levels of vibration resulting from vehicular traffic. Trigger values for seismographs shall be maintained at 0.2 inches per second above that of the peak background levels recorded.

3.5 FREQUENCY OF MONITORING

- A. At a minimum, survey monitoring shall be performed twice weekly during excavation. The frequency of monitoring shall be increased or decreased as directed by the Construction Manager and the Owner's Consultants, PANYNJ, and all other agencies having jurisdiction pending the results of recorded monitoring data trends.
- B. At a minimum, crack gauges shall be measured on a weekly basis. The frequency of monitoring shall be increased as directed by the Construction Manager, the Owner's Consultants, PANYNJ, and all other agencies having jurisdiction.
- C. Vibration and Strain Gage Monitoring shall be performed on a continuous basis (24/7).

3.6 DATA FORMAT AND TRANSMITTAL

- A. Data shall be transmitted in an electronic format (MS Excel) and shall include all cumulative readings taken. Data shall include baseline values and offset measurements. Provide coordinates for readings, as requested. Include the following information for all readings:
1. Instrument Type
 2. Date and time of readings
 3. Name of observer
 4. Monitoring Point ID #
 5. Readings
 6. Incremental and cumulative deviation of readings
 7. Weather condition and temperature
 8. Remark of any visual observations of conditions and construction activities
- B. Transmit all data to the Construction Manager for distribution to the Owner's Architect and Engineers, PANYNJ, and all other agencies having jurisdiction within 2 days of taking measurements. Contact Construction Manager, the Owner's Engineers, PANYNJ, and all other agencies having jurisdiction immediately in the event that values exceed threshold values specified herein.

3.7 REVIEW AND LIMIT VALUES

- A. The following criteria shall be used to evaluate the necessity for modifying or ceasing construction activities. Where a work stoppage is required, construction activities shall not continue until adequate measures are in place to ensure stability of adjacent structures, excavation support, or utilities. Where movements in excess of the Review level are detected the frequency of data collection shall be increased to once daily, or as directed by the Construction Manager, Owners Consultants, PANYNJ, and all other agencies having jurisdiction. The criteria provided shall not relieve the Contractor of any responsibility with respect to damage incurred by any structures or utilities.
1. Vibration Monitoring: Peak particle velocities
 - a. Review Level
 - i) 0.5-inches per second for Lincoln Tunnel tubes.
 - ii) 0.5-inches per second, all other tunnels, buildings, and other structures.
 - b. Limit Level
 - i) 1.0-inches per second for Lincoln Tunnel tubes.
 - ii) 2.0-inches per second, all other tunnels, buildings, and other structures.
 2. Crack Gauge Monitoring: Cumulative movement in any direction
 - a. Review Level – 1/16th inch in any direction
 - b. Limit Level – 1/8th inch in any direction
 3. Survey Monitoring:
 - a. Review Level:
 - i) Vertical movement of buildings or other structures: 3/8-inch total movement, or 3/16-inch between two consecutive readings.
 - ii) Horizontal movement of building or other surface structures: 3/16-inch total movement, or 1/8-inch between two consecutive readings
 - b. Limit Level:
 - i) Vertical movement of buildings or other structures: ½-inch total movement, or 1/4-inch between two consecutive readings.

- ii) Horizontal movement of building or other surface structures: 1/4-inch total movement, or 3/16-inch between two consecutive readings
- 4. Strain Gage Monitoring: Cumulative movement in excess of ambient conditions corrected for any temperature effects.
 - a. Review Level – 150 microstrains
 - b. Limit Level – 500 microstrains

3.8 ACTION ITEMS

- A. Any movement or vibration exceeding the criteria outlined in 3.7 above shall be reported immediately to the Construction Manager, the Owner, the Owner's Consultants, PANYNJ, and all other agencies having jurisdiction. Work in the immediate area shall be suspended, unless directed otherwise by the Owner's Engineers, PANYNJ, or NYCDOT. Corrective measures to ensure integrity and stability of adjacent structures shall be the responsibility of the Contractor.
- B. In the event that a Review Level is reached the following shall be required:
 - 1. PANYNJ and all other required governing agencies shall be notified of the exceedance.
 - 2. The exceedance shall be investigated to identify potential correlation to construction activities.
 - 3. Contractor shall meet with the Owner, Owner's Consultants, PANYNJ, and all other agencies having jurisdiction to discuss the need for a response to mitigate the potential for readings exceeding the Review Level.
 - 4. Where required, submit a detailed plan of action to mitigate the potential for additional movement or vibration.
 - 5. Install additional instruments as required evaluate the need for any action necessary to prevent reaching the Limit Level.
- C. In the event that a Limit Level is reached the following shall be required:
 - 1. PANYNJ and all other required governing agencies shall be notified of the exceedance.
 - 2. The exceedance shall be investigated to identify potential correlation to construction activities.
 - 3. Foundation construction shall be suspended and the structures shall be inspected by the Owner, Owner's Consultants, the Contractors Engineer, and any governing agencies including, but not limited to PANYNJ, NYCDOT, and NYCDOB.
 - 4. The Contractor shall take all actions necessary to protect structures and utilities and maintain integrity and stability of said structures and utilities. The Contractor shall be solely responsible for providing all necessary services in conjunction with developing and applying remedial measures including any required engineering design.
- D. Should vibration levels exceed the Limit Level, construction activities shall be suspended. The adjacent structures shall be visually inspected, and construction methods modified as necessary to maintain vibrations within acceptable levels.
- E. Corrective actions requiring repair of any structure shall be the sole responsibility of the Contractor. Repairs shall be at no cost to the Owner, PANYNJ, and all other agencies and entities.

3.9 WASTE MANAGEMENT

- A. Separate and dispose of waste in accordance with the Project's Waste Management Plan.

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SECTION 312315
GROUNDWATER CONTROL

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Work governed by this section, as shown or specified shall be in accordance with the requirements of the Contract Documents and the New York City Building Code (2014 edition).

1.2 SECTION INCLUDES

- A. Work of this section consists of furnishing and operating ground water control during construction, and includes but is not limited to the following:
 - 1. Furnishing all labor, materials, tools, and equipment for the design, installation, operation, and maintenance of systems to control groundwater throughout the duration of excavation and foundation construction.
 - 2. Furnish all labor, materials, and equipment necessary for monitoring of groundwater levels, pump rates, and discharge volumes for all construction dewatering.
 - 3. Collect groundwater samples required for obtaining all necessary regulatory permits pertaining to groundwater control.
 - 4. Obtain all necessary permits required for execution of the work of this Section.

1.3 RELATED SECTIONS

- A. Related Documents and Sections: Examine Contract Documents for requirements that directly affect or are affected by work of this Section. A list of those Documents and Sections include, but is not limited to the following:
 - 1. Earthwork – Section 310000
 - 2. Monitoring of Structures and Utilities – Section 310901
 - 3. Excavation Support and Protection – Section 315000

1.4 STANDARDS AND REFERENCES

- A. Geotechnical Memorandum: The Geotechnical Engineer engaged by the Owner, has prepared a memorandum entitled Geotechnical Engineering Evaluation – Jacob Javits Convention Center – Transformer Yard Relocation, dated 1 April 2016. Copies of this report shall be available to the Contractor, upon request. Boring and other in situ test logs are made available to the Contractor for information only. Conditions are not intended as representations or warranties of accuracy or continuity between borings. The Owner will not be responsible for interpretation conclusions drawn from this data by the Contractor.
- B. All work shall comply with requirements of the New York City Building Code, New York State Department of Labor, Occupational Safety and Health Administration (OSHA), New York State Department of Health (NYSDOH), New York State Department of Environmental Conservation (NYSDEC), New York City Department of Environmental Protection

(NYCDEP), New York State Department of Transportation (NYSDOT), and with applicable requirements of all other authorities having jurisdiction.

- C. The Contractor shall procure and pay for all permits and licenses required to complete the work of this Section, including fees for disposal of groundwater into NYC sewers.
- D. Regulatory Requirements and Reference Standards
 - 1. The Contractor shall comply with all the laws, ordinances, codes, rules and regulations of the Federal, State and Local authorities having jurisdiction over any of the work specified herein. The Contractor shall meet NYCDEP Limitations for Effluent, NYSDEC and EPA limitations for discharge into any surface water bodies, federal EPA and State Department of Transportation regulations for shipping of regulated substances to off-site disposal facilities, and meet all regulatory requirements imposed by the Treatment, Storage and Disposal Facility. Regulations pertaining to the transport and disposal of regulated substances/materials include, but are not limited to the following:
 - a. Department of Transportation 49 CFR 172 through 179
 - b. Department of Transportation 49 CFR 387 (46 FR 30974)
 - c. Department of Transportation DOT-E 8876
 - d. Environmental Protection Agency 40 CFR 136 (41 FR 52779)
 - e. Environmental Protection Agency 40 CFR 262 and 761
 - f. Resource Conservation and Recovery Act (RCRA)
 - g. NYCDEC, Rules of the City of New York (RCNY), Title 15, Chapter 19, Use of the Public Sewers.
 - h. NYCDEP, Limitations for Effluent to Sanitary or Combined Sewers.
 - 1. NYCDEP, Dewatering Sampling and Testing Requirements.
 - 2. Any transporter of contaminated/hazardous materials shall be licensed in the state in which handling and transportation shall take place in accordance with all applicable regulations.
 - 3. Comply with OSHA (Occupational Safety and Health Administration) Standards and Regulations contained in Title 29 CFR Part 1910.120 "Hazardous Waste Operations and Emergency Response."
 - 4. Where reference is made to one of the above standards the revision in effect at the time of the bid opening shall apply.
- E. Nothing in clause 1.4 shall relieve Subcontractor of his responsibility of providing a higher standard than the relevant Code or Standard, in order to comply with this Specification.

1.5 QUALITY CONTROL

- A. The Contractor shall evaluate the groundwater conditions resulting from excavation of soils. The Contractor shall evaluate recharge potential of groundwater seepage including, but not limited to, pumping tests.
- B. Groundwater control systems shall be capable of operating on a continuous basis throughout excavation and foundation construction. The Contractor shall provide adequate backup systems in the event of equipment failure or malfunction.
- C. The Contractor's groundwater control system shall be capable of maintaining dry stable subgrade conditions.

- D. The Contractor's groundwater control system shall consider methods and measures necessary to reduce inflow through soils or fissures in rock including, but not limited to, grouting and installation of pumping wells in an effort to minimize daily discharge quantities.
- E. The Contractor's work shall not result in damage to adjacent property. Protect adjacent property from the effects of groundwater lowering, as required.
- F. The Contractor shall record groundwater monitoring data.
- G. The Contractor shall meet minimum qualifications as defined in Section 1.6.

1.6 QUALIFICATIONS

- A. The Contractor or Subcontractor performing the work of this Section shall be one specializing in groundwater control including methods to reduce inflow and in the installation and operation of groundwater control equipment. Submit evidence substantiating a minimum of 5 years satisfactory experience in the installation and maintenance of such systems, with at least 5 projects of similar size and nature. The Contractor shall designate a superintendent responsible for oversight of all groundwater control operations.
- B. The Contractor shall retain the services of a Professional Engineer, licensed in the State of New York. The Professional Engineer shall design the groundwater control system. The Professional Engineer shall have not less than ten (10) years of field and analytical experience with similar groundwater control operations.

1.7 SUBMITTALS

- A. Unless otherwise indicated, transmit all submittals to the Construction Manager for review. Review of submittals by the Construction Manager, Owner's Architect, and Owner's Engineers is required before proceeding with ordering, fabricating, or any work of this Section. Submittal review will be of concept only and shall not in any way diminish or limit Contractor's responsibility for the quality and performance of his work. All material orders shall be the sole responsibility of the Contractor.
- B. The Contractor shall submit the Professional Engineer's calculations, plans, and details of the groundwater control system to the Construction Manager for review by the Owner's Geotechnical and Structural Engineers.
- C. The Contractor shall submit a method statement for the evaluation of soil and rock permeability, and any field testing to evaluate groundwater recharge.
- D. Submit log of soils and rock encountered during drilling of any observation or test wells installed of the Contractor's own accord. Drilling logs should be submitted within 2 days of completion of the installation.
- E. Submit field pumping test results within 2 days of completion of field tests, as required.
- F. Submit shop drawings and manufacturer's literature, and show and describe proposed groundwater control system, general arrangement procedures to be used, method of installation, materials, equipment, methods of treatment and disposal of pumped water, emergency action plans, and procedures for deactivating the system. Proposed procedures and methods of disposal of water shall prevent damage to existing structures, roadways and

utilities. Shop drawings and literature should be submitted a minimum of 20 working days prior to mobilization.

- G. Submit working drawings and details, show observation wells and method of maintaining for any additional monitoring undertaken by the Contractor. Working drawings and details should be submitted a minimum of 20 working days prior to mobilization.
- H. Submit any related sheeting and bracing shop drawings in accordance with the requirements of Section 31 50 00.
- I. Submit approved water disposal discharge permit (if applicable) and evidence of applicable fee payment a minimum of 10 days prior to start of pumping.

1.8 PROJECT CONDITIONS

- A. Subsurface Conditions - The subsurface conditions within the development area are generally characterized by uncontrolled fill underlain by consecutive layers of slightly organic silty clay, glacial till, and finally bedrock; a thin mantle of decomposed rock may be present above competent bedrock at some locations. Groundwater is anticipated to be tidally influenced within the project site, and is estimated to fluctuate between elevations el +2 and el -3 ft. Additional details pertaining to the subsurface conditions are presented in the memorandum entitle Geotechnical Engineering Evaluation – Jacob Javits Convention Center – Transformer Yard Relocation, prepared by Langan Engineering, Environmental, Surveying and Landscape Architecture, D.P.C., dated 1 April 2016. This information is provided for Contractor's information only.
- B. The project site is underlain by three vehicular tunnels, referenced as the Lincoln Tunnel North Tube, Lincoln Tunnel Center Tube, and Lincoln Tunnel South Tube. All Lincoln Tunnel facilities are operated by the Port Authority of New York and New Jersey (PANYNJ).
- C. Boring logs are available for the Contractor's review. The Owner makes no predictions or representations regarding the character or extent of soil, rock, or other subsurface conditions to be encountered during the work. The Contractor shall make his own deductions of the subsurface conditions which may affect the methods or cost of construction of the work hereunder, and he agrees that he will make no claims for damages or compensations, except as are provided under the agreement, should he find conditions during the progress of the work different from those as calculated or anticipated by him. Additional borings and other exploratory operations, not included in the Contract Documents, may be performed by Contractor, at the Contractor's option and following the Owner's approval. No reimbursement or change in the Contract Sum will be authorized for such additional exploration undertaken by the Contractor.
- D. The Contractor, by careful examination, shall inform himself as to the nature and location of the work; the conformation of the ground, the nature of the subsurface conditions; the locations of the groundwater table; the character, quality and quantity of the materials to be encountered; the character of the equipment and facilities needed prior to and during the execution of the work; and all other matters which can be in any way effect the work.
- E. The Contractor shall be held to have visited the site and to have familiarized himself with the existing conditions of adjoining properties, utilities, and buildings.

- F. The Contractor shall investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to, ingress and egress of the site of the work. The Contractor shall conform to all New York City and State, and Federal regulations in regard to the transportation of materials to and from and at the job site and shall secure in advance such permits as may be required.

1.9 LINCOLN TUNNEL

- A. The Lincoln Tunnel (North and Center Tube) and other structures shall be monitored during construction activities as specified in Section 310901.
- B. Per Section 310901, the Contractor shall photograph and map all cracks in the Lincoln Tunnel and other structures to remain that are within 100 ft of the construction prior to execution of any excavation activities.

1.10 EXISTING UTILITIES

- A. Existing Utilities: Locate existing underground utilities within and beyond the areas of work. If utilities are indicated to remain in place, provide adequate means of support and protection during the work. Utilities scheduled for relocation are identified in the Contract Documents.
 - 1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
 - 2. Do not interrupt existing utilities serving facilities occupied by Owner or others, during occupied hours, except when permitted in writing by the Construction Manager and then only after acceptable temporary utility services have been provided. Provide minimum of 48-hour notice to the Construction Manager, and receive written notice to proceed before interrupting any utility.
 - 3. Where necessary, demolish and completely remove existing underground utilities indicated to be removed from the site. Coordinate with utility companies for shutoff of services if lines are active.
 - 4. Examine drawings to determine sequence of operations, and relation to work of other trades. Start of work will signify acceptance of field conditions and will acknowledge coordination with other trades.

1.11 PERMITS

- A. Apply for and obtain required permits from City and State Departments and other agencies having jurisdiction.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Contractor shall submit all details and other supporting data for materials proposed for use in performing groundwater control operations. All proposed materials shall be of a type acceptable to the Owner's Engineer.

- B. Equipment proposed for use in groundwater control operations shall be of a type acceptable to the Owner's Engineer and shall be installed in such a manner that it does not interfere with the operations of work specified under other Sections.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Install groundwater monitoring wells as shown on the Contract Drawings or as approved by the Owner's Engineer.
- B. Coordinate location of wells, header pipes and manifolds as required.
- C. Collect and provide all necessary laboratory testing of groundwater samples for the purpose of obtaining regulatory permits.
- D. Perform an evaluation of the groundwater conditions including elevations, permeability rates, and potential for groundwater fluctuations. The Contractor's design shall account for local geology and shall be capable of effectively controlling groundwater as necessary to achieve the proposed subgrade elevations. The Contractor's groundwater control system shall be capable of maintaining the site in the dry and maintaining stability of subgrades, excavations, and slopes.
- E. The Contractor shall take any measures necessary to decrease groundwater flow, including but not limited to grouting, prior to excavation proceeding. The efficacy of all methods to reduce groundwater inflow shall be evaluated in the field based on observed conditions.
- F. The groundwater control system shall be installed for the purpose of dewatering the below grade excavation to a depth of at least 2 ft below the bottom of proposed excavation, or as required to provide a "dry" stable construction site.
- G. The groundwater control system must be kept in full operation as required by the Owner's Engineer until adequate measures are in place to resist hydrostatic pressure. This may include the period of excavation, foundation and waterproofing installation.
- H. The Contractor shall monitor and report groundwater levels outside the excavation and shall provide all monitoring results to the Owner's Engineer for review.

3.2 CLEANING/PROTECTION/ADJUSTMENT

- A. The Contractor shall patch, repair, or replace any existing improvements, or work of other Sections, damaged or cut by work of this Section, subject to approval by the Owner's Architect.
- B. At termination of activities, the Contractor shall remove from the site, all equipment and installations of the groundwater control system.

3.3 DRAINAGE AND PUMPING

- A. It is the responsibility of the Contractor to furnish, operate and maintain sufficient drainage and pumping facilities to control groundwater within the site so that the excavation can proceed while maintaining stability of excavation support and stabilization systems.
- B. Typically, the groundwater must be depressed at all times to at least 2 feet below the excavated ground surface, or as required to provide a stable excavation.
- C. Prior to the start of excavation, the Contractor shall prepare and submit to the Construction Manager his groundwater control plans including procedures for initial pump tests and shall not proceed until they are approved. Subsequently, the groundwater control plans are to be adjusted as necessary to accomplish the above listed goals and other requirements in this section.
- D. Groundwater monitoring shall be performed to monitor water levels inside and outside of the excavation. Contractor shall coordinate with the Owner's Engineer regarding the locations of monitoring installations and shall provide suitable site access for maintenance of monitoring locations. The Contractor shall record water levels on a daily basis and shall record pump flow rates and cumulative daily discharge volumes. All groundwater monitoring records shall be submitted to the Construction Manager and Owner's Engineer within 24-hours of taking readings.
- E. The Contractor shall protect all monitoring locations. Contractor shall be responsible for all costs incurred to repair or replace monitoring equipment damaged as a result of the Contractor's activities.
- F. Discharge of the pumped water must be performed in strict accordance with local regulations and directives of the local authorities and the Erosion Control Plan.
- G. Pumped water must be held in a settling tank prior to discharge to NYCDEP sewers. Dewatering manufacturer's system must be capable of removing suspended solids such that discharge does not exceed NYCDEP limit of 350 ppm total suspended solids (TSS).
- H. The dewatering system shall be installed and operated in such a manner as to avoid the movement of fines or loss of ground from below the bearing level and shall not influence the stability of surrounding areas. Insure that no fines are removed by the dewatering system. The collector shall be placed at a location approved by the Engineer.

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SECTION 312500

EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Work of this section, as shown or specified, shall provide Erosion and Sedimentation Controls in accordance with the requirements of the Contract Documents. The Contractor must accept the site as-is and shall be deemed to have inspected the site and reviewed all Contract Documents prior to submitting a bid.
- B. LEED – General Requirements
 - 1. The Owner has made a decision that this project will reflect the values of a sustainable or 'Green Building' as defined by the US Green Building Council's LEED Rating System Version 3.0 for New Construction (NC), 2009 edition. The Contractor is required to establish practices and procedures designed to meet the project's environmental goals as indicated in the Specifications and other Contract Documents, which are intended to contribute to the achievement of a minimum LEED Silver Rating under the LEED NC v3.0 Program. These requirements, which may have an impact on some or all of the work of this Specification, include the following:
 - a. Implementation of a Construction Waste Management Plan (recycling)
 - b. Implementation of a Construction Indoor Air Quality Management Plan
 - c. Use of salvaged, reusable or refurbished materials.
 - d. Use of materials which contain recycled-content.
 - e. Use of regionally manufactured materials.
 - f. Use of materials that have been regionally extracted, harvested and/or recovered
 - g. Use of rapidly renewable materials
 - h. Use of certified wood products.
 - i) Use of low-emitting, environmentally benign materials
 - i. Implementation of a Construction Activity Pollution Prevention Plan
 - j. Water and energy efficiency requirements
 - k. Use of materials that reduce the heat island effect
 - l. Building reuse
 - 2. The Contractor is required to ensure that procedures relating to the achievement of the outlined goals, as defined in this Specification and related Contract Documents, are implemented throughout all phases of the work. Note that while proposed substitutions to specified products or other changes to the work introduced by the Contractor or the Sub-Contractors will be considered, any such substitution must meet or exceed all stated environmental (Green Building) criteria.

1.2 WORK INCLUDED

- A. Overall work under this Contract shall include all labor, materials, equipment, supervision, coordination efforts, permitting costs, certificate costs, services, filing fees, testing costs, security, insurance and all other associated or related items specified herein that are necessary and are required to complete the Work. Work elements shall include:
 - 1. Installing and maintaining temporary and permanent erosion control systems.

2. Requirements for the development of a LEED Erosion and Sedimentation Control Plan (alternately known as the ESC Plan).
3. Procedures for documenting compliance with LEED for New Construction Version 3.0, 2009 Edition - Sustainable Sites Prerequisite 1 (SSp1): Construction Activity Pollution Prevention.

1.3 PROJECT CONDITIONS

- A. Work of this section, as shown or specified, shall provide erosion and sediment control in accordance with the requirements of the contract documents. The Contractor must accept the site as is and shall be deemed to have inspected the site and reviewed all Contract Documents prior to submitting a bid.

1.4 CONTRACTOR RESPONSIBILITIES

- A. Contractor is responsible for coordinating this work with other trades on-site.
- B. All work to be performed in accordance with the latest NYS DEC standards and specifications for erosion and sediment control and meet EPA 832 regulations.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, and handle materials as recommended by the Department of Environmental Conservation to protect from further contaminating site soils.

1.6 PERMITS AND APPROVALS

- A. Contractor shall prepare and obtain all required permits prior to construction unless otherwise directed by Owner. Copies of all permits shall be supplied to the Owner prior to the commencement of work authorized by the permit.
- B. Connections with existing facilities shall be performed in accordance with the requirements of the Owner of the facility. The Contractor shall be required to comply with all such requirements, including securing all permits, and payment of all permit and/or connection fees.

1.7 RELATED SECTIONS AND DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 00 and 01 Specification Sections.
- B. Erosion and Sediment Control measures shall comply with the requirements of the Contract Drawings
- C. Project Specifications:
 1. Section 021000 – Protection of Existing Utilities
 2. Section 310000 – Earthwork
 3. Section 319000 – Trench Excavation and Backfill
- D. Project Documents:
 1. Refer to the requirements of the NYS DEC Brownfields Cleanup Program.
 2. Contract Documents and Contract Drawings

E. LEED Summary

1. Prepare a site-specific LEED ESC Plan.
2. Document that the implementation of the LEED ESC Plan is continuous throughout the duration of construction.
3. LEED for New Construction Version 3.0, 2009 Edition- SSp1 requires the preparation and documentation of an ESC Plan for all LEED projects, regardless of project site size or lot coverage conditions

1.8 REFERENCE STANDARDS

- A. Unless more restrictive criteria or differing requirements are explicitly stated in the Specifications, or mandated by governing codes or regulations, the recommendations, suggestions, and requirements described in the referenced standards shall be deemed mandatory and applicable to the Work.
- B. The latest edition, as of the date of the executed construction contract, of referenced standards listed below applies to this contract.
1. EPA Standard 832/R-92-005, Chapter 3 Sediment and Erosion Control
 2. NYSDEC Standards and Specifications for Erosion and Sediment Control 2012, or latest revision.
 3. EPA 2003 Construction General Permit, outlining a set of provisions construction operations must follow to comply with NPDES stormwater regulations, regardless of project site size.
 4. All state and local standards and codes applicable to the Project.
 5. USGBC LEED 2009 for New Construction Reference Guide for Green Building and Construction.
- C. Acronyms and Abbreviations
1. BMP: Best management Practice.
 2. EPA: United States Environmental Protection Agency.
 3. ESC: Erosion and Sedimentation Control.
 4. GBCI: Green Building Certification Institute.
 5. USGBC: United States Green Building Council.
 6. LEED: Leadership in Energy and Environmental Design.
 7. NC: The USGBC LEED for New Construction program.
 8. NPDES: National Pollutant Discharge Elimination System.
- D. Definitions:
1. Controls: Measures employed to minimize erosion and sedimentation due to construction activities.
 2. Erosion: A natural process involving water, wind or ice that results in the loosening and removal of soil and rock. Human activities, such as site disturbance during construction, accelerate the natural process.
 3. On-site Pollution: Sources of site pollution include, but are not limited to: oil dripping from vehicles; improperly disposed material scraps and delivery wrapping; concrete wash-water; lunch trash from workers on the site.
 4. LEED Soil Erosion and Sedimentation Control Plan: A written plan and legible site map describing an overall project-specific Erosion and Sedimentation Control program, covering all construction and demolition related activities on site in accordance with the requirements of LEED for New Construction Version 3.0, 2009 Edition - SSp1.
 5. Sedimentation: A natural process involving water, wind or ice that results in the deposit of soil and rock. Sedimentation during construction limits the passage of water,

potentially causing: backflow; flooding of streets; overflow of downstream drainage; damage to off-site locations due to deposit of sedimentation.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. The Contractor shall protect adjacent properties and waterways from erosion and sediment damage throughout construction in accordance with NYCDEP and NYSDEC.
- B. Discharge from dewatering operations shall not be directed to public sewers without prior approval from the NYC DEP.

1.10 QUALITY ASSURANCE

- A. Perform work specified herein and shown on the Contract Drawings in compliance with applicable requirements of the New York City Building Code and requirements of all state and local authorities, and utility companies having jurisdiction.

1.11 EXTRA MATERIALS

- A. Extra materials should be kept on site at all times. Should any erosion and sediment controls be deemed deficient, the contractor must repair and/or replace

1.12 LEED EROSION AND SEDIMENTATION CONTROL PLAN OBJECTIVES

- A. Create and implement an ESC Plan for all construction activities associated with the project.
- B. LEED Project erosion and sedimentation control objectives include (but are not limited to):
 - 1. Minimize unnecessary soil disturbance and dust generation on site.
 - 2. Inhibit dust migration from the construction site to adjacent properties without excessive use of water.
 - 3. Remove dirt from vehicles leaving the site.
 - 4. Minimize on-site pollution due to construction activity.
 - 5. Prevent concrete washout from filling stormwater catch basins.
 - 6. Minimize stormwater contamination from on-site activities.
 - 7. Inhibit or slow the flow of stormwater runoff across the site.
 - 8. Remove sediment from onsite stormwater runoff before it leaves the site.
- C. Before site work begins, prepare and submit a LEED ESC Plan demonstrating how the Project will achieve LEED for New Construction SSp1.
- D. As construction progresses, update the ESC plan to reflect actual site conditions processes.
- E. All ESC Measures must be maintained in operating condition throughout the construction process.

1.13 SUBMITTAL FOR REVIEW: DETAILED LEED ESC PLAN REQUIREMENTS

The contractor shall submit the following for review:

- A. The ESC Plan must be responsive specific to the conditions of this Project.
- B. Provide a LEED ESC Plan including at a minimum:
 - 1. The LEED ESC Plan Team:

- a. The person(s) with the operational control over the Project ESC measures, including the ability to make modifications in the type and implementation of the measures.
 - b. The person(s) with day-to-day control over the ESC Measures necessary to ensure compliance with the ESC Plan requirements.
 - c. The person(s) responsible for performing, coordinating and providing required LEED documentation of the LEED ESC Plan implementation.
2. Written section listing:
 - a. All potential sources of pollution which may reasonably be expected to affect the quality of storm water discharge from the construction site.
 - b. Practices to be used to reduce pollutants in storm water discharge from the construction site.
 - c. The sequence and timing of activities that disturb soil on the site.
3. A legible map of the site area over which the LEED ESC Plan will apply and for which this Project will be responsible for ESC Measures showing:
 - a. Direction of anticipated stormwater flow.
 - b. Areas of soil that to be disturbed and to remain unchanged.
 - c. Locations of structural and non-structural BMPs.
 - d. Location of truck wash-off area.
 - e. Location of perimeter dust control fencing.
 - f. Locations where stabilization practices are likely to occur.
 - g. Areas where stabilization has already been achieved.

1.14 SUBMITTAL FOR REVIEW: LEED ESC PLAN DOCUMENTATION

The contractor shall submit the following for review:

- A. At a minimum demonstrate compliance with the 2003 EPA General Permit. Where local standards or codes are more stringent, the more stringent measures must be documented. Minimum documentation includes:
 1. Completed inspection forms documenting periodic inspections with corrective actions noted. Sample forms are attached as Appendix A.
 2. A copy of the final LEED ESC Plan, including written and graphic portions.
 3. A minimum of 24 date-stamped photographs taken over the course of the construction period and labeled with the ESC Measure illustrated.
 4. Completion of the LEED On-line Template for LEED for New Construction Version 3.0, 2009 Edition – SSp1.
 5. If local standards or regulations have been followed in place of the NPDES permits measures, provide an explanation of to how the local requirements are at least as stringent as the NPDES requirements.

PART 2 - MATERIALS

- A. Silt Fence
 1. Silt fence posts: shall be wood, steel, or an approved synthetic material, with a minimum length of three feet. Hardwood posts shall have a minimum cross sectional area of three square inches and steel posts of standard T and U sections weighing not less than 1.00 pounds per linear foot.
 2. Silt fence fabric: the fabric shall meet or exceed the following specifications:

Physical Property	Units	Test Method	Minimum Requirement
filtering efficiency	%	ASTM 5141	75% (minimum)
grab tensile strength	(lbs.)	ASTM D4632	100
elongation @ failure	%	ASTM D4632	15 %
Mullen burst strength	psi	ASTM D3786	250
puncture strength	lbs	ASTM 4833	50
apparent opening size	mm	ASTM D4751	no greater than 0.90 mm and no less than 0.60 mm
flow rate	Gal/ft ² /min	ASTM D4491	0.2
permittivity	Sec ⁻¹	ASTM D4491	0.05 (minimum)
ultraviolet radiation stability	%	ASTM-D4355	70% after 500 hours of exposure (minimum)

3. Wire Fence: Minimum 14 ga. with a maximum six inch mesh opening
 4. Prefabricated silt fence units: Mutual MISF 1776, Mirafi 100X, Stablenka T140N or approved equal
 5. Non-woven filter fabric fence - Mirafi 100x or approved substitute
- B. Catch basin and trench drain erosion control – as shown on contract documents
- C. Catch Basin Silt Sack
1. The silt sack shall be an open-top geotextile bag that can be suspended from a catch basin grate. The suspended solids are allowed to settle out of the slowed flow and are captured by the sack prior to entering the inlet. There shall be two dump straps attached at the bottom of the sack to facilitate the emptying and cleaning of the sack and there shall be two lifting hoops as an integral part of the system to be used to lift the sack from the catch basin.
- D. The geotextile sack shall be constructed with high-tenacity, monofilament, polypropylene yarns which are woven into a stable network such that the yarns retain their relative position. The geotextile shall be resistant to ultraviolet degradation and to biological and chemical environments normally found in soils. Acceptable materials are “Dandy Sack™” Mirafi, “Silt Sack®” The BMP Store or “StormSok” Fabco or equivalent Orange Construction Fencing (placement location to be coordinated with the owner)
- E. Polyethylene Sheeting (minimum thickness 6 mil) for stockpiles
- F. Quick growing grasses such as wheat, rye or oats

- G. Bale stakes (shall be a minimum of 4 feet in length and 1" in width)
- H. Fibrous blankets by North American Green SC150BN, biodegradable
- I. Temporary mulches such as loose hay, straw, netting, wood cellulose or agricultural silage
- J. Filter Stone: AASHTO No. 57 crushed stone
- K. Stabilized Construction Access
 - 1. Stone aggregate: 1-inch to 4-inch clean stone or reclaimed or recycled concrete
 - 2. Geotextile: woven or non-woven fabric consisting only of continuous chain polymeric filaments or yarns of polyester. The fabric shall be inert to commonly encountered chemicals, hydro-carbons, mildew, rot resistant, and conform to the fabric properties shown:

PROPERTY	UNIT	TEST METHOD	Light duty*	Heavy duty** Haul Roads Rough Graded
Grab Tensile Strength	lbs.	ASTM D1682	200	220
Elongation at Failure	%	ASTM D1682	50	60
Puncture Strength	lbs.	ASTM D751	40	125
Mullen Burst Strength	PSI	ASTM D3786	190	430
Equivalent Opening Size		US Std. Sieve CW-02215	40-80	40-80
Aggregate Depth	inches	-	6	10

- a. Light duty roads: Area sites that have been graded to subgrade and where most travel would be single axle vehicles and an occasional multi-axle truck. Acceptable materials are Trevira Spunbound 1115, Mirafi 100X, Typar 3401, or approved substitute.
- b. Heavy duty roads: Area sites with only rough grading, and where most travel would be multi-axle vehicles. Acceptable materials are Trevira Spunbound 1135, Mirafi 600X or equivalent.

PART 3 EXECUTION

3.1 PREPARATION

- A. Review site conditions with Owner and Contract Drawings prior to the commencement of earth moving activities/excavation.
- B. Notify the Construction Manager and Owner prior to the commencement of Work. Any proposed deviations from the specifications must be submitted to the Engineer in writing 72 hours prior to commencing work.

- C. By beginning Work, the site conditions are accepted and corrections to encountered unsatisfactory conditions will occur at no additional cost to the Owner.
- D. All erosion and sediment controls shall be installed prior to land disturbing activities or as necessary to control erosion from land disturbing activities. Comply with all applicable standards for Soil Erosion and Sediment Control in New York State.
- E. The Contractor will be responsible for the proper construction, stabilization, and maintenance of all temporary and permanent erosion and sedimentation control measures and related items.
- F. All erosion and sediment controls shall remain in place until the tributary area to the control is completely stabilized. All controls shall be checked daily and after storm events to ensure they are in proper working order.
- G. The Contractor shall replace at no extra payment any control device that is not functioning properly as directed by contracting officer or authorized regulatory personnel.
- H. The Contractor shall implement dust control measures during construction. Contractor to minimize dust clouds by watering down construction area or other approved methods as required.
- I. Inlet protection shall be installed on all new catch basins immediately upon construction.
- J. All construction vehicles hauling materials either into or out of the construction area shall have a secured tarp over materials to prevent sediment pollution of public roadways.
- K. Contractor shall provide a rock construction entrance and construction vehicle wash down area at all egress points from un-stabilized areas to prevent tracking mud onto public sidewalks and roadways.
- L. Any storm water that must be disposed of off-site shall be discharged to a combined sewer with a NYCDEP permit (Contractor to obtain permit). Contractor is prohibited from discharging dewatering devices to city sewers without prior NYCDEP approval.
- M. Contractor shall field verify quantity of all drains and install protection for each.

3.2 MAINTENANCE AND REMOVALS

- A. Maintain erosion and sediment controls in good working order, using best management practices.
- B. Soil sediment removed from any temporary control measure during regular maintenance shall be treated as site earthwork and returned to site or disposed of per contract documents.
- C. Erosion and sediment controls shall not be removed until the site has been adequately stabilized, or as otherwise directed by the Engineer.
- D. Stabilization shall be defined as a uniform, 70% vegetative cover for landscaped areas. Stabilization shall be defined as installation of stone subbase in pavement and slab areas.

3.3 STABILIZED CONSTRUCTION ACCESS – INSTALLATION AND MAINTANANCE

- A. Install stabilized construction entrances at any point where traffic will be entering or leaving a construction site to or from a public-right-of-way, street, alley, sidewalk, or parking area.
- B. Stabilized construction entrance stone thickness shall be a minimum of 6 inches.
- C. The stabilized construction access shall be twelve feet minimum but not less than the full width of points of where ingress or egress occurs. The stabilized construction access shall be a minimum of 24 feet if there is only one entrance to the site.
- D. The length of the stabilized construction access shall be 50-feet minimum.
- E. Geotextile shall be placed over the entire area to be covered with aggregate.
- F. Piping of surface water under entrance shall be provided as required. If piping is impossible, a mountable berm with 5:1 slopes will be permitted.
- G. The entrance shall be maintained in a condition which will prevent tracking of sediment onto public-right-of-way or streets. This may require periodic top dressing with additional aggregate. All sediment spilled, dropped, or washed onto public right-of-way must be removed immediately.
- H. When necessary, wheels must be cleaned to remove sediment prior to entrance onto public right-of-way. When washing is required, it shall be done on an area stabilized with aggregate, which drains into an approved sediment trapping device. All sediment shall be prevented from entering storm drains, ditches and watercourses.

3.4 INLET PROTECTION SILT SACK– INSTALLATION AND MAINTENANCE

- A. Silt sacks shall be installed prior to start of construction activity on site and shall not be removed until final acceptance of work, unless otherwise directed by the engineer. The Contractor shall remove the grate of the catch basin and install the sack in accordance with the Manufacturer's written instruction. The grate shall be set back into place after the sack is installed with the lifting straps outside or on top of the grate.
- B. The contractor shall remove all accumulated sediment and debris from the vicinity of the catch basin after each storm event and as directed by the Owner. Where the sack is more than one-third (1/3) full of sediment, the sack shall be cleaned by lifting the unit out of the catch basin and emptying the contents to an area within the Contract limit line as directed by the engineer.
- C. The silt sack shall be maintained in working condition for the life of the project. If the sack breaks, is damaged or ceases to function during the construction period, the Contractor shall remove and replace it with a new one at no additional cost.

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SECTION 315000

EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Work governed by this section, as shown or specified shall be in accordance with the requirements of the Contract Documents and the New York City Building Code (2014 edition).

1.2 SECTION INCLUDES

- A. The work of this section consists of providing excavation support and protection, and includes, but is not limited to the following:
 - 1. All professional engineering, surveying, layout, monitoring, and submittals in connection with the work in this Section.
 - 2. Design of all temporary support of excavation (SOE) systems, underpinning and any temporary bracing of existing foundation structures or utilities required.
 - 3. Installation of sheeting, bracing, underpinning, soil and/or rock support necessary to protect existing buildings, streets, walkways, utilities, and other improvements and excavation against loss of support and movement.
 - 4. Maintenance of sheeting, bracing, and underpinning.
 - 5. Monitoring of adjacent buildings and structures, as required.
 - 6. Monitoring of excavation support systems, as required.

1.3 RELATED SECTIONS

- A. Related Documents and Sections: Examine Contract Documents for requirements that directly affect or are affected by work of this Section. A list of those Documents and Sections include, but is not limited to the following:
 - 1. 310000 – Earthwork
 - 2. 310901 – Monitoring of Structures and Utilities
 - 3. 312315 – Groundwater Control
 - 4. 316326 – Drilled Caissons

1.4 STANDARDS, REFERENCES AND REGULATORY REQUIREMENTS

- A. All work shall comply with requirements of the New York City Building Code, New York State Department of Labor, Occupational Safety and Health Administration (OSHA), New York State Department of Health (NYSDOH), New York State Department of Environmental Conservation (NYSDEC), New York City Department of Environmental Protection (NYCDEP), New York State Department of Transportation (NYSDOT), and with applicable requirements of all other authorities having jurisdiction.
- B. Where there are in existence ASTM Standards applicable to this work, the recommendations and requirements of such Standards shall be considered a minimum for the work described and must be complied with.
- C. The Contractor shall procure and pay for all permits and licenses required to complete the

work of this Section.

- D. Post Tensioning Institute (PTI) Recommendations for Prestressed Soil and Rock Anchors, Forth Ed. (2004)
- E. Geotechnical Memorandum: The Geotechnical Engineer engaged by the Owner, has prepared a memorandum entitled Geotechnical Engineering Evaluation – Jacob Javits Convention Center – Transformer Yard Relocation, dated 1 April 2016. Copies of this report shall be available to the Contractor, upon request. Boring and other in situ test logs are made available to the Contractor for information only. Conditions are not intended as representations or warranties of accuracy or continuity between borings. The Owner will not be responsible for interpretation conclusions drawn from this data by the Contractor.
- F. Nothing in clause 1.4 shall relieve Subcontractor of his responsibility of providing a higher standard than the relevant Code or Standard, in order to comply with this Specification.

1.5 SUBMITTALS

- A. Unless otherwise indicated, transmit all submittals to the Construction Manager for review by the Owner's Architect and Engineers before proceeding with ordering, fabricating, or any other work of this Section. Submittal review will be of the concept only and shall not in any way diminish or limit the Contractor's responsibility for quality and performance of the work of this Section and for the protection of existing structures, nor shall review by Owners Engineers be construed to be an approval of means and methods or design. The Contractor shall be solely responsible for support of excavation, underpinning, protection of adjacent structures, streets, and utilities, and maintaining a safe excavation.
- B. Resumes: The following resumes shall be submitted to the Construction Manager at least 30 days prior to anticipated start of on-site construction activities:
 - 1. Contractor Staff: Submit resumes for Superintendent and Foremen to be engaged in construction and oversight of the work. Only those personnel approved by the Owner's Engineer shall be used for the project. The Owner's Engineers shall approve or reject the Contractors qualifications within 15 working days from receipt of submittal. The Contractor shall not make substitutions for staff without the consent of the Owner's Engineers. No work shall be performed on-site until all qualifications are approved.
 - 2. Professional Engineering: Submit the name of Contractor's Professional Engineer engaged for the design of SOE, shoring, bracing and underpinning systems. Consultant and field supervisor shall be Professional Engineers licensed in the State of New York with at least 10 years of relevant experience.
- C. References: The Contractor shall submit resumes for at least 5 projects of similar scope and nature completed within the last 10 years. For each project include: (1) name of client contact, address, and telephone number; (2) name and telephone contact of Architect or Owners; (3) location of the project; (4) contract value; and (5) scheduled or actual completion dates of project. References shall be submitted at least 30 days prior to performing on-site construction activities.
- D. The Contractor's Professional Engineer shall prepare an outline of the Contractor's construction methods and step-by-step procedures together with plans and details of any proposed sheeting, bracing, and underpinning. These activities shall be coordinated with the relevant submittals identified in this Section, and shall be submitted and reviewed prior to submittal of the more detailed shop drawings.
- E. Shop Drawings and Calculations

1. Prepare and submit shop drawings of all items in this Section, in accordance with the Contract Documents at least 30 days before beginning work. The shop drawings and calculations shall be submitted signed and sealed by a Professional Engineer licensed in the State of New York engaged by the Contractor.
 2. Shop drawings shall show in detail the various portions of the work, kind of materials and methods of securing same together and the work of other trades. Drawings shall show in the elevations and sections the manner and sequence proposed for all work of this Section. Details for temporary needles, shores, support patterns, sizes, locations, etc., shall be included on the shop drawings.
 3. Shop drawings shall show all design loads (including surcharge loading from cranes, buildings, adjacent structures, etc.) upon which the sheeting, bracing, underpinning, and soil and rock support measures are based along with design calculations for all methods of support.
 4. Shop drawings and calculations shall show and completely describe the Contractor's soil and rock support methods, schedule, and procedures.
 5. Shop drawings shall identify construction sequence for all proposed methods of shoring, support, bracing, etc.
- F. Product data, laboratory testing and all other relevant information for all proposed materials.
- G. Monitoring Program: Monitoring shall be as per Section 310901.

1.6 PROJECT CONDITIONS

- A. Subsurface Conditions - The subsurface conditions within the development area are generally characterized by uncontrolled fill underlain by consecutive layers of slightly organic silty clay, glacial till, and finally bedrock; a thin mantle of decomposed rock may be present above competent bedrock at some locations. Groundwater is anticipated to be tidally influenced within the project site, and is estimated to fluctuate between elevations el +2 and el -3 ft. Additional details pertaining to the subsurface conditions are presented in the memorandum entitle Geotechnical Engineering Evaluation – Jacob Javits Convention Center – Transformer Yard Relocation, prepared by Langan Engineering, Environmental, Surveying and Landscape Architecture, D.P.C., dated 1 April 2016. This information is provided for Contractor's information only.
- B. The project site is underlain by three vehicular tunnels, referenced as the Lincoln Tunnel North Tube, Lincoln Tunnel Center Tube, and Lincoln Tunnel South Tube. All Lincoln Tunnel facilities are operated by the Port Authority of New York and New Jersey (PANYNJ).
- C. Boring logs are available for the Contractor's review. The Owner makes no predictions or representations regarding the character or extent of soil, rock, or other subsurface conditions to be encountered during the work. The Contractor shall make his own deductions of the subsurface conditions which may affect the methods or cost of construction of the work hereunder, and he agrees that he will make no claims for damages or compensations, except as are provided under the agreement, should he find conditions during the progress of the work different from those as calculated or anticipated by him. Additional borings and other exploratory operations may be performed by Contractor, at the Contractor's option and following the Owner's approval. No reimbursement or change in the Contract Sum will be authorized for such additional exploration undertaken by the Contractor.
- D. The Contractor, by careful examination, shall inform himself as to the nature and location of the work; the conformation of the ground, the nature of the subsurface conditions; the locations of the groundwater table; the character, quality and quantity of the materials to be encountered; the character of the equipment and facilities needed prior to and during the execution of the work; and all other matters which can be in any way effect the work.

- E. The Contractor shall be held to have visited the site and to have familiarized himself with the existing conditions of adjoining properties, utilities, and buildings.
- F. The Contractor shall investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to, ingress and egress of the site of the work. The Contractor shall conform to all New York City and State, and Federal regulations in regard to the transportation of materials to and from and at the job site and shall secure in advance such permits as may be required.

1.7 LINCOLN TUNNEL

- A. Installation of support of excavation systems shall be subject to the review and observation of PANYNJ representatives. The Contractor shall cooperate with the PANYNJ's representatives and shall follow all protocols set forth in the Contract Documents. The Contractor shall be prepared to develop and submit a Work Plan where required by PANYNJ.
- B. The Lincoln Tunnel (North and Center Tube) and other structures shall be monitored during construction activities as specified in Section 310901.
- C. Per Section 310901, the Contractor shall photograph and map all cracks in the Lincoln Tunnel and other structures to remain that are within 100 ft of the construction prior to execution of any excavation activities.

1.8 EXISTING UTILITIES

- A. Existing Utilities: Locate existing underground utilities within and beyond the areas of work. If utilities are indicated to remain in place, provide adequate means of support and protection during the work. Utilities scheduled for relocation are identified in the Contract Documents.
 - 1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
 - 2. Do not interrupt existing utilities serving facilities occupied by Owner or others, during occupied hours, except when permitted in writing by the Construction Manager and then only after acceptable temporary utility services have been provided. Provide minimum of 48-hour notice to the Construction Manager, and receive written notice to proceed before interrupting any utility.
 - 3. Where necessary, demolish and completely remove existing underground utilities indicated to be removed from the site. Coordinate with utility companies for shutoff of services if lines are active.
 - 4. Examine drawings to determine sequence of operations, and relation to work of other trades. Start of work will signify acceptance of field conditions and will acknowledge coordination with other trades.

1.9 SURVEYING AND MONITORING

- A. Monitoring shall be in accordance with Section 310901 and the requirements set forth herein.
- B. Before starting work, the Contractor's Professional Engineer and Land Surveyor shall check and verify governing dimensions and elevations, survey conditions of adjoining structure, and record any prior settlement or cracking of structures, and other improvements.
- C. The Contractor shall be responsible for monitoring of excavation support systems, adjacent buildings, and other structures as outlined on Contract Drawings. The Contractor shall be

solely responsible for monitoring of existing buildings, structures, excavation support, etc.

- D. The Contractor shall install monitoring points (i.e. for groundwater conditions, ground movement, vibration, etc.) to adequately monitor and otherwise keep himself informed of the conditions during the work.

1.10 QUALITY ASSURANCE

- A. Contractor Qualifications: The Contractor performing the work of this Section shall demonstrate that they have at least 10 years of recent field experience on projects of similar size, scope, and complexity.
- B. Design Supervision: The Contractor shall retain the services of a Licensed Professional Engineer licensed in the State of New York who shall design and supervise installation of all SOE, shoring, underpinning, and bracing. The Contractor's Professional Engineer shall sign and seal all documents and shall submit all relevant NYC Building Department TR forms.
- C. Surveying and Monitoring: Engage and assign survey monitoring work of this Section to a Professional Land Surveyor licensed in the State of New York. The results of all monitoring work performed by the Contractor shall be made immediately available to the Contractor's Professional Engineer responsible for the design supervision of the work specified herein, the Construction Manager, and the Owner's Geotechnical Engineer.
- D. Codes and Permits:
 - 1. Comply with the New York City Building Code, and any other Federal, State, or Local codes and ordinances having jurisdiction.
 - 2. All labor, materials, equipment and services necessary to make the work comply with such requirements shall be provided without additional cost to the Owner.
 - 3. The Contractor shall procure and pay for all permits and licenses required to complete the work of this Section.

1.11 QUALITY CONTROL - INSPECTION AND TESTING

- A. The Owner will engage, under the requirements of Section 1704.1 of the Building Code, one or more Special Inspection Agencies to observe and provide all necessary material testing related to the work of this Section. All inspections and all materials testing shall be performed by Special Inspectors meeting the minimum qualifications outlined in RCNY 101-06.
- B. Observation of excavation, sheeting, shoring and bracing installation shall be performed on a full-time basis. Inspections associated with materials testing shall be made on a periodic basis, as required, as the work progresses.
- C. The Special Inspector for installation shall log the installation and prepare records of daily activities. This shall not relieve the Contractor's responsibility to provide an excavation support system capable of meeting the requirements outlined on the Contract Drawings and specified herein.
- D. The Special Inspector shall prepare and submit daily reports summarizing the installation and/or material testing activities. The Special Inspector shall prepare records, including items completed each day, job and weather conditions, a detailed construction log of each element installed, including sheeting depths, other general quantities, and any other pertinent construction details. The Contractor shall cooperate and assist the Special Inspector(s) in the making of these records.

- E. Where work is observed to be non-conforming, the Special Inspector shall immediately inform the Construction Manager and Owner's Engineer(s) of such conditions in writing. A summary of the observed non-conformance shall be issued within 24-hrs. The Special Inspector shall maintain a tracking log of all non-conformances and shall update the tracking log on a daily basis such that corrective measures, if required, can be facilitated in timely fashion. The tracking log shall include such information as ID number, date opened, description of non-conformance, actions required, actions taken, and date closed.
- F. The Special Inspector(s) shall submit all field logs and test reports necessary to facilitate any corrective design requirements.
- G. The Special Inspector(s) shall provide all necessary certifications of the work in compliance with Building Code requirements.
- H. The Contractor shall have the sole responsibility for coordinating his work with the Construction Manager to assure that all tests and inspection procedures required by the Contract Documents and the governing Building Codes are properly provided by the Special Inspector. The Contractor shall cooperate fully with the Special Inspector in the performance of his work.
- I. Materials and installed work may require testing at any time as work progresses. Allow free access to material stockpiles and facilities. Tests not specifically indicated herein may be performed at Owner's expense, as required by the Special Inspector.
- J. Retesting of rejected materials and installed work shall be Contractor's responsibility and shall be performed at his expense.
- K. The Special Inspector(s) shall be provided with reasonable office space (heating, cooling, electric) on-site by the Construction Manager to conveniently prepare and maintain all necessary project records pertinent to their duties and to store equipment. At a minimum the Special Inspector shall be provided with a minimum of one desk, a locking cabinet or closet, and wireless internet access.
- L. The Contractor shall notify the Construction Manager, and all other necessary parties at least 72 hours prior to each day of caisson drilling to allow for the appropriate personnel to be on the site.
- M. The role of the Special Inspector(s) shall not relieve the Contractor from any responsibility with respect to conformance to the proper workmanship, management of materials and waste, or any other requirements of the Contract Documents.

1.12 PRECONSTRUCTION MEETING

- A. Prior to work on site, the Construction Manager will arrange a series of meetings to discuss coordination and scheduling. Parties to be present: Structural Engineer, Geotechnical Engineer, Architect, Testing Laboratory, Construction Manager, Support of Excavation Contractor and his Engineer, PANYNJ, the Special Inspector, and the Owner. Review the earthwork procedures and responsibilities including testing and inspection procedures and requirements. Notify participants at least 3 working days prior to convening conference. Record discussions and agreements and furnish a copy to each participant.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide suitable sheeting, bracing, underpinning, and soil and rock support materials, which will withstand loads imposed without movement. Materials shall be kept in serviceable condition at all times throughout the duration of excavation and foundation construction.
- B. All proposed products shall be submitted to the Construction Manager for review by the Owner's Architect and Engineers for review prior to procurement or delivery to the site.

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor shall provide, erect and maintain all necessary sheeting, bracing, underpinning, and soil and rock support when and where required. Locate the system to clear permanent construction and to permit forming and finishing of concrete surfaces.
- B. Sheeting, bracing, underpinning and rock support shall be erected and maintained to the entire satisfaction of any City, State or local authorities having jurisdiction. Systems on which the support or stability of existing structures is dependent must be left in place at completion of work. In other areas, maintain system until structural elements are replaced by other bracing or until permanent construction is able to resist lateral earth, rock, surcharge, and hydrostatic pressures.
- C. The construction and performance of the sheeting, bracing, underpinning, and soil and rock support work for the purpose of which it is erected shall be the entire responsibility of the Contractor.
- D. Should any subsidence or any other damage occur due to the inefficiency of the work, the damage shall be made good by the Contractor at his own expense.
- E. The Contractor shall make use of such methods of work as are best adapted to preserve the safety and stability of foundations, walls, and other parts of affected buildings or structures.

3.2 SHEETING AND BRACING

- A. Excavation support and bracing shall be designed and constructed in accordance with the New York City Building Code and other jurisdictional agency requirements.
- B. Install excavation support and bracing to permit excavation to foundation subgrade level.
- C. Excavation support shall be adequate to resist earth and hydrostatic pressures and lateral pressures due to surcharge loads, to prevent displacement of adjacent ground; and to prevent loss of support or damage to buildings, utilities, sidewalks and streets. Lateral loads created from adjacent buildings, cranes and/or street loads shall be included in the design.
- D. Members shall be of adequate size and adequate lateral bracing shall be provided to meet design standards for allowable stresses and factors of safety for temporary construction.
- E. During the excavation work specified in Section 310000 - Earthwork, if additional locations require excavation support and bracing based on the Contractor's construction methods and procedures, then the Contractor shall provide such additional supports at no additional cost to the Owner. Such additional supports shall be designed and constructed in accordance

with the requirements of this Section.

- F. All the above work shall be carried on in such a manner as not to interfere with the progress of the work under this Contract.
- G. Excavation support and bracing may be removed, left in place, or cut as approved by the Owner's Structural and Geotechnical Engineers and as directed by the Construction Manager. Any material that affects finished construction shall be removed. Carefully remove materials such that no loss of support occurs beneath areas adjacent to the sheeting. Any material left in place must be removed not less than 4-feet below finished grade. Excavation support and bracing material removed from the excavation shall be immediately removed from the site and properly disposed of in accordance with all applicable State, City, and Federal Codes.
- H. Where excavation support and bracing is required to withstand earth pressures resulting from backfill placement, the backfill shall not be placed until after sheeting and bracing has been completely installed. Materials shall not be removed until the supporting structure has attained adequate strength.
- I. Excavation adjacent to the SOE wall shall not exceed a depth of 2 feet below the point of lateral support to be installed. Lateral support shall be installed and preloaded prior to continuing excavation.

3.3 UNDERPINNING

- A. Underpinning shall be completed before excavation reaches a depth or width, which might disturb the soil supporting the existing adjacent buildings or other structures.
- B. Underpinning of adjacent structures should be carried down to adequate bearing material meeting the stricter requirements of the New York City Building Code.
- C. All underpinning work shall be as indicated on the Contract Drawings or in the case of alternates as directed by the Contractor's Professional Engineer. The bottom of the underpinning excavation shall be checked for satisfactory bearing by a Licensed Professional Engineer.
- D. The Contractor shall provide temporary lateral support to retain in place the sides of the underpinning excavation as required to carry on the safe execution of the work under this Section. The temporary lateral support shall be constructed such that no loss of support occurs beyond the limits of underpinning.
- E. Dewatering of the underpinning excavation, if required, shall be in accordance with the requirements of Section 312319. Such dewatering shall be considered part of the underpinning operations.
- F. All underpinning shall be capable of withstanding lateral loads from water, soil, buildings loads, surcharge, etc., from behind and above with no measurable movements. Provide temporary lateral support of underpinning as necessary to achieve the above criteria.

END OF SECTION

SECTION 316326
DRILLED CAISSONS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Work governed by this section, as shown or specified shall be in accordance with the requirements of the Contract Documents and the New York City Building Code (2014 edition).

1.2 SUMMARY

- A. Work of this Section includes, but is not limited to the following:
1. Provide all labor, materials, equipment, and services and perform all operations required for the complete work of installing drilled caissons to lines and finished cut-off elevations as indicated on the Contract Drawings and as specified herein.
 2. Caissons shall include all sizes and configurations shown on the Contract Drawings. Caissons shall be constructed with minimum bond lengths as shown on the Contract Drawings. Caisson rock sockets shall be in New York City Building Code (NYCBC) Class 1c or better bedrock. Caissons shall have a permanent steel casing, centralized steel core beam and/or reinforcing cage, and all necessary concrete fill so as to sustain the minimum design capacities as indicated on the Contract Drawings.
 3. Furnish and install steel isolation casing with bond breakers and/or coatings, where indicated on the Contract Drawings.
 4. Design and testing of concrete mixes.
 5. Submission of all required shop drawings, supporting data, mill certificates and the like for cement, admixtures, aggregates, water, reinforcing steel, accessories, compounds, coatings, and the like.
 6. Furnish all required falsework, cribbing, dunnage, etc. to provide safe access to caisson locations.
 7. Protection of the Lincoln Tunnel (North and Center Tube), and all other adjacent structures and utilities to remain.
 8. Furnish all equipment, including down-hole digital video equipment and labor, necessary to facilitate visual inspection and documentation of caisson rock sockets. Entry into caissons will not be required. The Contractor shall provide all labor, materials, and equipment necessary for alternative means to verify the conditions of rock sockets where field conditions prevent use of down-hole video inspection.
 9. Removal and legal disposal of excess drilling mud and spoils generated as part of the drilling process.
 10. Provide all surveying required for determining the location of the Lincoln Tunnel (North and Center Tubes) and all field stakeout, field monitoring and documentation of as-built conditions of caissons.
 11. The Contractor shall facilitate monitoring of all structures, utilities, and tunnels in accordance with Section 310901.
 12. Provide all necessary labor and monitoring equipment necessary to monitor inclination of the caissons during drilling as specified herein.
 13. Submission of as-built caisson location survey, video inspection records, and installation logs.
 14. The Contractor shall provide the Special Inspector with reasonable office space (with heating, cooling, electricity) on-site to conveniently prepare and maintain all necessary project records pertinent to their duties and store necessary equipment. This shall

include a minimum of 1 desk space, a lockable storage closet, and wireless internet access.

1.3 RELATED SECTIONS

- A. Related Documents and Sections: Examine Contract Documents for requirements that directly affect or are affected by Work of this Section. A list of those Documents and Sections include, but is not limited to the following:
1. Exploratory Borings – Section 023213
 2. Cast-in-Place Concrete – Section 033000
 3. Earthwork – Section 310000
 4. Monitoring of Structures and Utilities – Section 310901
 5. Groundwater Control – Section 312315

1.4 STANDARDS AND REFERENCES

- A. General: Except as modified or voided by requirements specified herein or by details or notes included in the Contract Drawings, the Work specified under this Section shall conform to all applicable provisions of the codes, specifications, standards and other reference documents cited in this Specification and/or noted in the Contract Drawings.
- B. Codes: All Work under this Section shall conform to the most restrictive requirements of the New York City Building Code (2014), and to the regulations of all governmental authorities having jurisdiction.
- C. Where more stringent, the following codes, standards and specifications (latest edition), shall apply to the Work, all as modified herein or by the above mentioned Building Code:
1. Field Reference Manual: Specifications for Structural Concrete, ACI 301, with Selected ACI and ASTM References, SP-15. Contractor shall keep at least one full copy in the field office at all times.
 2. Building Code Requirements for Structural Concrete (ACI 318-11) and Commentary (ACI 318R-11) referred to hereafter as ACI Code.
 3. Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete, ACI 211.1
 4. Guide for Measuring, Mixing, Transporting and Placing Concrete, ACI 304.
 5. Recommended Practice for Evaluation of Strength Test Results of Concrete, ACI 214.
 6. Structural Welding Code – Reinforcing Steel, ANSI/AWS D1.4.
 7. Structural Welding Code – Steel, ANSI/AWS D1.1
- D. ASTM (American Society for Testing and Materials) Specifications cited in ACI 318, ACI 301, this Specification or in cited reference documents shall be the year of adoption or tentative adoption and revision listed in the latest edition of the Annual Book of ASTM Standard, "Index", except that, should a specific year of adoption or revision be cited by the Contract Documents, by Building Code, or be proposed by Contractor and accepted by Owner, that edition shall apply to and control the Work.
- E. Geotechnical Memorandum: The Geotechnical Engineer engaged by the Owner, has prepared a memorandum entitled Geotechnical Engineering Evaluation – Jacob Javits Convention Center – Transformer Yard Relocation, dated 1 April 2016. Copies of this report shall be available to the Contractor, upon request. Boring and other in situ test logs are made available to the Contractor for information only. Conditions are not intended as representations or warranties of accuracy or continuity between borings. The Owner will not be responsible for interpretation conclusions drawn from this data by the Contractor.

1.5 SUBMITTALS

- A. Unless otherwise indicated, transmit all submittals to the Construction Manager for review. Review of submittals by the Construction Manager, Owner's Architect, and Owner's Engineers is required before proceeding with ordering, fabricating, or any other work of this Section. Submittal review will be of concept only and shall not in any way diminish or limit the Contractor's responsibility for the quality and performance of his work. All Material orders, including determination of quantities for core beams, reinforcing steel, and concrete fill, shall be the sole responsibility of the Contractor.
- B. At least two weeks prior to mobilization of any equipment or materials to the Site, submit satisfactory proof of Contractor or Subcontractor qualifications for performing the Work specified herein, and name of Contractor's Professional Engineer. Submit resumes of all key personnel, including supervising engineers and drilling operators and foreman.
- C. Shop Drawings and Caisson Details:
 - 1. Where the Contractor elects to modify the caisson design from that indicated on the Contract Drawings, the Contractor must submit full design calculations and details prepared by a Professional Engineer, licensed in New York State. The Contractor's design shall meet the requirements of all applicable codes and specifications and shall be suitable for attaining the referenced design load capacities indicated on the Contract Drawings including connection details to the superstructure. Shop drawings shall indicate the clear distance from all adjacent tunnels and structures. Shop drawings shall be signed and sealed by the Contractor's Professional Engineer. The unbonded lengths and minimum clear distances to Lincoln Tunnel shown on the Contract Drawings shall not be amended by the Contractor's design.
 - 2. Submitted shop drawings and caisson details shall indicate the following information:
 - a. Schedule of all applicable caissons types, sizes, and design capacities;
 - b. Dimensions and clear distances to Lincoln Tunnel (North and Center Tube) and other structures to remain and be protected;
 - c. Dimensions and lengths of rock sockets;
 - d. Location of rock socket bond zone and dimensions;
 - e. Schedule of reinforcing steel with all applicable dimensions, weights, and grades of embedded steel shapes;
 - f. Diameter, thickness, and grade of all temporary and isolation casing;
 - g. Details for installation and support of isolation casing during grouting;
 - h. Details for establishing a bond breaker at isolation casing;
 - i) Welding and splicing details.
- D. Manufacturer's or supplier's documentation certifying that casing, core beams and reinforcement steel conform to the requirements specified herein. This shall also include mill certificates covering physical and chemical tests. All material shall be delivered to the site with clear identification to link the materials to the certificates and tests.
- E. Submit all concrete mix designs, laboratory test results, and supplier data. Concrete mix designs shall be prepared by a Professional Engineer, licensed in the State of New York.
- F. Substitutions: Should the Contractor desire a substitution from the Contract Drawings or specifications, or both, the Contractor shall submit the specific substitution in writing prior to submittal of Shop Drawings. Requests for substitutions shall be submitted on the Contractor's letterhead. Approval of the Contractor's request for substitutions shall be at the discretion of the Owner and Owner's Structural and Geotechnical Engineers. Rejection of substitutions shall not be grounds for an adjustment to the Contract price.
- G. Installation Equipment and Procedures:

1. The type of equipment for installation of caissons, including but not limited to drill rig, proposed soil and rock drilling bits, drilling techniques, and methods for passing obstructions, and temporary casing (if required). Review of the drilling equipment does not relieve the Contractor from the responsibility of properly drilling caissons (in consideration of any neighboring structures and tunnels), in a satisfactory condition, to the specified criteria, to achieve the design capacities specified herein.
2. Installation procedures for the caissons including but not limited to: detailed sequence of construction; drilling of any required pilot holes; use of temporary casing; drilling of rock sockets; optical or geophysical imaging to evaluate rock quality and the presence of obstructions; cleaning of the caisson prior to concreting; placement of concrete fill under gravity tremie; and placement of reinforcing steel.
3. Methodology and details for establishing and maintaining the accurate centerline (at the top of caissons) during drilling operations (i.e. guide walls, jigs, etc).
4. Methodology for monitoring borehole verticality during drilling and means to correct orientation.
5. Methodology for identifying and clearing obstructions including any pre-drilling, pre-excavation and associated backfilling including proposed backfill materials.
6. Methods for sealing the caisson and preventing groundwater and sediment infiltration.
7. Methods for advancing the rock socket and removing spoils.
8. Methods for cleaning the bottom of the rock socket.
9. Methodology for maintaining a stable bottom during drilling including use, type and estimated quantity of any mineral (i.e. bentonite) or polymer slurry products.
10. Methodology to stabilize the borehole during drilling in the event that bottom heave or running sands are observed including temporary backfilling procedures and materials.
11. Methodology and all necessary shop drawing for templates to ensure that the centerline location of rock sockets does not deviate more than 1.0-inch from the intended location.
12. Submit all materials data and procedures for the splicing of reinforcement and permanent, temporary, and/or isolation casings.
13. Submit product data and details for application of bond-breakers to isolation casing.
14. Submit detailed description of the tools and procedures for use in tremie placement of concrete.
15. Resumes of all welders to perform the Work.
16. Method of handling and disposal of drilling fluid and drilling spoils in compliance with soil management requirements.
17. Corrective Action Plan: In the event that any tolerances specified herein are exceeded that necessitate abandonment or redrilling of caissons, the Contractor shall prepare and submit a corrective action plan. The plan shall include all pertinent means and methods to be employed in performing the corrective work.

H. Caisson Identification Plan:

1. A plan clearly showing the designation and location of all caissons by an identification system, including the cut-off elevations for all caissons; location plan shall be referenced to the Foundation Drawings. The plan shall include the location of the centerline of each caisson referenced to a known benchmark and orientation.
2. All detailed records for individual caissons shall bear identification corresponding to that shown on the identification plan. A copy of this plan shall also be available at the site for inspection at all times. The identification plan shall be signed and sealed by a professional engineer, and shall be provided in electronic and hard copy formats.

I. Survey:

1. Submit as-built survey plans prepared by a Professional Surveyor, licensed in the State of New York, showing the completed locations of the caissons at cut-off elevation with respect to the proposed locations. Survey shall show actual locations of centers of caissons at top, made from accurate field surveys, with all other pertinent data.

Caissons that exceed location tolerances specified herein shall be highlighted and offset dimensions provided. As-built surveys shall include a tabular summary of all data including: date of measurement; caisson ID; cut-off elevation; deviation measured in the north-south and east-west axes; and maximum percent inclination relative to the vertical axis.

1.6 PROJECT CONDITIONS

- A. Subsurface Conditions - The subsurface conditions within the development area are generally characterized by uncontrolled fill underlain by consecutive layers of slightly organic silty clay, glacial till, and finally bedrock; a thin mantle of decomposed rock may be present above competent bedrock at some locations. Groundwater is anticipated to be tidally influenced within the project site, and is estimated to fluctuate between elevations el +2 and el -3 ft. Additional details pertaining to the subsurface conditions are presented in the memorandum entitle Geotechnical Engineering Evaluation – Jacob Javits Convention Center – Transformer Yard Relocation, prepared by Langan Engineering, Environmental, Surveying and Landscape Architecture, D.P.C., dated 1 April 2016. This information is provided for Contractor's information only.
- B. The project site contains is underlain by three vehicular tunnels operated by the Port Authority of New York and New Jersey (PANYNJ). These tunnels are collectively referred to as the Lincoln Tunnel. Caissons are anticipated to be installed at lateral clearances of less than 15 ft from the North and Center Tubes of the Lincoln Tunnel. The minimum lateral clearance between all projected outside faces of the tunnel liners and the caissons (as measured at the ground surface) shall be 10 ft, unless otherwise permitted by PANYNJ and the Owner.
- C. The Contractor's means and methods shall account for the possibility of obstructions being encountered during drilling (including but not limited to timber crib bulkheads, remnant foundations, and rubble fill), and necessity to maintain strict adherence to the requisite tolerances for both plan location and verticality (plumbness). In all cases, the Contractor shall take necessary measures to establish and maintain the proposed centerlines at the cut-off elevation, and plumbness of the excavation.
- D. Boring logs are available for the Contractor's review. The Owner makes no predictions or representations regarding the character or extent of soil, rock, or other subsurface conditions to be encountered during the work. The Contractor shall make his own deductions of the subsurface conditions which may affect the methods or cost of construction of the work hereunder, and he agrees that he will make no claims for damages or compensations, except as are provided under the agreement, should he find conditions during the progress of the work different from those as calculated or anticipated by him. Additional borings and other exploratory operations, not included in the Contract Documents, may be performed by Contractor, at the Contractor's option and following the Owner's approval. No reimbursement or change in the Contract Sum will be authorized for such additional exploration undertaken by the Contractor.
- E. The Contractor, by careful examination, shall inform himself as to the nature and location of the work; the conformation of the ground, the nature of the subsurface conditions; the locations of the groundwater table; the character, quality and quantity of the materials to be encountered; the character of the equipment and facilities needed prior to and during the execution of the work; and all other matters which can be in any way effect the work.
- F. The Contractor shall be held to have visited the site and to have familiarized himself with the existing conditions of adjoining properties, utilities, and buildings.
- G. The Contractor shall investigate the conditions of public thoroughfares and roads as to

availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to, ingress and egress of the site of the work. The Contractor shall conform to all New York City and State, and Federal regulations in regard to the transportation of materials to and from and at the job site and shall secure in advance such permits as may be required.

1.7 LINCOLN TUNNEL

- A. Field stakeout of all caissons shall be performed by a licensed surveyor. Caisson drilling shall not commence until PANYNJ has had the opportunity to review and approve the caisson stakeout.
- B. Exploratory borings shall be drilled to evaluate the subsurface conditions for all caissons within a horizontal distance of 25 ft from the Lincoln Tunnel as per PANYNJ. Where practical, exploratory borings shall be drilled at the centerline of the proposed caisson. Where required, exploratory borings shall be performed in accordance with Section 022313.
- C. All caisson installation shall be subject to the review and observation of PANYNJ representatives. The Contractor shall cooperate with the PANYNJ's representatives and shall follow all protocols set forth in the Contract Documents. The Contractor shall be prepared to develop and submit a Work Plan where required by PANYNJ.
- D. The Lincoln Tunnel (North and Center Tube) and other structures shall be monitored during construction activities as specified in Section 310901.
- E. Per Section 310901, the Contractor shall photograph and map all cracks in the Lincoln Tunnel and other structures to remain that are within 100 ft of the construction prior to execution of any caisson drilling activities.

1.8 EXISTING UTILITIES

- A. Existing Utilities: Locate existing underground utilities within and beyond the areas of work. If utilities are indicated to remain in place, provide adequate means of support and protection during the work. Utilities scheduled for relocation are identified in the Contract Documents.
 - 1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
 - 2. Do not interrupt existing utilities serving facilities occupied by Owner or others, during occupied hours, except when permitted in writing by the Construction Manager and then only after acceptable temporary utility services have been provided. Provide minimum of 48-hour notice to the Construction Manager, and receive written notice to proceed before interrupting any utility.
 - 3. Where necessary, demolish and completely remove existing underground utilities indicated to be removed from the site. Coordinate with utility companies for shutoff of services if lines are active.
 - 4. Examine drawings to determine sequence of operations, and relation to work of other trades. Start of work will signify acceptance of field conditions and will acknowledge coordination with other trades.

1.9 PROTECTION

- A. Monuments, bench marks, monitoring points, crack gages, and other reference features on streets and structures in the work area shall be protected. Should these be disturbed in any manner, they shall be reset, at the Contractor's expense.

- B. While performing work of this Section, or any other related Section, the Contractor shall take care that his operations do not adversely affect the stability and integrity of existing buildings and structures in the vicinity, or induce settlement in them.
- C. The responsibility for any damage to tunnels, buildings, structures, utilities, sidewalks, pavement, and other facilities in the vicinity resulting from the Contractor's operations will be entirely his, and he shall take whatever measures are necessary to prevent the same. Should damage occur due to work under this Section, all costs in connection with the repair of such damage and the restoration of damaged construction to its original condition shall be borne by the Contractor.
- D. Provide barricades, warning lights, barriers, etc., to prevent accidents, avoid all necessary hazards and protect the public, the work and property at all times, including Saturdays, Sundays and Holidays.

1.10 PROFESSIONAL ENGINEERING

- A. Contractor shall retain at its own cost, an engineer experienced with drilled caisson operations. Contractor's engineer shall be a registered Professional Engineer in the State of New York. Contractor's engineer shall design all drilled caisson work where alternates are proposed. Contractor's engineer shall sign and seal all submittals related alternates for drilled caissons and shall be present at all meetings associated with this Work.
- B. When a modification to the caisson design is elected, the Contractor shall submit the Professional Engineer's caisson design, plans, and details, as specified herein, to the Construction Manager for review by the Owner's Geotechnical and Structural Engineers.

1.11 SURVEYING

- A. Contractor shall retain at its own cost, a land surveyor to perform all necessary field layout, monitoring, and to document as-built conditions. The Contractor's surveyor shall be a New York State Licensed Land Surveyor. Non-licensed surveyors shall only be used to independently verify results provided by the licensed surveyor.

1.12 QUALITY ASSURANCE

- A. Source Quality Control: Contractor's material control procedures shall be effective and shall assure that all Work fulfills the requirements of the project as well as the applicable provisions of the Contract Documents.
- B. Contractor Qualifications: Contractor performing the Work of this Section shall demonstrate that the firm and their personnel they intend to use for this project have at least five recent successfully completed contracts installing drilled caissons of the type, size and scale as those specified for this project. The staff for this project shall include a supervising engineer with at least ten years of experience in the installation of drilled caissons. Drilling operators and foremen shall have a minimum of five years of experience installing drilled caissons.
- C. All labor, materials, equipment and services necessary to make the Work comply with such requirements shall be provided without additional cost to the Owner.
- D. Contractor shall procure and pay for all permits and licenses required to complete the Work of this Section.

1.13 PRECONSTRUCTION MEETING

- A. Prior to work on site, the Construction Manager will arrange a series of meetings to discuss coordination and scheduling. Parties to be present: Structural Engineer, Geotechnical Engineer, Environmental Engineer, Testing Laboratory, Construction Manager, Caisson Contractor and his Engineer, PANYNJ, the Special Inspector, and the Owner. Agenda to include: size and capacity of equipment used; review of boring and groundwater data; caisson inspection procedures and reporting format; safety measures to be followed; groundwater control; soil and spoils management plan and requirements; and emergency procedures in unanticipated instability of uncased socket wall.

1.14 DAILY PLANNING MEETING

- A. Construction Manager shall arrange for daily site meeting with Special Inspector, Contractor, Environmental Engineer and Construction Manager to review all proposed work before the start of each shift.

1.15 QUALITY CONTROL - INSPECTION AND TESTING

- A. Special Inspections
 - 1. The Owner shall engage, under the requirements of Section 1704.1 of the Building Code, one or more Special Inspection Agencies to observe and provide all necessary material testing related to the work of this Section. All inspections and all materials testing shall be performed by Special Inspectors meeting the minimum qualifications outlined in RCNY 101-06.
 - 2. Caisson installation shall be observed on a full-time basis by the Owner's Special Inspector(s). Contractor shall arrange for Special Inspector(s) to be on the site during caisson installation to verify that caissons are installed in accordance with design requirements and to perform any requisite materials testing. A minimum of 72 hours notice shall be provided to the Special Inspector by the Contractor.
 - 3. The Special Inspector(s) shall prepare and submit daily reports summarizing the construction and/or material testing activities to the Construction Manager for review by the Owner's Engineer.
 - 4. The Special Inspector(s) shall submit detailed logs and test reports necessary to facilitate any corrective design requirements by the Owner's Engineer. The contents and format of all logs shall be as directed by the Owner's Engineer.
 - 5. Where work is observed to be non-conforming, the Special Inspector shall immediately inform the Construction Manager and Owner's Engineer(s) of such conditions in writing. A summary of the observed non-conformance shall be issued within 24 hrs. The Special Inspector shall maintain a tracking log of all non-conformances and shall update the tracking log on a daily basis such that corrective measures, if required, can be facilitated in timely fashion. The tracking log shall include such information as ID number, date opened, description of non-conformance, actions required, actions taken, and date closed.
 - 6. The Special Inspector shall provide all necessary certifications of the work in compliance with Building Code requirements.
 - 7. When a suitable bottom is presumably reached in each caisson, it shall be determined by the Special Inspector if the caisson socket length is suitable and the bottom is suitably cleaned. Before placement of concrete, the socket and any casings shall be thoroughly cleaned and the rock inspected to verify that the rock is of the class on which the design has been predicated, or of a better class. Cleaning with buckets, water flush and/or air lift shall be performed, as required.
 - 8. Visual inspection shall be made by down-hole digital video camera by the Contractor under the direction of the Special Inspector to determine the class of rock in the socket. A video record of the inspection shall be forwarded to the Construction Manager, for review by the Owner's Engineer, and others as directed. The video recordings shall clearly identify the caisson ID #, and separate files shall be generated for each caisson

inspected. If video inspection is not possible, the Contractor shall provide other means to allow the Special Inspector to assess the rock socket (i.e., borings, geophysical methods, etc). Alternative means to verify rock sockets shall be subject to the approval of the Owner's Engineer.

9. The Special Inspector shall keep detailed records, including items completed each day, job and weather conditions, a log of each caisson drilled with soil or rock strata encountered, water entry and flow, drilling difficulties, fluid loss, obstructions, casing size and location, bottom cleanout and water removal, description of bearing material, depth and size of shaft, plumbness, location of center of caisson with respect to design location (survey by Contractor), top of caisson elevation (survey by Contractor), placement of steel reinforcement, size of reinforcement, location and types of splices for casings and reinforcement, concreting, and any other pertinent construction details. These records shall be provided to the Construction Manager, and others as directed.
 10. The Special Inspector(s) shall document all welding performed for steel casings and reinforcement. These records shall be provided to Construction Manager on a daily basis, and others as directed.
 11. Concrete Placement and Testing
 - a. With respect to concrete filling of caissons, the Special Inspector(s) will (with the Contractor's assistance) verify that the actual volumes of concrete placed into the caissons are within the established acceptable criteria.
 - b. Concrete testing shall be as required in Specification Section 033000: Cast-in-Place Concrete and as specified herein. Concrete testing shall be performed by Special Inspector(s). As a minimum, six concrete cylinders shall be obtained per 25 cubic yards of concrete placed; at least six cylinders shall be obtained for each day of concrete placement, and not less than one set of cylinders shall be obtained for each caisson. The samples shall be tested in accordance with ASTM C109. If the required design strength is not attained, caissons shall be subject to rejection. The Contractor shall be responsible to install replacement caisson(s) as required at no additional cost to the Owner.
 - c. The Contractor shall provide the Special Inspector(s) with suitable storage space and initial curing facilities for concrete test specimens.
- B. The Special Inspector(s) shall be provided with reasonable office space (heating, cooling, electric) on-site by the Construction Manager to conveniently prepare and maintain all necessary project records pertinent to their duties and to store equipment. At a minimum the Special Inspector shall be provided with a minimum of one desk, a locking cabinet or closet, and wireless internet access.
- C. The Contractor shall have the sole responsibility for coordinating his work with the Construction Manager to assure that all tests and inspection procedures required by the Contract Documents and the governing Building Codes are properly provided by the Special Inspector. The Contractor shall cooperate fully with the Special Inspector in the performance of his work.
- D. Materials and installed work may require testing at any time as work progresses. Allow free access to material stockpiles and facilities. Tests not specifically indicated herein may be performed at Owner's expense, as required by the Special Inspector.
- E. Retesting of rejected materials and installed work shall be Contractor's responsibility and shall be performed at his expense.
- F. The Contractor shall notify the Construction Manager, and all other necessary parties at least 72 hours prior to each day of caisson drilling to allow for the appropriate personnel to be on the site.

- G. The role of the Special Inspector(s) shall not relieve the Contractor from any responsibility with respect to conformance to the proper workmanship, management of materials and waste, or any other requirements of the Contract Documents.
- H. The Contractor shall prepare and periodically submit to the Construction Manager for review partial area surveys to facilitate the design of corrective measures.
- I. Upon completion and approval of all caisson drilling, the Contractor shall deliver to the Construction Manager the original as-built tracings (equal in size to that of the Construction Drawings) and the requisite copies for review and filing with the New York City Building Department.

1.16 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

- A. Deliver materials to the project site in such quantities and at such times to assure the continuity of caisson drilling operations, and to maintain the project schedule. Carefully handle caisson materials by means of rope slings or other means so as not to damage the materials.
- B. Casings and reinforcement shall be stored in orderly groups above ground, sufficiently blocked to minimize bending stresses. Material exhibiting variations beyond specified limits shall be considered distorted and shall not be used in the work. Casing and reinforcement shall each have unique identification tags confirming material lot number and origin.
- C. Concentrated loads, which occur during stacking or lifting, shall be kept below the level that would produce permanent deformation or overstress of the material. Damaged material will be rejected from use in the performance of the work and shall be removed from the site.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Minimum sizes and quantities of all steel reinforcement shall be as shown on the Contract Drawings.
 - 1. Structural steel reinforcement: Hot-rolled wide flange sections shall conform to ASTM A992, Grade 50. The natural mill camber of wide flange sections shall not exceed 1/8-inch per 10 feet.
 - 2. Plates shall conform to ASTM A572, Grade 50.
- B. Longitudinal reinforcing bars shall conform to ASTM A615, Grade 75.
- C. Transverse reinforcing bars shall conform to ASTM A615, Grade 60.
- D. Tie-wire: 16 gauge or heavier, black annealed wire conforming to ASTM A82.

2.2 STEEL CASING

- A. Minimum sizes for steel casings shall be as shown on the Contract Drawings.
- B. Steel casing shall be of suitable quality and shall consist of rolled and welded pipe meeting ASTM 252 Grade 3.
- C. Casing to be used for "isolation" shall be round, free of surface defects, or dents which would result in increased shear resistance.

2.3 CONCRETE

- A. Contractor furnished concrete mixes shall be in accordance with Section 033000 – Cast-in-Place Concrete.
- B. Concrete shall have a minimum 28-day unconfined compressive strength as indicated on the Contract Drawings.
- C. Source Changes: Should the source of an ingredient change, for any of the concrete products specified herein, Contractor shall redesign the affected mix and shall resubmit all prior to incorporating such material into the work.

2.4 BOND-BREAKER MATERIALS

- A. Acceptable methods for bond-breakers include:
 - 1. Coat outside face of isolation casing with bituminous coating at least 20 mils thick.
 - 2. Wrap the outside of isolation casing with at least 3 layers of 10 mil thick Visqueen polyethylene sheeting. All edges of the sheeting shall be taped with Preprufe CJ tape as manufactured by Grace Construction Products.
- B. Contractor shall submit product data and details for application of bond-breakers to isolation casing.

2.5 WELDING MATERIALS

- A. All welding materials shall be consistent with the requirements of the metals to be welded.
- B. Welding materials shall be stored to prevent contamination and degradation of electrodes, filler, or shielding materials as per the Manufacturer's specifications.

2.6 INSTALLATION EQUIPMENT

- A. Provide equipment, machinery, tools, and other apparatus for drilling, digging, pumping, and hauling. Provide ample standby equipment to prevent flooding, distortion, or caving so that work may be carried on without interruption.
- B. Provide adequate lighting to permit clear sight conditions in all work and access areas.
- C. Provide hoisting equipment of sufficient capacity to handle casing, reinforcing steel, and other materials.
- D. Provide sufficient equipment to completely clean bottom prior to concreting and reinforcement installation.
- E. Provide hoses of sufficient size and strength, grout pump, and connections required to perform tremie concrete placement. Provide temporary rubber plugs necessary to prevent mixing of water and concrete in the tremie pipe.

2.7 VERTICALITY MONITORING EQUIPMENT

- A. The following systems shall be considered suitable for measuring the verticality (plumbness) of caissons during drilling of pilot holes or full size rock sockets.
 - 1. Reflex Gyro - Borehole gyroscope by Reflex Instruments, or approved equal.
 - 2. Borehole Inclination Tester as manufactured by Geo Instruments.

3. SoniCaliper as manufactured by Load Test Inc.
- B. Alternative systems for use in monitoring the verticality of caissons during drilling, including real-time gyroscopic systems, shall be subject to the approval of the Owner's Engineer and the PANYNJ.
- C. Monitoring equipment shall have a minimum accuracy of +/-0.5 percent for measuring inclination and +/- 2 degrees for measuring the azimuth.

PART 3 - EXECUTION

3.1 FIELD STAKEOUT

- A. Caissons shall be staked out in the field by a New York State licensed Land Surveyor and shall be verified independently by a second surveyor prior to commencement of drilling. The Contractor, Owner's Engineer, and PANYNJ shall meet on-site to review the proposed caisson locations and discuss any necessary modifications before drilling commences.
- B. A template shall be provided to ensure the plan location of the caisson does not deviate by more than 1-inch from the intended plan location. Templates shall consist of a plain concrete ring footing suitable for preventing translation of the caisson during initial setout, or as otherwise approved by the Owner's Engineer.

3.2 DRILLING, CONCRETING, AND PLACEMENT OF REINFORCEMENT

- A. The Contractor shall drill all caissons of specified sizes to required depths suitable for achieving the intended design load. The methods of construction shall be as specified herein, but the Contractor shall be solely responsible for the adequacy of all operations.
- B. Caisson drilling equipment shall have the minimum torque capacity and downward force capacity for the site conditions to install the caissons to the required depth. Selection of equipment shall be the sole responsibility of the Contractor.
- C. Where required, casings shall be advanced ahead of the drill stem, and a soil plug of at least 5 ft shall be maintained until the casing is seated into bedrock. Drilling fluids, including but not limited to, water, mineral slurry, or polymer slurry shall be provided as necessary to ensure a stable bottom throughout drilling. All methods employed shall be as described in the Contractor's method statement as required by Item 1.5.G of this Section.
- D. The Contractor's drilling methods shall prevent inflow of soils from beyond the shaft limits (i.e., running sands, etc.) which can result in erosion, destabilization, and subsidence.
- E. The Contractor shall advance the rock socket to the minimum required depth and diameter shown on the Contract Documents. The drilling method should produce a rough surface on the side walls of the rock socket.
- F. As soon as the required rock socket length is reached the Contractor shall clean the caisson bottom of all loose material, and notify the Construction Manager and Special Inspector, who will determine the actual bottom depth. The socket lengths indicated on the Contract Drawings are approximate, and may be adjusted by the authorized representative depending on the conditions of rock encountered. The caissons shall be advanced into bedrock to obtain required socket length necessary for achieving the intended design load as determined by the Special Inspector.

- G. Down-hole digital video camera shall be performed by the Contractor to allow inspection of the rock socket by the Special Inspector. Caissons shall be flushed with clean water to remove sediment so that the side walls and bottom of the rock socket can be video inspected. Where conditions prevent the use of down-hole video, the Contractor shall provide alternative means to establish the quality of rock within caissons including but not limited to drilling of test borings with rock coring and associated geophysical testing. Where borings are to be utilized in lieu of down-hole video, such borings shall be performed in accordance with Section 023213, and shall be taken prior to full scale caisson drilling (at the center axis of the element).
- H. If the Special Inspector's inspection indicates that the rock is not capable of providing the required design capacity, the shaft length shall be advanced as directed by the Special Inspector, in consultation with the Owner's Engineer, and the above steps repeated, unless other recommendations are made by the Owner's Engineer.
- I. After shaft walls and bottom have been inspected and shown to comply with the Contract Documents, caissons shall be reinforced and filled immediately with concrete.
- J. Reinforcing steel shall be clean and free of foreign matter that may adversely affect bond. All reinforcing cages shall be centralized within the borehole and the minimum cover shown on the Contract documents shall be maintained. Steel shall be braced temporarily as required to facilitate making any required field splices and to maintain reinforcement in a suitable alignment.
- K. Concrete shall be continuously placed by methods that insure against segregation and dislodging of excavation sidewalls and shall completely fill the shaft. Concrete shall be placed by tremie unless otherwise approved by the Owner's Engineer. The discharge shall be kept a minimum of 6 feet below the fresh concrete surface during placement. Concrete shall be pumped until fresh concrete is observed to be continuously discharging from the top of the caisson.
 - 1. Reinforcing steel shall be placed within a maximum of 72 hours after the completion of the drilling of the rock socket unless otherwise approved by the Engineer.
 - 2. Concrete shall be placed within 2 hours after installing the reinforcing steel unless otherwise approved by the Engineer.
- L. Drilling of caissons shall not be permitted within 20 feet of concrete that has not cured for at least 3 days unless otherwise approved by the Owner's Engineer.
- M. A maximum of 2-inches of sediment will be permitted to accumulate at the bottom of the rock socket after video inspection and prior to concrete placement. The Contractor shall flush the rock socket immediately prior to placing concrete to suspend sediment accumulated in the bottom of the socket. The Contractor shall remove sediment greater than 2-inches prior to concrete placement.
- N. Concrete shall be placed using underwater tremie techniques only after water flow has stabilized.
- O. A rubber plug or other temporary separation device shall be utilized to prevent mixing of water and concrete in the tremie pipe. Tremie pipes shall be removed from the caisson following concrete placement unless otherwise approved by the Owner's Engineer.
- P. Reinforcing steel shall be centralized and braced as necessary to remain within proper alignment until concrete has set.
- Q. Concrete shall be brought to a true level surface inside the shaft and a full width cross key

formed or dowels installed should it become necessary to interrupt placing concrete in any caisson. Prior to placing additional concrete, clean surface of laitance and slush with 1:1 Portland cement grout. The grout shall have a water cement ratio not exceeding that of the concrete.

- R. No extra payment will be made to the Contractor for overcoming of obstructions under any condition whatsoever.
- S. During drilling of caissons, all openings shall be properly protected and covered when work is not in progress. Prevent debris from being dislodged in the caisson and concrete. Suitable lights and barricades shall be provided as required.

3.3 CAISSONS CUT OFF

- A. Caissons shall be cut-off in a neat and workmanlike manner to the elevations given or implied from the drawings. Cutting shall be done with approved equipment that will not damage the area below the cut surface.
- B. Where caissons are cut-off below the stipulated elevation, and where accepted by the Architect, the caisson cap may be both lowered and thickened so as to properly engage the caisson.
- C. Removal: Caissons cut material, regardless of length or volume, shall be the property of Contractor, and shall be disposed of in a legal manner. All debris resulting from excavation and drilling, removal of obstructions, and any material not to remain as part of the construction is to be removed and disposed of off-site by Contractor in a legal manner. The site shall be cleaned at frequent intervals and no material shall be stored on the site in a manner which would obstruct the easy access of equipment and personnel stock piling of material will not be permitted except where accepted by Construction Manager.

3.4 LOAD TESTING

- A. Axial Load Testing: None Required
- B. Lateral Load Testing:
 - 1. Perform a minimum of 2 successful lateral load tests for each caisson diameter.
 - 2. Load tests shall be performed at locations selected by the Owner's Engineer.
 - 3. All load tests shall be performed in accordance with ASTM D3966 and evaluated in accordance with the NYCBC.
 - 4. Load tests shall be administered by the Contractor and shall be observed by the Special Inspector. The Special Inspector shall record all load test data.
 - 5. A detailed report shall be prepared by the Special Inspector and shall be submitted for review by the Owner's Engineer(s). The load test report shall include but not be limited to the following information:
 - a. Caisson ID, design loads, geometry, and materials
 - b. Description of installation methods and equipment
 - c. Description of subsurface information including boring and testing logs
 - d. Caisson installation logs and notes
 - e. Description and details of test apparatus and methods
 - f. Elevations and datum
 - g. Concrete strength at time of testing
 - h. Test data and notes pertaining to each test
 - i. Evaluation and rated capacity per NYCBC acceptance criteria.
 - 6. Caissons tested as pairs by pushing or pulling one another shall be considered a single

- load test, unless otherwise acceptable to the Owner's Engineer.
7. Caissons not meeting the prescribed design loads shall be immediately brought to the attention of the Owner's Engineer(s).

3.5 MONITORING

A. General

1. Monitoring of surrounding structures, utilities and tunnels shall be performed in accordance with Sections 310901.

B. Verticality

1. Inclination of the casing shall be checked prior to initiation of drilling by optical surveying techniques or as approved by the Owner's Engineer. The plumbness measurement shall be provided to the Special Inspector and Construction Manager prior to commencing with drilling. Initial deviation from vertical shall not be greater than 1 percent prior to proceeding with drilling.
2. The inclination of the borehole shall be checked at intervals not to exceed 15 ft during drilling to ensure that deviations are within acceptable tolerances in accordance with the Contractors approved method statement and procedures.
3. Should any caissons within 25 ft of existing PANYNJ tunnels exceed any of the tolerances noted in Section 3.5 the Contractor shall cease drilling and take corrective action including but not limited to backfilling with approved materials, extraction of all casing, and redrilling in accordance with the approved corrective action plan.

3.6 TOLERANCES

- A. Shafts shall be vertical and with minimum diameter as indicated on the Contract Drawings or as approved by the Owner's Engineer.
- B. Maximum permissible deviation of center of top of any caisson from required location at cut-off shall be 0.5-inches. Shaft shall not be out of plumb more than 1% of shaft length, based on the final centers at top and bottom of caisson. Tolerances shall be determined in the field by optical survey, performed by a Licensed Surveyor retained by the Contractor.
- C. Maximum permissible deviation of the center of the core beam from the as-built center of the caisson shall be 0.5-inches.
- D. Maximum permissible deviation of rebar cages from the as-built center of the caisson shall be 0.5-inches. Distribution and placement of rebar shall meet the standard tolerances described in ACI 318-11.
- E. Tolerances shall be determined in the field by optical survey, performed by a Licensed Surveyor retained by the Contractor.
- F. Damaged caissons, and caissons drilled outside the required drilling tolerances, will not be accepted.
- G. Caissons rejected after drilling shall be cut-off and additional caissons drilled to replace the lost capacity as required by the Structural Engineer.
- H. If tolerances are exceeded, design and furnish, at no additional cost, all additional or corrective construction to compensate for excessive eccentricity. Corrective construction shall be submitted for approval by the Owner's Engineer(s).

- I. The Contractor shall be responsible for all costs associated with review of such calculations and corrective construction by the Owner's Engineer(s).
- J. Approvals: The Special Inspector will make final approval of caisson shaft holes and authorize subsequent concrete placement.

3.7 SEQUENCE OF WORK

- A. Drilling of caissons shall be performed so that reinforcing steel and concrete placement is a continuous operation performed the same day that the excavation is completed, and in no instance greater than 72 hours following excavation, unless otherwise approved by the Owner's Engineer.
- B. Concrete shall be placed within 2 hours after placement of reinforcement, unless otherwise approved by the Owner's Engineer. The Contractor shall flush the rock socket immediately prior to placing concrete to suspend sediment accumulated in the bottom of the socket.

3.8 CLEAN-UP

- A. All debris resulting from excavation and drilling, removal of obstructions, cut-off butts, and any material not to remain as part of the construction is to be removed and disposed of off-site by the Contractor in a legal manner at no additional cost to the Owner.
- B. The site shall be cleaned at frequent intervals and no material shall be stored on the site in a manner which would obstruct the easy access of equipment and personnel. Stockpiling of material will not be permitted.

3.9 WASTE MANAGEMENT

- A. Separate and dispose of waste in accordance with the Project's Waste Management Plan.

3.10 CLOSEOUT

- A. Substantial Completion Requirements:
 - 1. Provide Final Cleaning immediately prior to Substantial Completion inspection.
 - 2. Corrective Work:
 - a. Remove, Repair and Reinstall, or Restore in Place damaged items.
 - b. Replace damaged materials or items if repair not acceptable to Architect.
 - 3. Provide product data to complete Operation & Maintenance Manuals.
 - 4. Submit executed Warranties.

END OF SECTION

SECTION 319000

TRENCH EXCAVATION AND BACKFILL

PART 1 - GENERAL

1.1 SUMMARY

- A. Work of this section, as shown or specified, shall provide trench excavation and backfill in accordance with the requirements of the Contract Documents. The Contractor must accept the site as-is and shall be deemed to have inspected the site and reviewed all Contract Documents prior to submitting a bid.

1.2 WORK INCLUDED

- A. Overall work under this Contract shall include all labor, materials, equipment, supervision, coordination efforts, permitting costs, certificate costs, services, filing fees, testing costs, security, insurance and all other associated or related items specified herein that are necessary and are required to complete the Work. Work elements shall include:
 - 1. Excavating trenches for the installation of utilities.
 - 2. Backfilling trench with bedding aggregate as specified and finish filling trenches with suitable material to proposed subgrade.
 - 3. Compacting subgrade, bedding, and backfill materials in an acceptable manner.
 - 4. Compliance with all environmental and health and safety regulations.

1.3 SUBMITTALS

- A. No work shall be performed until shop drawings, if required, have been reviewed and accepted by the Owner. The Contractor shall contact all utility companies and identify any requirements. Contractor shall provide written confirmation of the status of all utility construction to the Owner at the time of the preconstruction conference or no later than 30 days following the project possession date.
- B. The Contractor must provide the following submittals to the Owner for approval prior to purchase of materials:
 - 1. Submit a sample of each type of offsite fill and/or bedding material that is to be used in backfilling.
 - 2. Material Certificates: Submit materials certificate to the Owner's which is signed by material producer and Contractor, certifying that materials comply with, or exceed, the requirements herein and applicable regulatory requirements.

1.4 OWNER'S RESPONSIBILITIES

- A. The Owner will retain an independent testing agency to perform material testing as required. The Contractor shall provide any necessary assistance to the testing agency and provide the testing agency with the intended construction schedule at least one week prior to the start of construction.
- B. NYC DOB Special Inspections
 - 1. The Owner will retain an independent testing agency to perform special inspections as required by the NYC Building Code.

1.5 CONTRACTOR RESPONSIBILITIES

- A. Contractor is responsible for coordinating this work with other trades on-site.

1.6 PERMITS AND APPROVALS

- A. Contractor shall prepare and obtain all required permits prior to construction unless otherwise directed by Owner. Copies of all permits shall be supplied to the Owner prior to the commencement of work authorized by the permit.
- B. Connections with existing facilities shall be performed in accordance with the requirements of the Owner of the facility. The Contractor shall be required to comply with all such requirements, including securing all permits, and payment of all permit and/or connection fees.

1.7 RELATED SECTIONS AND DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 00 and 01 Specification Sections.
- B. Project Specifications:
 - 1. Section 020110 – Maintenance of Existing Conditions
 - 2. Section 310000 – Earthwork
 - 3. Section 312500 – Protection of Existing Utilities
 - 4. Section 312500 – Erosion and Sedimentation Controls
 - 5. Section 321313 – On-site Concrete Paving
 - 6. Section 322000 – Pavement Restoration Within City Right-Of-Way
- C. Contract Documents and Contract Drawings
- D. Refer to Preliminary Geotechnical report dated 21 April 2016 by Langan for soil conditions.

1.8 REFERENCE STANDARDS

- A. Unless more restrictive criteria or differing requirements are explicitly stated in the Specifications, or mandated by governing codes or regulations, the recommendations, suggestions, and requirements described in the referenced standards shall be deemed mandatory and applicable to the Work.
- B. The latest edition, as of the date of the executed construction contract, of referenced standards listed below applies to this contract.
 - 1. American Society for Testing and Materials (ASTM) Latest Edition
 - a. ASTM D 422 - Method for Particle Size Analysis
 - b. ASTM D 698 - Test of Moisture Density Relations of Soils - Standard Proctor Method
 - c. ASTM D 1557 - Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.
 - d. ASTM D 2216 - Test Method for Laboratory Determination of Water (Moisture) Content of Rock and Soil.
 - e. ASTM D 2487 - Test Method for Classification of Soils for Engineering Purposes.
 - f. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

- g. ASTM D 3017 - Test for Moisture Content of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)
- h. ASTM D 4318 - Test for Plastic Limit, Liquid Limit, & Plasticity Index of Soils
- 2. American Association of State Highway and Transportation Officials (AASHTO) Latest Edition
 - a. T88 Mechanical Analysis of Soils

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Bedding aggregate: AASHTO No. 57 processed sand and gravel free from debris, clay lumps, organic, or other deleterious material, and complying with the following gradation requirements:
- B.

Sieve Size	Percent Passing (by weight)
1 ½ Inch	100
1 Inch	90-100
1/2 Inch	20-60
No. 4	0-10
No. 8	0-5
- C. Backfill material as specified in Section 31 00 00 and approved by the Owner and/or the Engineer.

PART 3 - EXECUTION

3.1 GENERAL SITE PREPARATION

- A. Set all lines, elevations, and grades for utility and drainage system work and maintain for the duration of work. Provide careful maintenance of benchmarks, property corners, monuments, or other reference points.
- B. Protect and maintain in operating condition, existing utilities encountered during utility installation. Repair any damage to surface or subsurface improvements shown on Drawings.
- C. Install dewatering systems that will be required to construct the proposed utilities to the design elevations and using the methods described herein. Water pumped out of excavations shall be disposed of on-site, and will not be discharged directly to the city storm drainage system.
- D. Preparation for utility trenching shall be in accordance with Section 31 00 00.
- E. All utilities intended to connect to services within any building will be extended to within 5 feet of the exterior face of building in the direction and elevation to connect at those geometrical locations indicated or inferred on the drawings. All utility ends will be plugged and marked by a 2" x 4" piece of wood extending from the utility invert to 4 feet above final grade.

3.2 EXCAVATION

- A. Contact local utility companies before excavation begins. Dig trenches at proper width and depth for laying pipe, conduit, or cable and in accordance with utility company requirements. Cut trench banks for safety and remove stones as necessary to avoid point bearing.
- B. All trench excavation side walls shall be sloped, shored, sheeted, braced or otherwise supported by means of sufficient strength to protect the workmen within them in accordance with the applicable rules and regulations established for construction by the Department of Labor, Occupational Safety and Health Administration (OSHA), and by local ordinances. Lateral travel distance to an exit ladder or steps shall not be greater than 25 feet in trenches 4 feet or deeper.
- C. Trench width requirements below the top of the pipe shall not be less than 12" nor more than 18" wider than outside surface of any pipe or conduit that is to be installed. All other trench width requirements for pipe, conduit, or cable shall be the minimum practical width that will allow for proper compaction of trench backfill and satisfy safety and utility company regulations.
- D. Accurately grade trench bottom to an elevation 6 inches below the pipe, as per bedding details in construction drawings. Provide uniform bearing and support for each section of pipe on bedding aggregate at every point along the entire length, except where necessary to excavate for bell holes, pipe joints, or other required connections. Dig bell holes and depressions for joints after trench bottom has been graded. Dig no deeper, longer, or wider than needed to make the joint connection properly.
- E. During excavation, stockpile excavated material suitable for backfilling in an orderly manner far enough from the trench to avoid overloading, slides, or cave-ins.
- F. Remove excavated materials from the site which are not suitable for backfill.
- G. Any abandoned structures, utilities or debris discovered during excavation shall be removed and disposed of, or capped and filled with flowable fill.
- H. Utility alignments have been designed to avoid expected obstructions wherever possible. If unanticipated significant obstructions are encountered during utility installation work immediately notify the Owner and Engineer.
- I. Prevent surface water from flowing into trenches or other excavations by temporary grading or by other methods, as required. Remove accumulated water in trenches or other excavations by pumping or other acceptable methods. Water shall not be directly pumped to the city sewer system.
- J. Utility installation shall meet the following minimum pipe installation depths, or applicable codes and ordinances, measured from finished grade or the paved surface.
 - 1. Storm Sewer: Elevations, and grades as shown on Construction Drawings.

3.3 FILL PLACEMENT, GRADING, AND COMPACTION

- A. BACKFILLING
 - 1. Backfilling for utilities shall be in accordance Section 31 00 00.

B. COMPACTION

1. All off-site materials used for backfill shall be tested in accordance with Section 31 00 00.
2. Exercise proper caution when compacting immediately over top of pipes or conduits.
3. Maintain optimum moisture content of fill materials to attain required compaction density.

3.4 CLEANING

- A. The Contractor shall remove all excess material, including earth, rock, and fill, from site and legally dispose of it.
- B. The Contractor shall be responsible for removal of all debris from the site produced by the Work of this Section.
- C. The Contractor shall ensure that the sidewalk and streets adjoining the property are broom cleaned and free of debris, rubbish, trash and obstructions of any kind caused by the Work of this Section.

3.5 EMBEDDED ITEMS

- A. Utility bedding shall be in accordance with Section 31 00 00 and this Section.

3.6 MAINTENANCE AND PROTECTION

- A. The Contractor shall protect newly graded areas from erosion and traffic. They shall keep the work area free of trash and debris.
- B. The Contractor shall repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.
- C. Where completed or compacted areas are disturbed by subsequent construction operations or adverse weather, the Contractor shall scarify surface, reshape, and compact to required density prior to any further construction.
- D. Where settling is measurable or observable at excavated areas during the general project warrantee period, the Contractor shall remove the surface (pavement, or other finish), add backfill material, compact, and replace surface treatment. They shall restore the appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

END OF SECTION

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SECTION 321216
ON-SITE ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections apply to this Section.

1.2 SUMMARY

- A. Work of this section, as shown or specified, shall provide On-Site Asphalt Paving in accordance with the requirements of the Contract Documents. The Contractor must accept the site as-is and shall be deemed to have inspected the site and reviewed all Contract Documents prior to submitting a bid.

1.3 WORK INCLUDED

- A. Overall work under this Contract shall include all labor, materials, equipment, supervision, coordination efforts, permitting costs, certificate costs, services, filing fees, testing costs, security, insurance and all other associated or related items specified herein that are necessary and are required to complete the Work. Work elements shall include:
 - 1. All asphalt work in this specification is for on-site work only. Public sidewalk work is excluded.

1.4 SUBMITTALS

- A. No work shall be performed until shop drawings, if required, have been reviewed and accepted by the Owner.
- B. The Contractor must provide the following submittals to the Owner for approval prior to purchase of materials:
 - 1. Material Certificates: Submit materials certificate to the Owner's which is signed by material producer and Contractor, certifying that materials comply with, or exceed, the requirements herein and applicable regulatory requirements.
 - 2. Product Warranty: Submit documentation of standard product warranty terms for all products pertaining to this section.
 - 3. Design Mix: Before any asphaltic concrete paving is constructed, submit actual design mix to the Owner's Representative for review and/or approval. Design mix submittal shall include the type/name of the mix, gradation analysis, grade of asphalt cement used, sources of all ingredient materials, and percentages by weight and the number of pounds of each of the materials and direct references to the Standard Specifications sections for each material. Mix designs over three (3) years old will not be accepted by the owner.

1.5 QUALITY ASSURANCE

- A. The Contractor shall submit the required submittals to the Owner or the Engineer at least one week prior to the start of construction for approval.

1.6 OWNER'S RESPONSIBILITIES

- A. The Owner will retain an independent testing agency to perform material testing as required. The Contractor shall provide any necessary assistance to the testing agency and provide the testing agency with the intended construction schedule at least one week prior to the start of construction.

1.7 CONTRACTOR RESPONSIBILITIES

- A. Contractor is responsible for coordinating this work with other trades on-site.

1.8 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle materials as recommended by the manufacturer to protect from damage.

1.9 PERMITS AND APPROVALS

- A. Contractor shall prepare and obtain all required permits prior to construction unless otherwise directed by Owner. Copies of all permits shall be supplied to the Owner prior to the commencement of work authorized by the permit.

1.10 PROJECT RECORD DOCUMENTS

- A. Upon completion of the work of this and related sections, the contractor shall provide the Owner with an as-built survey of all new utilities. The data shall include elevations, tied into established project benchmarks. The survey shall be provided in digital (AutoCAD DWG) and paper formats, and shall be signed and sealed by a New York State Licensed Professional Land Surveyor. This survey may be combined with other as-built survey requirements of site-work items, with the approval of the Owner. Marked-up design plans are not acceptable for the requirements of this section. All survey elevations shall be in North American Vertical Datum (NAVD) 88.

1.11 RELATED SECTIONS AND DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 00 and 01 Specification Sections.
- B. Contract Documents and Contract Drawings
- C. Project Specifications:
 - 1. Section 02 01 10 – Maintenance of Existing Conditions
 - 2. Section 02 10 00 – Protection of Existing Utilities
 - 3. Section 31 00 00 – Earthwork
 - 4. Section 31 90 00 – Trench Excavation and Backfill
- D. Contract Documents and Contract Drawings

1.12 REFERENCE STANDARDS

- A. Unless more restrictive criteria or differing requirements are explicitly stated in the Specifications, or mandated by governing codes or regulations, the recommendations,

suggestions, and requirements described in the referenced standards shall be deemed mandatory and applicable to the Work.

- B. The latest edition, as of the date of the executed construction contract, of referenced standards listed below applies to this contract.
1. New York City Department of Transportation Standard Highway Specifications, dated November 1, 2012, and as amended to date.
 2. American Society for Testing Materials (ASTM)
 - a. ASTM D946 Penetration Graded Asphalt Cement for use in Pavement Construction
 - b. ANSI/ASTM D1557 – Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures using 10 lb (4.54 Kg) Hammer and 18 inch (457 mm) Drop.
 - c. ASTM D2922 – Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth), Method B (Direct Transmission).
 - d. ASTM D424 – Standard Method of Test for Plastic Limit
 - e. ASTM C33 – Standard Specification for Concrete Aggregates
 - f. ASTM D1559 – Test Method for Resistance of Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
 - g. ASTM D2028 – Standard Specification for Cutback Asphalt (Rapid-Curing Type)
 - h. ASTM D2950 - Density of Bituminous Concrete in Place by Nuclear Methods
 - i) ASTM D2041 - Specific Gravity and Density of Bituminous Paving Mixture, Theoretical Maximum
 3. TAI - (The Asphalt Institute)
 - a. TAIMS-2 Mix Design Methods for Asphalt Concrete and Other Hot Mix Types
 - b. TAI - MS-8 Asphalt Paving Manual

1.13 PERFORMANCE REQUIREMENTS

- A. Contractor shall maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

1.14 ENVIRONMENTAL REQUIREMENTS

- A. Weather Limitations: Do not place asphalt pavement top course when ambient air or base surface temperature is less than 40 degrees F, or surface is wet. Asphalt binder course may be placed when ambient air or base surface temperature is above 30 degrees and rising and base is dry.
- B. Apply tack coat when ambient air or base surface temperature is above 50 degrees F for 12 hours immediately prior to application. Do not apply when base is wet.

PART 2 - PRODUCTS

2.1 ASPHALT MATERIALS

- A. Asphaltic Concrete Wearing Course

- Asphaltic concrete wearing course shall consist of a binder mixture and a fine-mix asphaltic concrete surface course mixture in layer thicknesses indicated on Drawing.
- Asphaltic cement shall comply with the requirements of ASTM D946, except that the ductility test shall be run at 60 degrees Fahrenheit and that the petroleum derivative in the Spot Test with standard naphtha solvent in 24 hours shall be negative. Asphaltic cement shall be NYCDOT viscosity grade AC-20 meeting the requirements listed below and shall be either fluxed natural asphalt or residual asphalt derived from the distillation of asphaltic petroleum.

NYCDOT Grade	AC-10		AC-20	
Requirements	Min.	Max.	Min.	Max.
Viscosity@ 140F(60C), poises	800	1200	1600	2400
Viscosity@ 275F(135C), Cs.	250 *	-	300 *	-
Penetration, 77F(25C) 100g, 5 sec.	70 *	120	60 *	100
Flash Point, COC, F (C)	425 (219)	-	450 (232)	-
Solubility in Trichloroethylene, %	99	-	99	-
Test on residue from Thin-film oven test (TFOT): Viscosity, 140 F (60 C), P Loss on heating, % Ductility, 77F (25C). 5 cm/min., cm	- - 75*	5,000 0.50 -	- - 50**	10,000 0.50 -
Viscosity Ratio: poises @ 140F (60C) after TFOT poises @ 140F (60C) before TFOT	-	4***	-	4***

NOTE * For asphalt cements refined from Domestic Mid-continent or Canadian crudes, the following limits shall apply: Visc., 275F, Cs. - 200 min.; Pen. 77F, 100g, 5 sec. - 60 min.; and TFOT residue Duct. 60F, 5 cm./min. - 10 min.

NOTE ** For asphalt cements refined from Domestic Mid-continent or Canadian crudes, the following limits shall apply: Visc., 275F, Cs. - 250 min.; Pen 77F, 100g., 5 sec. - 50 min.; and TFOT residue Duct. 60F, 5 cm./min. - 5 min.

NOTE *** For asphalt cements refined from Boscan crude, the following limits shall apply: Viscosity Ratio - 5 max.

- The above requirements denoted with an asterisk (*) may deviate for asphalt cements refined from Domestic Mid-continent, Canadian, or Boscan crudes with prior approval of the Owner's Representative.

4. Sand shall be of NYCDOT Type 2A or 2B and shall consist of clean, hard, durable, rough-surfaced mineral particles. Sand shall not contain any deleterious substances in excess of that shown in Table 1 of ASTM C33.

B. Asphaltic Concrete Surface Course

1. Coarse aggregate for binder mix shall be a NYCDOT Type 1, Grade B, AASHTO size #57 stone. Coarse aggregate for fine-mix surface course shall be a NYCDOT Type 1, Grade A, AASHTO size #8 stone. NYSDOT Standard Specifications section 401-2, Type 7, Item 403.18.
2. Mineral dust shall be limestone or other approved dust, be thoroughly dry when delivered, be of one grade, and contain no more than 50% free silicon dioxide. Dust shall have a record of satisfactory performance in pavements for not less than three (3) years. Mineral dust shall not be permitted in Binder Mixture.
3. Aggregate within asphaltic concrete mixes shall comply with the following sieve analyses:

Sieve Size	Binder Course		Fine-Mix Surface Course	
	% Passing	Tol.(%)	% Passing	Tol.(%)
1 1/2"	100	-		
1"	95-100	-	100	-
1/2"	70-90	± 6	90-100	-
1/4"	48-74	± 7	65-85	± 7
1/8"	32-62	± 7	36-65	± 7
#20	15-39	± 7	15-39	± 7
#40	8-27	± 7	8-27	± 7
#80	4-16	± 4	4-16	± 4
#200	2-8	± 2	2-6	± 2
Bitumen percent by weight soluble in chloroform	4.5-6.5	± 0.4	5.8-7.0	± 0.4

4. Tack Coat shall be rapid curing liquid asphalt conforming to ASTM D2028 Grade RC-70, and shall be a product of fluxing an asphaltic residuum with a distillate. Liquid

asphalt shall be homogeneous and free from water. Homogeneous Asphalt Emulsion Tack Coat conforming to NYSDOT Material Designation 702-90.

C. Asphalt Curb:

1. The Contractor shall have the option of supplying the mix specified herein or he may elect to furnish an alternate mixture subject to prior approval by the Owner's Representative. The requirements of NYSDOT Section 401 - Hot Mix Asphalt Production shall apply with the following modifications:
 - a. Automatic batching and recording equipment will not be required.
 - b. The asphalt concrete mix shall include a powdered, devulcanized tire rubber which is moisture free, black in color, free flowing and containing no fabric or cord material. The gradation shall conform to NYSDOT Section 714-06 Asphalt Concrete Curb.
 - c. The asphalt cement used in the mix shall comply with either material specification NYSDOT Sections 702-0400, 702-0500, or 702-0600.
 - d. The aggregate gradation shall conform to NYSDOT Section 714- 06 Asphalt Concrete Curb.
2. Tack Coat: Homogeneous Asphalt Emulsion Tack Coat conforming to NYSDOT Material Designation 702-90.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify sub-base conditions under provisions of Section 32 12 16. Proof roll base material surface to check for areas requiring additional compaction and areas requiring removal and re-compaction.
- B. Verify that compacted sub-base is dry and ready to support paving and imposed loads.
- C. Verify gradients and elevations of base are correct, including crown and cross slope.

3.2 INGREDIENTS

- A. The asphaltic cement shall be heated in approved receptacles to a temperature between 275 and 325 degrees F. It shall be kept uniform in composition and consistency by thorough mixing and agitation. Approved methods of agitation that will not injure the cement shall be used.
- B. The materials comprising the charge for each batch shall be proportioned accurately by weight or by volume. The proportioning apparatus shall be of approved NYCDOT design, kept in good working order and accurate to 0.5 percent. Fluid materials may be measured by approved fluidometers.
- C. When mixed in a batch mixer prior to the addition of the asphaltic cement, the aggregate shall be deposited in the mixer and thoroughly mixed for a period of not less than ten seconds for binder mixture and fifteen seconds for surface mixtures.
- D. Mixing shall be continued until a homogeneous mixture is produced in which all particles of the mineral aggregate are completely coated with asphaltic cement.

3.3 PREPARATION

- A. Saw cut existing pavement to produce a clean, straight edge for new work to meet.
- B. Verify that substrate has been inspected and that substrate is hard, uniform and stable, true to gradients and elevations, and dry prior to any sub base course construction.
- C. Proof roll base material surface to check for areas requiring additional compaction and areas requiring removal and re-compaction.
- D. Do not begin paving work until deficient base material areas have been corrected and are ready to receive paving.
- E. Weather limitations:
 - 1. Apply tack coat when ambient temperature is above 40°F, and when temperature has been above 35°F for 12 hours immediately prior to application. Do not apply when base is wet, contains excess moisture, or during rain.
 - 2. Construct asphaltic concrete paving when atmospheric temperature is above 40°F.

3.4 TRANSPORTATION

- A. Asphalt mixtures shall be transported to work site in tight vehicles having clean and smooth heated metal beds and protected from weather.
- B. The inside surface of transportation vehicles shall be lightly coated, just before the vehicles are loaded, with either a whitewash of lime and water, soap solutions, or detergents, as approved by the Commissioner. After application, the truck bodies shall be raised for a sufficient time to allow the excess fluid to drain.

3.5 APPLICATION

- A. Tack Coat
 - 1. Apply to contact surfaces of previously constructed asphaltic concrete base courses or Portland cement concrete and surfaces abutting or projecting into asphaltic concrete or into asphaltic concrete pavement.
 - 2. Apply tack coat between each lift or layer of full depth asphaltic concrete and on surface of all such bases where asphaltic concrete paving will be constructed.
 - 3. Apply at minimum rate of 0.10 gallon per square yard of surface.
 - 4. Allow to dry until at proper condition to receive paving.
- B. Asphaltic Concrete Placement
 - 1. Place asphaltic concrete mixture on completed compacted subgrade surface, spread, and strike off. Spread mixture at following minimum temperatures:
 - a. When ambient temperature is between 40°F and 50°F, mixture temp. = 285°F
 - b. When ambient temperature is between 50°F and 60°F, mixture temp. = 280°F
 - c. When ambient temperature is higher than 60°F, mixture temp. = 275°F
 - 2. Whenever possible, all pavements shall be spread by a finishing machine; however, inaccessible or irregular areas may be placed by hand methods. The hot mixture shall be spread uniformly to the required depth with hot shovels and rakes. After spreading, the hot mixture shall be carefully smoothed to remove all segregated course aggregate

and rake marks. Rakes and lutes used for hand spreading shall be of the type designed for use on asphalt mixtures. Loads shall not be dumped faster than can be properly spread. Workers shall not stand on the loose mixture while spreading.

3. Place in typical strips not less than 10' 0" wide or the full path width, whichever is smaller. Place in strips of equal width for each driving lane. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Any irregularities in the surface of the pavement shall be corrected directly behind the paver. Excess materials forming high spots shall be removed. Indented areas shall be filled with hot mix and smoothed. Casting of mix over such areas will not be permitted.
4. Joints: Make joints between old and new pavements, or between successive days and work in a manner that will provide a continuous bond between adjoining works. Construction joints shall have same texture, density, and smoothness as other sections of asphaltic concrete course. Clean contact surfaces of all joints and apply tack coat.

C. Placing Extruded Asphalt Curb

Use one of the following methods, or other method approved by the Engineer, to furnish and place an asphalt concrete curb of the required cross-section

1. Method A:
 - a. After completing the surface course, paint or spray only the area to be occupied by the asphalt concrete curb with tack coat. Apply the asphalt material at the rate of 0.15 gallon per square yard (0.7 L/m²).
 - b. Place the curb with a hand-operated or self-propelled machine consisting of a hopper and power-driven screw, which forces the material through an extrusion tube. Force the material through a die attached to the end of the extrusion tube to obtain the proper density and cross-section.
2. Method B:
 - a. As an independent operation preceding the final rolling of the asphalt concrete surface course that the curb is placed, place loose asphalt concrete of sufficient height and shape by hand methods using suitable templates or by other means to produce the specified cross-section.
 - b. Compact the loose asphalt concrete using a hand-operated mechanical vibrating tamper equipped with a compacting shoe of such shape that will produce the specified final cross-section dimensions of the curb.

3.6 ROLLING AND COMPACTION

1. The mixture, after being spread, shall be thoroughly compacted by rolling as soon as it will bear the weight of the rollers without undue displacement. The number, weight, and types of rollers and sequences of rolling operations shall be such that the required density and surface are consistently attained while the mixture is in a workable condition.
2. The bituminous concrete pavement shall have a minimum thickness as specified on the Contract Documents and should be compacted to a minimum of 96% of the maximum unit weight as determined by the Marshall Mix Design Procedures in accordance with ASTM D-1559.
3. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.
4. Breakdown Rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling, and repair displaced areas by loosening and filling with hot material.
5. Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.

6. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.
7. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut out such areas and fill with fresh, hot asphaltic concrete. Compact by rolling to maximum surface density and smoothness.
8. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 CLEANING

- A. Clean-up and dispose of all surplus or waste material as a result of work of this section. Asphalt Pavement shall be broom cleaned and the surrounding area shall be cleaned of any loose asphalt mix.

3.8 CORRECTION OF THE WORK

- A. Correction of faulty work shall be completed at no additional cost to the Owner.

3.9 FIELD QUALITY CONTROL

- A. Grade Control: Establish and maintain required lines and elevations.
- B. Temperature: The Owner's Representative shall monitor the asphaltic concrete mixture on the paver immediately prior to spreading asphalt mixture to certify that the minimum temperature requirements of this section are met. Temperature measurement shall be taken on the average of one test per 20 tons of material.
- C. Thickness: In place compacted thickness shall not be less than thickness specified on the drawings. Areas of deficient paving thickness shall receive a tack coat and a minimum 1" overlay; or shall be removed and replaced to the proper thickness, at the discretion of the Owner; until specified thickness of the course is met or exceeded at no additional expense to the Owner. Saw cut adjacent pavement to match overlay; "feathering" shall not be permitted.
- D. Surface Smoothness: The Contractor shall perform testing on the finished surface of each asphalt concrete course for smoothness, using 10' 0" straightedge applied parallel with, and at right angles to centerline of paved area. These tests shall be performed under the observation of the Owner's Representative. Surfaces will not be acceptable if the following 10' straightedge tolerances for smoothness are exceeded.
 1. Wearing Course Surface: 3/16"
- E. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable paving as directed by Owner's Representative.
- F. Compaction: The Owner's Representative shall perform in place density tests as part of the construction testing requirements using the Nuclear Method in accordance with ASTM D-2922 Method B direct transmission. Field density tests shall be performed at the rate of one test per 20,000 square feet of pavement.

3.10 MAINTENANCE AND PROTECTION

- A. Immediately after placement, protect pavement from mechanical injury for 2 days, or until surface temperature is less than 140 degrees F.

3.11 TOLERANCES

- A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.
- B. Scheduled Compacted Thickness: Within 1/4 inch.
- C. Variation from True Elevation: Within 1/2 inch.

END OF SECTION

SECTION 321313
ON-SITE CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

- A. Work of this section, as shown or specified, shall provide on-site concrete paving in accordance with the requirements of the Contract Documents. The Contractor must accept the site as-is and shall be deemed to have inspected the site and reviewed all Contract Documents prior to submitting a bid.

1.2 WORK INCLUDED

- A. Overall work under this Contract shall include all labor, materials, equipment, supervision, coordination efforts, permitting costs, certificate costs, services, filing fees, testing costs, security, insurance and all other associated or related items specified herein that are necessary and are required to complete the Work. Work elements shall include:
 - 1. All concrete work in this specification is for on-site work only. Public sidewalk work is excluded.

1.3 SUBMITTALS

- A. No work shall be performed until shop drawings, if required, have been reviewed and accepted by the Owner.
- B. The Contractor must provide the following submittals to the Owner for approval prior to purchase of materials:
 - 1. Material Certificates: Submit materials certificate to the Owner's which is signed by material producer and Contractor, certifying that materials comply with, or exceed, the requirements herein and applicable regulatory requirements.
 - 2. Product Warranty: Submit documentation of standard product warranty terms for all products pertaining to this section.
 - 3. Concrete Formula: Before the Contractor begins to manufacture concrete, he shall secure the Engineer's approval of the formula he proposes to use. He shall submit for this purpose a statement, in writing, of the sources of all ingredient materials, the type and brand of the cement and the number of pounds of each of the materials in a saturated surface-dry condition making up on cubic yard of concrete. The range of water-cement ratios within which the concrete will be manufactured and the method of mixing to be employed shall also be stated. The approved formula shall not be changed without written permission of the Engineer.
 - 4. Welded Wire Fabric: Shop drawings of reinforcing steel showing the location and type of supports and tie wires shall be submitted to the Engineer for his approval before any work covered by these drawings is undertaken.
 - 5. Asphalt Design Mix: Before any asphaltic concrete paving is constructed, submit actual design mix to the Owner's Representative for review and/or approval. Design mix submittal shall include the type/name of the mix, gradation analysis, grade of asphalt cement used, sources of all ingredient materials, percentages by weight, and the number of pounds of each of the materials and direct references to the Standard Specifications sections for each material. Mix designs over three (3) years old will not be accepted by the owner.

6. Material Certificates: Submit materials certificate to the Owner's Representative which is signed by material producer and Contractor, certifying that materials comply with, or exceed, the requirements herein.
7. Contractor shall prepare and obtain all required permits prior to construction unless otherwise directed by owner. Supply permits to owner.
8. Submit, when applicable, Contractors proposed plans for hot and cold weather concreting. The review and acceptance of the proposed procedure will not relieve the Contractor responsibility for quality of finished product.
9. Contractor must submit delivery ticket from batch plant or delivery truck. Ticket shall include the mix design number, time of concrete mixing, and batching plant name.

1.4 QUALITY ASSURANCE

- A. The Contractor shall submit the required submittals to the Owner or the Owner's Engineer at least one week prior to the start of construction for approval.
- B. The Owner will retain an independent testing agency to perform the required tests. The Contractor shall provide any necessary assistance to the testing agency and provide the testing agency with the intended construction schedule at least one week prior to the start of construction.
- C. The Owner's testing agency shall randomly core the pavement at a minimum rate of one core per 20,000 square feet of pavement, with a minimum of 3 cores from heavy-duty areas and 3 cores from standard duty areas. Core shall be tested for thickness and quality of aggregate distribution. Core holes shall be patched immediately with Portland cement concrete conforming to section 2.2 and shall be finished to provide a level surface conforming to section 3.1E & 3.1F.

1.5 OWNER'S RESPONSIBILITIES

- A. The Owner will retain an independent testing agency to perform material testing as required. The Contractor shall provide any necessary assistance to the testing agency and provide the testing agency with the intended construction schedule at least one week prior to the start of construction.

1.6 CONTRACTOR RESPONSIBILITIES

- A. Contractor is responsible for coordinating this work with other trades on-site.
- B. Contractor shall maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, and handle materials as recommended by the manufacturer to protect from damage.

1.8 PERMITS AND APPROVALS

- A. Contractor shall prepare and obtain all required permits prior to construction unless otherwise directed by Owner. Copies of all permits shall be supplied to the Owner prior to the commencement of work authorized by the permit.

1.9 PROJECT RECORD DOCUMENTS

- A. Upon completion of the work of this and related sections, the contractor shall provide the Owner with an as-built survey of all new water, sewer, electric and gas service lines. The data shall include elevations tied into established project benchmarks. The survey shall be provided in digital (AutoCAD DWG) and paper formats, and shall be signed and sealed by a New York State Licensed Professional Land Surveyor. This survey may be combined with other as-built survey requirements of site-work items, with the approval of the Owner. Marked-up design plans are not acceptable for the requirements of this section. All survey elevations shall be in North American Vertical Datum (NAVD) 88.

1.10 RELATED SECTIONS AND DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 00 and 01 Specification Sections.
- B. Project Specifications:
 - 1. Section 020110 – Maintenance of Existing Conditions
 - 2. Section 021000 – Protection of Existing Utilities
 - 3. Section 312500 – Erosion and Sedimentation Controls
 - 4. Section 319000 – Trench Excavation and Backfill
- C. Contract Documents and Contract Drawings
- D. New York Department of Transportation (NYCDOT) Standard Specifications

1.11 REFERENCE STANDARDS

- A. Unless more restrictive criteria or differing requirements are explicitly stated in the Specifications, or mandated by governing codes or regulations, the recommendations, suggestions, and requirements described in the referenced standards shall be deemed mandatory and applicable to the Work.
- B. The latest edition, as of the date of the executed construction contract, of referenced standards listed below applies to this contract.
- C. FS TT-C-800 - Curing Compound, Concrete, for New and Existing Surfaces.
 - 1. New York Department of Transportation (NYCDOT) Standard Specifications.
 - 2. American Concrete Institute (ACI)
 - a. ACI 301 - Specifications for Structural Concrete for Buildings.
 - b. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
 - c. ACI 306 – 1-90 Standard Specification for Cold Weather Concreting
 - d. ACI 309 - Guide for Consolidation of Concrete
 - 3. American Society for Testing Materials (ASTM)
 - a. ANSI/ASTM A185 - Welded Steel Wire Fabric for Concrete Reinforcement.
 - b. ANSI/ASTM A497 - Welded Deformed Steel Wire Fabric for Concrete Reinforcement.
 - c. ASTM D946 Penetration Graded Asphalt Cement for use in Pavement Construction

- d. ANSI/ASTM D1557 – Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures using 10 lb (4.54 Kg) Hammer and 18 inch (457 mm) Drop
- e. ANSI/ASTM D1751 - Preformed Expansion Joint Fillers for Concrete Paving and Structural construction.
- f. ANSI/ASTM D1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
- g. ASTM A615 - Deformed and Plain Billet-Steel for Concrete Reinforcement.
- h. ASTM C31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field
- i. ASTM C33 – Standard Specification for Concrete Aggregates
- j. ASTM C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
- k. ASTM C94 - Ready Mix Concrete.
- l. ASTM C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
- m. ASTM C136 - Method for Sieve Analysis for Fine and Coarse Aggregate.
- n. ASTM C143 – Standard Test Method For Slump of Hydraulic Cement Concrete
- o. ASTM C150 – Standard Specification for Portland Cement
- p. ASTM C260 - Air-Entraining Admixtures for Concrete.
- q. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete.
- r. ASTM C 311, Standard Methods of Sampling and Testing Fly Ash and Natural
- s. ASTM D424 – Standard Method of Test for Plastic Limit
- t. ASTM C494 - Chemical Admixtures for Concrete.
- u. ASTM C 618, Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Uses as a Mineral Admixture in Portland Cement Concrete
- v. ASTM D698 - Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 5.5-lb (2.49 kg) Rammer and 12 in. (305 mm) drop.
- w. ASTM D1559 – Test Method for Resistance of Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
- x. ASTM D2922 – Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth), Method B (Direct Transmission)
- y. ASTM C 989, Ground Granulated Blast-Furnace Slag for Use in Concrete Mortars

PART 2 - PRODUCTS

2.1 CONCRETE STONE BASE

- A. Base material shall consist of Size No. 3 broken stone and conform to NYCDOT Type 1, Grade B: Broken Stone, Moderately Resistant to Abrasion; or other approved granular material containing not more than five (5) percent material passing a No. 200 mesh sieve and not more than (5) percent retained on a 2" square sieve.
- B. Aggregate shall be broken, clean, hard, unweathered stone of uniform quality. It shall consist of fragments roughly cubicle or pyramidal in shape.
- C. Aggregate shall comply with the following sieve analysis (percent by weight passing square sieve openings):

Size No. (ASTM C 33)	Nominal Size (inches)	3.5"	3"	2.5"	2"	1.5"	1"	3/4"	1/2"	3/8"	#4
3	2 to 1	-	-	100	90-100	35-70	0-15	-	0-5	-	-

2.2 CONCRETE PAVEMENT

- A. Concrete shall conform to NYCDOT Class B-32 Type IA: Normal Air-entrained concrete; a homogeneous mixture of the following:

1. Portland Cement

- a. Portland cement shall conform to NYCDOT Type 1: Normal. Cement shall be uniform in color. The brand shall have an established reputation of uniformity of character and have been successfully used in the United States for at least two (2) years. Cement shall be stored in such a manner as to permit easy inspection and to protect the cement from dampness and minimize warehouse set. Portland cement shall comply with the requirements of ASTM C 150.

2. Fine Aggregate

- a. Sand shall consist of clean, hard, durable, angular, rough-surfaced mineral particles and conform to NYCDOT Type 1A and comply with the following requirements:

Sieve Number	Total Passing -Percent By Weight
3/8"	100
No. 4	95-100
No. 8	--
No. 16	45-85
No. 50	10-30
No. 100	0-6

- b. Fineness Modulus of all sands shall not vary more than plus or minus 0.20 from the first approved test sample.
- c. Sand shall not contain any deleterious substances in excess of that shown in Table 1 of ASTM Designation C 33. The calculated quantity of sodium chloride shall not exceed three-tenths (0.3) of one percent, by weight.

3. Coarse Aggregate

- a. Coarse Aggregate shall be broken, clean, hard, unweathered stone of uniform quality and conform to NYCDOT Type 1, Grade B: Moderately Resistant to Abrasion, Size No. 57, ASTM Designation C-33, and comply with the following requirements:

Size No.(ASTM C 33)	NOMINAL SIZE (INCHES) (except as noted)	2"	1.5"	1"	3/4"	1/2"	3/8"	#4	#8	#1 6
57	1 to #4	-	100	95-100	-	25-60	-	0-10	0-5	-

4. Based on dry-rodded volumetric measurement of ingredient materials, concrete shall conform to the following properties, approximately equal to a "1:2:3¼" mix:

Class Of Concrete	Nominal Size Of Coarse Aggregate Used - Inches	Bags of Cement Per Cubic Yard Of Freshly Mixed Concrete – Minimum	Fine Aggregate Percentage By Weight of Total Aggregate
Class B-32	1.5	6.0	29 to 37

5. The volume of freshly mixed concrete shall be assumed to be the absolute volume of the cement, plus the volume of the unabsorbed water, plus the absolute volume of the aggregates in a saturated surface-dry condition, plus entrained air.
- Quantity of fine aggregate may be varied within the limits indicated according to the type of coarse aggregate used, in order to obtain a smooth, dense, homogeneous and plastic mixture.
 - Air-entrained concrete shall have an air content of 5.5% with a tolerance of 1.5%.

2.3 CONCRETE FILLER, EXPANSION JOINT, PREFORMED

- Prefomed Expansion Joint Filler shall be non-extruding and one-quarter (1/4) inch thick. The filler shall conform to either NYCDOT Type IV: Bituminous Fiber, conforming to ASTM Designation D 1751; closed cell neoprene, or approved equal.

2.4 CONCRETE WELDED WIRE FABRIC

- Welded wire fabric shall be 6x6 W29xW29 or approved equal and comply with the requirements of ASTM A185.

2.5 EQUIPMENT

- Maintain equipment in satisfactory operating condition and correct breakdowns in a manner that will not delay or be detrimental to progress of paving operations.
- Vibrators shall be internal type with an operating frequency between 8,000 and 12,000 vibrations per minute and average amplitude between 0.025-0.05 inches. The number, spacing, and frequency shall be as necessary to provide a dense and homogenous pavement and meet the recommendation of ACI 309.
- Hand held vibrators may be used in irregular areas only and meet the recommendations of ACI 309.

2.6 SUSTAINABILITY CHARACTERISTICS

- Minimum Recycled Content defined in Section 01 81 13 - "Sustainable Design Requirements"

1. Cementitious Materials:
 - a. Fly ash: 20% OR
 - b. Ground Granulated Blast Furnace Slag: 40% OR
 - c. Silica Fume: 10%
 2. Steel Reinforcing Bar: 60%
 3. Welded Wire Mesh: 60%
- B. All Design mixes subject to review and approval by Structural Engineer.
- C. Regional Content defined in Section 01 81 13 - "Sustainable Design Requirements". Report Regional Content only. No minimum requirement.
- D. VOC content limitations defined in Section 01 81 23 - "Volatile Organic Compound Limits".
- E. Paving Products: Minimum SRI 15.

2.7 CONCRETE MATERIALS

- A. Steel Faced Concrete Curb
1. Steel faced concrete curb construction within the public right-of-way shall conform to Section 4.09 "Curb, Concrete, Steel Faced" of the New York City Department of Transportation Standard Specifications

PART 3 - EXECUTION

3.1 INSTALLATION OF 4-INCH AND 7-INCH CONCRETE

- A. Excavation and Subgrade
1. Excavation shall be made to dimensions sufficient to permit the setting of forms. The earth subgrade, immediately before foundation material is placed on it, shall be compacted, smooth, parallel to and at the required depth below the finished pavement surfaced and be dampened with water, sufficient only to be absorbed by the subgrade. The Subgrade shall not be in a muddy or frozen condition and unsuitable material shall be removed and replaced with acceptable material thoroughly compacted.
- B. Stone Base
1. Base material shall be placed on the prepared subgrade and thoroughly compacted into lifts equal to the smaller of 6-inches in the full section thickness. Unsatisfactory subgrade material shall be removed and replaced with acceptable material and shall be thoroughly compacted to the satisfaction of the Engineer. The excavated material shall become the property of the Contractor and shall be removed from the site to the Engineer's satisfaction. The top surface shall be parallel to the finished grade and at a distance below the grade equal to the specified thickness of concrete. Additional depth of base material for special conditions shall be placed as required by the Engineer.
- C. Concrete Sidewalk Installation
1. Forms shall be made of substantial material with suitable metal dividing plates and of sufficient strength to satisfactorily resist distortion when fastened together and secured in place. Forms and dividing plates shall be of a depth not less than that of the

concrete sidewalk, be properly located with tops set to the designated sidewalk surface and be left in place until the concrete has hardened.

2. Concrete sidewalk shall be built in approximately twenty foot slabs between expansion joints. Expansion joints in sidewalk shall coincide with expansion joints in concrete curb. Tooled dummy joints not less than one-half inch in depth shall be provided five feet on center.
3. Sidewalk scoring shall be per NYCDOT requirements unless otherwise noted on drawings.
4. Expansion joints shall be one-quarter $\frac{1}{4}$ - inch in width and shall be filled with preformed joint filler within 1- inch of the sidewalk surface. The top 1- inch shall be sealed with poured joint filler.
5. Base material shall be wetted immediately before concrete is placed. The concrete shall be placed within the forms and thoroughly tamped until the surface is at the finished grade.

D. Welded Wire Fabric

1. Steel wire fabric shall be made up in sections of the length and width required. They shall be fastened together in an approved manner at each intersection.
2. Steel wire fabric shall be protected from moisture, and, when placed in the work, shall be free from grease, injurious rust, dirt or other foreign substances.
3. Steel wire fabric shall have transverse or longitudinal end members overlapping each other by not less than a full mesh length or width respectively. Overlapping sheets shall be securely and properly fastened.
4. Steel reinforcement shall be supported at the specified depth in such a manner that no displacement will occur during concreting operations. It shall be supported either on approved devices or upon a layer of concrete which has been evenly struck off. The method of supporting the steel at the proper elevation shall be approved by the Engineer.
5. Steel wire fabric shall be laid in sheets which shall be straight and true to form and shall be securely held in position by approved methods so that they will be in their prescribed position after the concrete has been thoroughly compacted.

E. Concrete sidewalk top surfaces shall be finished to true smooth planes by screeding, and finally by handled floats stiffened to prevent flexibility and warping. Each rectangular slab shall have all edges neatly rounded with proper tools and be bounded on all sides by trowelled border about one inch in width.

F. After completion of floating and troweling, eliminate any tool marks on concrete surface and broom finish by drawing fine-hair broom across surface perpendicular to line of traffic. Repeat as necessary to obtain a fine line texture.

G. Do not remove forms for twenty four hours after concrete has been placed. After form removal, clean ends of joints and point up any minor honeycombed areas. As directed, remove and replace sections with major defects at no cost to the owner.

H. Backfilling shall follow the removal of forms as soon as practicable and, unless otherwise permitted, shall be of clean earth, satisfactorily compacted.

I. Protection

1. Concrete sidewalk shall be carefully protected against injury from rain, frost, the drying effects of the sun and wind, traffic or other causes, by means of suitable guards and covering. Any damaged/vandalized concrete shall be replaced by the contractor at no cost to the owner.

2. Concrete shall be covered with a curing and anti-spalling material such as Durok Shield as manufactured by Durok Building Materials, Inc., Hastings-on-Hudson, N.Y. 10706; Duraltone as manufactured by Dural International, Inc., Deer Park, N.Y. 11729; Hydrozo Concrete Cure and Hydrozo Clear as manufactured by Hydrozo Coatings Co., Lincoln, Nebraska 68051; or an approved equal; and shall be applied in accordance with instructions of the manufacturer.
- J. Concrete shall be mixed by an approved NYCDOT method indicated below:
1. Method A – Central Plant Mix: Concrete produced at an approved plant, ready for use prior to discharge into a transporting vehicle.
 2. Method B – Truck Mix: Concrete whose constituent materials are proportioned at a central plant and mixed with water in a transporting vehicle.
 3. Method C – Job Mix: Concrete whose constituent materials are proportioned at a central plant and mixed at the job, or concrete whose constituent materials are proportioned and mixed at a job plant.
- K. The compressive strength, average of not less than three cylinders or cores, at 28 days shall be 3,200 psi tested in accordance with ASTM C39. Mold and store test cylinders meeting the requirements of ASTM C31.
- L. Slump shall be a minimum of 1.5” and a maximum of 4”. The slump requirement shall apply at the point of discharge. The Contractor shall supply at each point of concrete delivery a slump cone and rod conforming to the requirements of ASTM C143 for use by Owner’s Representative.

3.2 FIELD QUALITY CONTROL

- A. Concrete shall be free from lumps and have a temperature less than 90°F.
- B. For concrete exposed to view, the Contractor shall not use more than one (1) brand, unless otherwise permitted.
- C. Water shall not be added to the concrete mix without written approval from the Owner’s Representative. The Contractor shall submit a procedure for the addition of water on-site. Water shall not exceed the maximum volume for the mix design. Mixing water shall be fresh, clean, and potable.
- D. Product Measurement
1. Cement shall be measured by weight, or in full bags of 94 pounds each. When cement is measured by weight, it shall be weighed on a scale separate from those used for the other materials. After weighing, the entire contents of the hopper shall be completely discharged. When the cement is measured in bags, no fractions of bags shall be used unless weighed. Bags of cement shall be taken from the place of storage and placed adjacent to the mixer, in separate piles containing the exact number of bags for each mixer charge. Each pile shall be emptied into the mixer for each charge.
 2. Aggregates shall be measured by weight. Batch weights shall be based on saturated surface-dry materials and shall be corrected to take into account the weight of surface moisture contained in the aggregate.
 3. Water shall be measured by volume or by weight. The device for the measurement of the water shall be readily adjustable and, under all operating conditions, shall be accurate within 1.0 percent of its maximum capacity.

4. The concrete batching plant requirements, the handling, measuring, and batching of the concrete materials, and the mixing, transporting, and discharging of the concrete, shall be equal to the requirement specified therefore in Subsection 501-3.02, 502-3.03, and 501-3.04 of the current Standard Specifications, Construction and Materials, of the New York State Department of Transportation, Office of Engineering.
5. The concrete at the time of pouring shall be maintained at a temperature of not less than 50°F or more than 90°F. When the air temperature exceeds 85°F., the concrete subsequent to initial set shall be protected for three (3) days after pouring so as to prevent it from going above 90°F. When the air temperature is less than 38°F in the shade, concrete shall be poured only with the approval of the Engineer and shall be adequately protected. If the air temperature falls below 50°F., an accelerator may be used. If the air temperature exceeds 85°F., a retarder may be used. Accelerators and retarders must be approved by the Engineer before use.
6. Perform slump tests at the beginning of the concrete placement operation to determine if material control has been established. Continue testing consecutive batches until the consistency meets the requirements of this section, and test thereafter at random. Test batches at a rate of one test per 50 cubic yards or as directed by the Owner's Representative or Engineer.
7. From the same samples taken for slump tests as specified herein, mold a sufficient number of concrete test cylinders to meet the requirements of this section.
8. Selecting test batches by any means other than random selection chosen before concrete placement begins is not allowed.
9. Concrete testing required will be performed by an independent commercial testing laboratory employed and paid by the Owner. Representatives of the testing agency shall inspect, sample, and test the materials and monitor the production of concrete as required by the Owner's Representative. When it appears that any material furnished or work performed by the Contractor fails to fulfill specification requirements, the testing agency shall report the deficiencies to the Owner's Representative and the Contractor. The testing agency and its representatives are not authorized to revoke, alter, relax, enlarge, or release any requirement of the contract documents, nor to approve or accept any part of the work.

3.3 CONSTRUCTION WITHIN THE PUBLIC R.O.W.

- A. Construction within the public right-of-way to comply with all local, state, and federal agency specifications and requirements, including, but not limited to: NYCDEP, NYCDOT, NYSDOT and NYCDOB.
- B. Contractor to obtain all required permits for construction within the public right-of-way, such as the NYCDOT road opening permit, sidewalk occupancy permit etc.

END OF SECTION

SECTION 333000

SANITARY SEWERAGE UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work of this section, as shown or specified, shall provide sanitary sewerage utilities in accordance with the requirements of the Contract Documents. The Contractor must accept the site as-is and shall be deemed to have inspected the site and reviewed all Contract Documents prior to submitting a bid.

1.2 WORK INCLUDED

- A. Overall work under this Contract shall include all labor, materials, equipment, supervision, coordination efforts, permitting costs, certificate costs, services, filing fees, testing costs, security, insurance and all other associated or related items specified herein that are necessary and are required to complete the Work. Work elements shall include:
 - 1. Sanitary Sewerage piping, fitting and accessories and bedding.
 - 2. Sanitary sewer connection to New York City Sewers.
 - 3. For sewer structures refer to specification 331000 Storm Drainage Utilities.

1.3 SUBMITTALS

- A. No work shall be performed until shop drawings, if required, have been reviewed and accepted by the Owner.
- B. The Contractor must provide the following submittals to the Owner for approval prior to purchase of materials:
 - 1. Product Warranty: Submit documentation of standard product warranty terms for all products pertaining to this section.
 - 2. Product Data: Provide catalog materials indicating pipe, pipe accessories, and fittings.
 - 3. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
 - 4. Manufacturer's Certificate: Certify that products meet or exceed ANSI/ASTM or AWWA designations.
- C. The Contractor shall provide Owner with as-builts that accurately record actual locations of pipe runs, connections, outlet structures, headwalls, and invert elevations.

1.4 OWNER'S RESPONSIBILITIES

- A. The Owner will retain an independent testing agency to perform material testing as required. The Contractor shall provide any necessary assistance to the testing agency and provide the testing agency with the intended construction schedule at least one week prior to the start of construction.
- B. NYC DOB Special Inspections

1. The Owner will retain an independent testing agency to perform special inspections as required by the NYC Building Code.

1.5 CONTRACTOR RESPONSIBILITIES

- A. Contractor is responsible for coordinating this work with other trades on-site.
- B. Coordinate the Work with the building sanitary sewer connection point shown by the plumbing plans, and connection to the New York City sewers.
- C. Apply for and secure all necessary permits for the temporary sanitary connection, including a temporary connection permit, or a site connection permit, as may be required.
- D. Identify and describe unexpected variations to subsoil conditions and the discovery of uncharted utilities.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle materials as recommended by the manufacturer to protect from damage.

1.7 PERMITS AND APPROVALS

- A. Contractor shall prepare and obtain all required permits prior to construction unless otherwise directed by Owner. Copies of all permits shall be supplied to the Owner prior to the commencement of work authorized by the permit.
- B. Connections with existing facilities shall be performed in accordance with the requirements of the Owner of the facility. The Contractor shall be required to comply with all such requirements, including securing all permits, and payment of all permit and/or connection fees.

1.8 PROJECT RECORD DOCUMENTS

- A. Upon completion of the work of this and related sections, the contractor shall provide the Owner with an as-built survey of all new water, sewer, electric and gas service lines. The data shall include elevations for all new utilities, tied into established project benchmarks. The survey shall be provided in digital (AutoCAD DWG) and paper formats, and shall be signed and sealed by a New York State Licensed Professional Land Surveyor. This survey may be combined with other as-built survey requirements of site-work items, with the approval of the Owner. Marked-up design plans are not acceptable for the requirements of this section. All survey elevations shall be in North American Vertical Datum (NAVD) 88.

1.9 RELATED SECTIONS AND DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 00 and 01 Specification Sections.
- B. Project Specifications:
 1. Section 020110 – Maintenance of Existing Conditions
 2. Section 310000 – Earthwork
 3. Section 312500 – Protection of Existing Utilities

4. Section 319000 – Trench Excavation and Backfill
 5. Section 334000 – Storm Drainage Utilities
- C. Project Documents:
1. Contract Documents and Contract Drawings

1.10 REFERENCE STANDARDS

- A. Unless more restrictive criteria or differing requirements are explicitly stated in the Specifications, or mandated by governing codes or regulations, the recommendations, suggestions, and requirements described in the referenced standards shall be deemed mandatory and applicable to the Work.
- B. The latest edition, as of the date of the executed construction contract, of referenced standards listed below applies to this contract.
1. American Society for Testing Materials (ASTM), American National Standards Institute (ANSI), and American Water Works Association (AWWA)
 - a. ANSI C150/AWWA A21.50 - Ductile Iron Pipe (DIP) Class 56, Epoxy-Lined Tyton Joints.
 - b. ANSI C151/AWWA A21.51 - Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
 - c. ANSI C111/ANSI A21.11 - Rubber Gasket Joint Seals.
 - d. ANSI/ASTM C76 - Reinforced Concrete Culvert, Storm Drain and Sewer Pipe.
 - e. ANSI/ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, using Rubber Gaskets.
 2. New York City Department of Environmental Protection Bureau of Water and Sewer Rules, Standard Details, and Specifications.

PART 2 - PRODUCTS

2.1 SEWER PIPE MATERIALS

- A. Ductile Iron Pipe
1. ANSI C150/AWWA A21.50 - Ductile Iron Pipe (DIP) Class 56, Epoxy-Lined Tyton Joints.
 2. ANSI C111/ANSI A21.11 - Rubber Gasket Joint Seals.
 3. All pipe shall be in accordance with NYC Building Code , latest revision.

2.2 PIPE ACCESSORIES

- A. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

2.3 CLEANOUTS

- A. Lid and Frame: Heavy Duty cast iron construction. Closed Locking Lid Design.
- B. Shaft Construction: Cast Iron shaft of internal diameter as specified on plans with 4,000 psi concrete collar for cleanouts located in paved areas.
- C. Base Pad: Cast-in-place concrete, 4,000 psi leveled top surface to receive cast iron shaft sections, sleeved to receive sanitary sewer pipe sections.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Hand trim excavations to required elevations.
- B. Remove large stones or other hard matter, which could damage pipe or impede consistent backfilling or compaction.

3.2 INSTALLATION - PIPE

- A. Install pipe, fittings, and accessories in accordance with ANSI/ASTM or AWWA requirements and/or manufacturer's instructions. Seal joints watertight.
- B. Lay pipe to slope gradients noted on Construction Drawings.
- C. Lay pipe beginning at low point of system, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream.
- D. Refer to Sections 310000 and 319000 for trenching requirements. Do not displace or damage pipe when compacting.
- E. Refer to Section 334000 Storm Drainage Utilities for sewer structure requirements.
- F. Connect to building sanitary sewer outlet and New York City sewer systems.

3.3 INSTALLATION - CLEANOUTS

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.
- C. Mount lid and frame level in grout, to finished grade elevation indicated on plan.

3.4 INTERFACE WITH EXISTING FACILITIES

- A. Requirements: The Contractor shall make all required connections of the proposed drainage facilities into existing facilities, where and as shown on the Drawings in accordance with the requirements of NYCDEP.
- B. Compliance with Facility Owner Requirements: Connections made into existing facilities shall be performed in accordance with the requirements of the NYCDEP. The Contractor will be required to comply with all such requirements, including securing of all required permits, and paying the costs thereof. The cost of making the connections in accordance with the requirements of the City of New York of the existing facility shall be included in the Contract Sum.

- C. Guniting existing combined sewer pipe as shown on the Construction Documents per DEP specifications.

3.5 CONSTRUCTION WITHIN THE PUBLIC R.O.W.

- A. Construction within the public right-of-way shall conform to all requirements of the City of New York, NYCDOT, and any other agency having jurisdiction.

3.6 MODIFICATIONS OF EXISTING STRUCTURES

- A. General: The Contractor shall alter, reconstruct and/or convert existing structures where and as shown on the Drawings, and/or as approved by the Commissioner. In general, alterations shall be performed with the same type of material used in the original construction unless otherwise indicated on the Drawings or approved by the Commissioner.
- B. Damage to Existing Installations: The Contractor shall exercise extreme care during such alteration, reconstruction and/or conversions so as not to damage any portions of the structure and/or pipe shown to remain. Any such damage shall be repaired by the Contractor at his own expense and to the satisfaction of the Commissioner.

3.7 LATERALS

- A. General: The Contractor shall make all required lateral connections from the building to the on-site sewer system as shown on the Drawings and/or approved by the Commissioner. Work shall include making the connections into the on-site system, furnishing and installing all lateral pipe from the on-site sanitary sewer system to points located five (5) feet outside of the proposed building lines and properly sealing the ends with watertight plugs.
- B. Coordination with Building Contractor: The Contractor will be required to coordinate his work with the work of the other Contractors to determine the exact location and elevation of the point of entry into the building. If the other Contractor has installed his portion of the leader drain, work under this Contract shall also include final connection of the leader drain five (5) feet outside the building line.
- C. For laterals not immediately connected to Building System, stake and mark location of end of lateral.

3.8 CORRECTION OF THE WORK

- A. If leakage exceeds the specified amount, the Contractor shall at his own expense make the necessary repairs or replacements required to permanently reduce the leakage to within the specified limit and the tests shall be repeated until the leakage requirement is met.
- B. Any defects found in the system are to be repaired at the expense of the Contractor so to conform strictly to the Specifications and to the satisfaction of the Owner's Representative. All repairs shown necessary by the tests are to be made, broken or cracked pipe replaced, all deposits removed, and sanitary sewer left true to line and grade and entirely clean, free from lumps of cement, protruding gaskets, bulkheads, etc., and ready for use before final acceptance by the Owner.

3.9 FIELD QUALITY CONTROL

- A. Backfill placement and quantity control will be performed in accordance with Section 310000.
- B. If tests indicate work does not meet specified requirements, remove work, replace and retest at no cost to the Owner

3.10 INSPECTION AND TESTING

- A. The Contractor shall cooperate with the Owner's Representative as required to facilitate testing and inspection of the work. The Contractor shall clean and "Lamp" the lines in the presence of the Owner's Representative before final acceptance of the work. Infiltration and Exfiltration Testing shall be determined by the Engineer and shall meet all local agency regulations.
- B. The complete sanitary sewer system, including all mains, lateral sewers and manholes shall be tested for both infiltration and exfiltration. Contractor shall provide all materials equipment and services as necessary to perform the tests as described herein except as noted.
 - 1. Infiltration Testing
 - a. The ends of any service sewers shall be securely plugged and the sewer main plugged at the manhole at the low end. The uppermost manhole shall be filled with water to a level of 4 feet above the top of the sewer or 4 feet above the groundwater level. The water shall stand for 2 hours to allow the sewer system to reach its maximum absorption. Subsequently, the uppermost manhole shall be refilled to the original 4 foot height.
 - b. Rate of infiltration shall be determined by means of V-notch weirs or other approved measuring devices in an approved manner and at such times and locations as may be directed by the Engineer. The maximum leakage limit shall be 100 gallons per inch of diameter, per day, per mile.
 - c. For shorter stretches, less than 500 feet in length, rate of 100 percent in total excess of the above figures may be permitted, providing the total infiltration is in excess of the maximum allowable, the leaking joints shall be re-laid if necessary, or other remedial construction shall be performed by and at the expense of the Contractor. The section of sewer shall then be retested after repairs are completed to determine compliance with the specifications. All tests shall be made in the presence of the Contractor and the Municipal Engineer. The costs for these tests shall be included in the unit price bid for installing the pipe.
 - 2. Low Pressure Air Exfiltration Testing
 - a. The sewer mains and/or laterals shall be tested for leakage by the use of low-pressure air as specified hereinafter and as approved by the Owner's Representative. The Contractor shall furnish test plugs, air compressor, and personnel for conducting the test. The test length shall not exceed one (1) interval of pipe between two (2) manholes. Air test procedures may be dangerous and the Contractor shall take all necessary precautions to prevent blowouts.
 - b. After the pipe has been backfilled and cleaned, pneumatic plugs shall be placed in the line at each manhole and inflated to 25 psi. Low-pressure air shall be introduced into this sealed line until the internal air pressure reaches 4 psi greater than the average back pressure of any groundwater that may be over the pipe. At least two (2) minutes shall be allowed for the air pressure to stabilize.
 - c. After the stabilization period (3.5 psi minimum pressure in the pipe), the portion of line being tested shall be acceptable if the time required, in minutes, for the pressure to decrease from 3.5 to 3.0 psi (greater than the average back pressure

of any groundwater that may be over the pipe) is not less than the time indicated in the following table:

Pipe Size (in.)	Time (min.)
4	2
6	4
8	5
10	6
12	7
15	9

END OF SECTION

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SECTION 334000
STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Work of this section, as shown or specified, shall provide Storm Drainage Utilities in accordance with the requirements of the Contract Documents. The Contractor must accept the site as-is and shall be deemed to have inspected the site and reviewed all Contract Documents prior to submitting a bid. Work must conform to NYC DOB and NYC DEP standards.

1.2 WORK INCLUDED

- A. Overall work under this Contract shall include all labor, materials, equipment, supervision, coordination efforts, permitting costs, certificate costs, services, filing fees, testing costs, security, insurance and all other associated or related items specified herein that are necessary and are required to complete the Work. Work elements shall include:
 - 1. Storm drainage piping, excavation, fittings and accessories, and bedding.
 - 2. Storm detention system piping, excavation, fittings and accessories.
 - 3. Storm structures, manholes, catch basins etc.

1.3 SUBMITTALS

- A. No work shall be performed until shop drawings, if required, have been reviewed and accepted by the Owner.
- B. The Contractor must provide the following submittals to the Owner for approval prior to purchase of materials:
 - 1. Product Warranty: Submit documentation of standard product warranty terms for all products pertaining to this section.
 - 2. Product Data: Submit manufacturers cut sheets, component construction, features, configurations and dimensions.
 - 3. Product Certificates: Submit product certificate which is signed by manufacturer and Contractor, certifying that products comply with, or exceed, the requirements herein, and requirements identified on the construction documents.
 - 4. Shop Drawings: Submit plans indicating locations, elevations, invert elevations, piping, sizes and elevation penetrations of the on-site storm system, and storm detention system.
- C. Indicate underground structures and show pipe types, sizes, and materials and off-site storm lateral connection(s) to the Javits internal sewer network. Also include elevations of other utilities crossing system piping.
- D. The contractor shall accurately record actual locations of pipe runs, connections, outlet structures, headwalls, and invert elevations. The Contractor shall provide the owner with an as-built survey, performed by a licensed surveyor within 30 days of project completion.

1.4 QUALITY ASSURANCE

- A. The quality of materials, the process of manufacture, and the finished sections shall be subject to inspection by the Engineer. Such inspection may be made at the place of manufacture, or on the work site after delivery, or at both places, and the sections shall be subject to rejection at any time if material conditions fail to meet any of the specification requirements, even though sample sections may have been accepted as satisfactory at the place of manufacture. Sections rejected after delivery to the site shall be marked for identification and shall be removed from the site at once. All sections which have been damaged beyond repair during delivery will be rejected and, if already installed, shall be repaired to the Engineer's acceptance level, if permitted, or removed and replaced, entirely at the Contractor's expense.
- B. All sections shall be inspected for general appearance, dimensions, soundness, etc. The surface of all concrete shall be dense, close textured and free of blisters, cracks, roughness and exposure of reinforcement.
- C. Concrete imperfections may be repaired, subject to the acceptance of the Engineer, after demonstration by the manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final acceptance. Cement mortar used for repairs shall have a minimum compressive strength of 4,000 psi at the end of 7 days and 5,000 psi at the end of 28 days when tested in 3 inch diameter by 6 inch long cylinders stored in the standard manner. Epoxy mortar may be utilized for repairs.

1.5 CONTRACTOR RESPONSIBILITIES

- A. Contractor is responsible for coordinating this work with other trades on-site.
- B. Interruption of Existing Storm Drainage Service: Notify Engineer and Owner no fewer than 7 days in advance of proposed interruption of storm drainage system. Do not proceed with interruption of storm drainage system without Owner's written permission.
- C. Identify and describe to the engineer unexpected variations to subsoil conditions and the discovery of uncharted utilities.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle materials as recommended by the manufacturer to protect from damage.

1.7 PERMITS AND APPROVALS

- A. Contractor shall prepare and obtain all required permits prior to construction unless otherwise directed by Owner. Copies of all permits shall be supplied to the Owner prior to the commencement of work authorized by the permit.
- B. Connections with existing facilities shall be performed in accordance with the requirements of the Owner of the facility. The Contractor shall be required to comply with all such requirements, including securing all permits, and payment of all permit and/or connection fees.
- C. The Contractor shall be responsible for coordinating all street openings with the Javits Convention Center to minimize impact of operations to the Owners satisfaction.

1.8 PROJECT RECORD DOCUMENTS

- A. Upon completion of the work of this and related sections, the contractor shall provide the Owner with an as-built survey of all new water, sewer, electric and gas service lines. The data shall include elevations, tied into established project benchmarks. The survey shall be provided in digital (AutoCAD DWG) and paper formats, and shall be signed and sealed by a New York State Licensed Professional Land Surveyor. This survey may be combined with other as-built survey requirements of site-work items, with the approval of the Owner. Marked-up design plans are not acceptable for the requirements of this section. All survey elevations shall be in North American Vertical Datum (NAVD) 88.
- B. The contractor shall accurately record actual locations of pipe runs, connections, outlet structures, headwalls, and invert elevations. The Contractor shall provide the owner with an as-built survey, performed by a licensed surveyor within 30 days of project completion.
- C. Identify and describe to the engineer unexpected variations to subsoil conditions and the discovery of uncharted utilities.

1.9 RELATED SECTIONS AND DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 00 and 01 Specification Sections, apply to this section.
- B. Project Specifications:
 - 1. Section 020110 – Maintenance of Existing Conditions
 - 2. Section 310000 – Earthwork
 - 3. Section 312500 – Erosion and Sedimentation Controls
 - 4. Section 319000 – Trench Excavation and Backfill for Utilities
 - 5. Contract documents and drawings

1.10 REFERENCE STANDARDS

- A. Unless more restrictive criteria or differing requirements are explicitly stated in the Specifications, or mandated by governing codes or regulations, the recommendations, suggestions, and requirements described in the referenced standards shall be deemed mandatory and applicable to the Work.
- B. The latest edition, as of the date of the executed construction contract, of referenced standards listed below applies to this contract.
 - 1. American Society for Testing Materials (ASTM), American National Standards Institute (ANSI), American Water Works Association (AWWA), and American Association of State Highway and Transportation Officials (AASHTO)
 - a. ASTM A48 – Gray Iron Casting.
 - b. ASTM C478 – Precast Reinforced Concrete Manhole Sections.
 - c. ASTM C923 – Resilient Connectors between Reinforced Concrete Manhole Structures and Pipes.
 - d. ASTM D1248 – Polyethylene Plastics Molding and Extrusion Materials.
 - e. ASTM D3350 – Polyethylene Plastics Pipe and Fittings Materials
 - f. ANSI C150/AWWA A21.50 - Ductile Iron Pipe (DIP) Class 56, Cement-Lined Tyton Joints.
 - g. ANSI C151/AWWA A21.51 - Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
 - h. ANSI C110/AWWA A21.10 – Ductile-Iron and Gray-Iron Fittings

- i. ANSI C115/AWWA A21.15 – Flanged Ductile-Iron or Gray-Iron Threaded Flanges
- j. AASHTO M294 and M252 – Corrugated Polyethylene Pipe Smooth Interior.
- 2. NYSDEC rules, regulations and codes
- 3. New York City Department of Environmental Protection Bureau of Water and Sewer Rules, Standard Details, and Specifications
- 4. New York City Department of Environmental Protection Bureau of Water and Sewer rules and specifications.
- 5. NYC Building Code.
- 6. NYSDEC/ACoE rules, regulations, specifications, and construction codes.

PART 2 - PRODUCTS

2.1 SEWER PIPE MATERIALS AND ACCESSORIES

- A. Ductile Iron Pipe: Comply with the requirements of AWWA C115-Flanged Ductile Iron Pipe with threaded flange and NYC Building Code.
- B. Hub-and-Spigot, Cast-Iron Soil Pipe and Fittings: ASTM A 74 Service class, gray iron, for gasketed joints. Include ASTM C 564 rubber, compression-type gaskets.
- C. HDPE: High-Density Polyethylene Pipe shall comply with requirements of AASHTO M252 Type S, AASHTO M294, Type S for 12" through 60" diameter and be HS-20 load rated. Fittings shall be watertight and conform to AASHTO M294, AASHTO M252, and ASTM D3350 Cell Classification 435400C. Joints shall be bell and spigot with an o-ring gasket meeting ASTM F477.
 - 1. Acceptable manufacturers include (Or approved equal):
 - a. Advanced Drainage Systems, Inc. N-12 pipe (MEA 301-96-M) for sizes up to 60" diameter;
 - b. Hancor Inc. Sure-Lok pipe (MEA 321-99-M)
- D. Bedding: Section 319000 – Trench Excavation and Backfill for Utilities.

2.2 UTILITY STRUCTURES

- A. Precast Concrete Catch Basins: ASTM C 913, precast, reinforced concrete; designed according to ASTM C 890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading, with provision for sealant joints.
 - 1. Joint Sealants: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
 - 2. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and grate.
 - 3. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 60 inches.
 - 4. Pipe Connectors: ASTM C 923 (ASTM C 923M), resilient, of size required, for each pipe connecting to base section.
 - 5. Include 24-by-24-inch- minimum flat grate for 2' x 2' catch basin with small square or short-slotted drainage openings. ASTM A 536, Grade 60-40-18, ductile iron designed for AASHTO HS-25, structural loading. Grates to be ADA compliant.

6. Include 48-by-48-inch- minimum flat grate for 4'x4' catch basin with small square or short-slotted drainage openings. ASTM A 536, Grade 60-40-18, ductile iron designed for AASHTO HS-25, structural loading. Grates to be ADA compliant.

2.3 CLEAN OUTS

- A. Gray-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug. Use units with heavy-duty top-loading classification in vehicle-traffic service areas and medium-duty in paved foot-traffic areas.
- B. Lid and Frame: Heavy Duty cast iron construction manufactured by Campbell Foundry or approved equal. Closed Locking Lid Design.
- C. Shaft Construction: Cast Iron shaft of internal diameter as specified on plans with 4,000 psi concrete collar for cleanouts located in paved areas.
- D. Base Pad: Cast-in-place concrete, 4,000 psi leveled top surface to receive cast iron shaft sections, sleeved to receive sanitary sewer pipe sections.
- E. Project substitutions shall be submitted to the engineer for review and approval in accordance with the requirements of section 1.3 - Submittals

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Refer to specification 319000 Trench Excavation and Backfill.
- B. Verify the trench cut and excavation base to be hard, smooth, and dry.
- C. Verify excavation location, dimensions and elevation with contract drawings.
- D. Ensure all OSHA requirements are met prior to beginning work, including trenching and excavation requirements. Do not begin work if the site is unsafe or if OSHA requirements are not met.

3.2 PREPARATION

- A. Hand trim excavations to required elevations and thoroughly compact as per Section 319000.
- B. Remove large stones or other hard matter which may damage piping or impede consistent backfilling or compaction.

3.3 BEDDING

- A. Excavate pipe trench in accordance with Section 319000 for work of this section.
- B. Place and compact a minimum 6-inch bedding material at trench bottom. Hand trim bedding for accurate placement of pipe to elevations indicated.

- C. Maintain moisture content of bedding material between 1% below and 3% above the optimum.
- D. Install piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream.
- E. Install piping pitched at minimum slope of 1 percent and 36-inch minimum cover unless otherwise indicated.
- F. Install pipe, fittings, and accessories in accordance with the Reference Standards listed above in section 1.10, the manufacturer's instructions and/or state or local requirements. Seal joints to be watertight.
- G. Lay pipe to slope gradients noted on Contract Documents; with maximum variation from true slope of 1/32 inch in 20 feet.
- H. Use manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.
- I. Install hub-and-spigot, cast-iron soil pipe and fittings with rubber gaskets according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Volume I. Use gaskets that match class of pipe and fittings.
- J. Install PE pipe and fittings according to ASTM D 2321. Join pipe, tubing, and fittings with couplings for soil tight joints according to manufacturer's written instructions. Install corrugated piping according to CPPA's "Recommended Installation Practices for Corrugated Polyethylene Pipe and Fittings."
- K. Install PVC pipe and gasketed fittings with gaskets according to ASTM D 2321.
- L. Refer to Section 319000 for trenching and backfill requirements. Do not displace or damage pipe when compacting.

3.4 INSTALLATION – PIPE

- A. Install pipe, fittings, and accessories in accordance with ANSI/ASTM or AWWA requirements and/or manufacturer's instructions. Seal joints watertight.
- B. Lay pipe to slope gradients noted on Construction Drawings.
- C. Lay pipe beginning at low point of system, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream.
- D. Refer to Sections 310000 and 319000 for trenching requirements. Do not displace or damage pipe when compacting.
- E. Connect to building sanitary sewer outlet and New York City sewer systems.

3.5 INSTALLATION - CLEANOUTS

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Form and place cast-in-place concrete base pad, with provision for storm pipe end sections.

- C. Mount lid and frame level in grout to finished grade elevation indicated on plan.

3.6 MODIFICATIONS OF EXISTING STRUCTURES

- A. General: The Contractor shall alter, reconstruct and/or convert existing structures where and as shown on the Drawings, and/or as approved by the Engineer. In general, alterations shall be performed with the same type of material used in the original construction unless otherwise indicated on the Drawings or approved by the Engineer.
- B. Damage to Existing Installations: The Contractor shall exercise extreme care during such alteration, reconstruction and/or conversions so as not to damage any portions of the structure and/or pipe shown to remain. Any such damage shall be repaired by the Contractor at his own expense and to the satisfaction of the Engineer.

3.7 CLEANING

- A. The Contractor shall clean the entire drainage system downstream of the proposed work of all debris and obstructions. This shall include, but not be limited to, removal of all formwork from structures, concrete and mortar droppings, construction debris and dirt. The system shall be thoroughly flushed clean and the Contractor shall furnish all necessary hose, pumps, pipe and other equipment that may be required for this purpose. No debris shall be flushed into existing storm drains or streams; all debris shall be removed from the system.
- B. After the system has been cleaned, the Contractor shall thoroughly inspect the system and all repairs shown to be necessary shall be promptly made by the Contractor.
- C. All Work of cleaning and repair as specified herein shall be performed at the Contractor's expense and to the complete satisfaction of the Owner.

3.8 INSPECTION AND TESTING

- A. Final Inspection: Upon completion of the Work and before backfill is placed and final acceptance by the Owner, the entire drainage system shall be subject to a final inspection in the presence of the Engineer or Owner's Representative. The Work shall not be considered as complete until all requirements for line, grade, cleanliness, and workmanship have been completed to the satisfaction of the Owner's Representative and/or the Engineer.
- B. If work does not meet specified requirements, the contractor is to remove work, replace and retest at no additional cost to the owner.

3.9 CONSTRUCTION WITHIN THE PUBLIC R.O.W.

- A. Construction within the public right-of-way shall conform to all requirements of the City of New York, NYCDOT, NYSDOT, and any other agency having jurisdiction.

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