The design of this project conforms to all applicable provisions of the New York State Uniform Fire Prevention and Building Code, the New York State Energy Conservation Code.

This building meets or exceeds the seismic structural requirements of the uniform building code with New York State supplements and therefore satisfies the requirements as established under the National Earthquake Hazard Reduction Protection Act (NEHRPA)

August 25, 2017
Out to Bid: October 30, 2017

HUNT 2813-004

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PROCUREMENT AND CONTRACTING REQUIREMENTS

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PART 1 GENERAL

1.1 SECTION INCLUDES
A. Pipe, fittings, sleeves, escutcheons, seals, and connections for sprinkler systems.

1.2 RELATED REQUIREMENTS
A. Section 07 84 00 - Firestopping.
B. Section 09 91 23 - Interior Painting: Preparation and painting of interior fire protection piping systems.
C. Section 21 05 23 - General-Duty Valves for Water-Based Fire-Suppression Piping.
D. Section 21 13 00 - Fire Suppression Sprinklers: Sprinkler systems design.

1.3 REFERENCE STANDARDS
A. ASME A112.18.1 - Plumbing Supply Fittings; 2012.
E. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; 2011.
V. AWWA C606 - Grooved and Shouldered Joints; 2011.
X. ITS (DIR) - Directory of Listed Products; current edition.

1.4 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturers catalogue information. Indicate valve data and ratings.
C. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
D. Project Record Documents: Record actual locations of components and tag numbering.
E. Operation and Maintenance Data: Include installation instructions and spare parts lists.

1.5 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
B. Installer Qualifications: Company specializing in performing work of the type specified this section.
   1. Minimum three years experience.
   2. Approved by manufacturer.
C. Conform to FM (AG) and UL (DIR) requirements.
D. Valves: Bear FM (AG) and UL (DIR) product listing label or marking. Provide manufacturer's name and pressure rating marked on valve body.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Deliver and store valves in shipping containers, with labeling in place.
B. Provide temporary protective coating on cast iron and steel valves.
C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.7 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
PART 2  PRODUCTS

2.1  FIRE PROTECTION SYSTEMS
   B. Welding Materials and Procedures: Conform to ASME BPVC-IX.

2.2  ABOVE GROUND PIPING
   A. Steel Pipe: ______, black.
      1. Malleable Iron Fittings: ASME B16.3, threaded fittings and ASTM A47/A47M.
      2. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.

2.3  PIPE SLEEVES
   A. Vertical Piping:
      1. Sleeve Length: 1 inch above finished floor.
      2. Provide sealant for watertight joint.

2.4  ESCUTCHEONS
   A. Material:
      1. Chrome-plated.
   B. Construction:
      1. One-piece for mounting on chrome-plated tubing, pipe, or ______ and one-piece, split-pattern, or ______ type elsewhere.
      2. Internal spring tension devices or setscrews to maintain a fixed position against a surface.

2.5  PIPE HANGERS AND SUPPORTS
   A. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
   B. Hangers for Pipe Sizes 2 inches and Over: Carbon steel, adjustable, clevis.
   C. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   D. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.
   E. Vertical Support: Steel riser clamp.

2.6  MECHANICAL COUPLINGS
   A. Manufacturers:
      1. Tyco Fire Protection Products; Grinnell G-Fire Figure 705 Grooved Flexible Couplings: www.tyco-fire.com.
   B. Rigid Mechanical Couplings for Grooved Joints:
3. Housing Material: Fabricate of ductile iron conforming to ASTM A536.
4. Housing Coating: Factory applied orange enamel or __________.
5. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
6. Bolts and Nuts: Hot dipped galvanized or zinc electroplated steel.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.
B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
C. Install piping to conserve building space, to not interfere with use of space and other work.
D. Group piping whenever practical at common elevations.
E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
F. Pipe Hangers and Supports:
   1. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   2. Place hangers within 12 inches of each horizontal elbow.
   3. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
G. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
H. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
I. Do not penetrate building structural members unless indicated.
J. Provide sleeves when penetrating footings, floors, walls, partitions, and ________ and seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.
K. Escutcheons:
   1. Install and firmly attach escutcheons at piping penetrations into finished spaces.
   2. Provide escutcheons on both sides of partitions separating finished areas through which piping passes.
   3. Use chrome plated escutcheons in occupied spaces and to conceal openings in construction.
L. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

END OF SECTION
SECTION 21 05 23
GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES
A. Two-piece ball valves with indicators.
B. Bronze butterfly valves with indicators.
C. Check valves.
D. Bronze OS&Y gate valves.
E. Iron OS&Y gate valves.
F. Trim and drain valves.

1.2 RELATED REQUIREMENTS
A. Section 07 84 00 - Firestopping.
B. Section 21 05 00 - Common Work Results for Fire Suppression: Pipe and fittings.
C. Section 21 05 53 - Identification for Fire Suppression Piping and Equipment.
D. Section 21 13 00 - Fire Suppression Sprinklers.

1.3 REFERENCE STANDARDS

1.4 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
C. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

1.5 QUALITY ASSURANCE
A. Manufacturer Qualifications:
   1. Obtain valves for each valve type from single manufacturer.
   2. Company must specialize in manufacturing products specified in this section, with not less than three years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Set valves open to minimize exposure of functional surfaces.
B. Use the following precautions during storage:
   1. Maintain valve end protection and protect flanges and specialties from dirt.
      a. Provide temporary inlet and outlet caps.
      b. Maintain caps in place until installation.
   2. Store valves in shipping containers and maintain in place until installation.
      a. Store valves indoors and maintain at higher than ambient dew point temperature.
      b. If outdoor storage is unavoidable, store valves off the ground in watertight enclosures.

C. Use the following precautions for handling:
   1. Do not use operating handles or stems as lifting or rigging points.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Comply with NFPA 13 for valves.

B. Valve Pressure Ratings: Not less than minimum pressure rating indicated or higher as required.

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

2.2 TWO-PIECE BALL VALVES WITH INDICATORS

A. Description:
   2. Body Design: Two piece.
   3. Body Material: Forged brass or bronze.
   4. Port Size: Full or standard.
   5. Seat: PTFE.
   6. Stem: Bronze or stainless steel.
   7. Ball: Chrome-plated brass.
   8. Actuator: Worm gear or traveling nut.

2.3 BRONZE BUTTERFLY VALVES WITH INDICATORS

A. Minimum Pressure Rating: 175 psig.

B. Body Material: Bronze.

C. Seat: EPDM.

D. Stem: Bronze or stainless steel.

E. Disc: Bronze with EPDM coating.

F. Actuator: Worm gear or traveling nut.

G. Supervisory Switch: Internal or external.

2.4 CHECK VALVES

A. Minimum Pressure Rating: 175 psig.

B. Type: Center guided check valve.

C. Body Material: Cast iron, ductile iron.
D. Center guided check with elastomeric seal.
E. Hinge Spring: Stainless steel.
F. End Connections: Flanged, grooved, or threaded.

2.5 IRON OS&Y GATE VALVES
A. Minimum Pressure Rating: 175 psig.
B. Body and Bonnet Material: Cast or ductile iron.
C. Wedge: Cast or ductile iron, or bronze with elastomeric coating.
D. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
E. Stem: Brass or bronze.
F. Packing: Non-asbestos PTFE.
G. Supervisory Switch: External.
H. End Connections: Flanged.

2.6 TRIM AND DRAIN VALVES
A. Ball Valves:
   1. Description:
      b. Body Design: Two piece.
      c. Body Material: Forged brass or bronze.
      d. Port Size: Full or standard.
      e. Seat: PTFE.
      f. Stem: Bronze or stainless steel.
      g. Ball: Chrome-plated brass.
      h. Actuator: Hand-lever.

PART 3 EXECUTION

3.1 EXAMINATION
A. Confirm valve interior to be free of foreign matter and corrosion.
B. Remove packing materials.
C. Examine guides and seats by operating valves from the fully open position to the fully closed position.
D. Examine valve threads and mating pipe for form and cleanliness.

3.2 INSTALLATION
A. Comply with specific valve installation requirements and application in the following Sections:
B. Install listed fire protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections.
C. Valves in horizontal piping installed with stem at or above the pipe center.
D. Position valves to allow full stem movement.

E. Install valve tags. Comply with Section 21 05 53 requirements for valve tags, schedules, and signs on surfaces concealing valves; and the appropriate NFPA standard applying to the piping system in which valves are installed.

END OF SECTION
SECTION 21 13 00
FIRE SUPPRESSION SPRINKLERS

PART 1  GENERAL

1.1 SECTION INCLUDES
A. Wet-pipe sprinkler system.
B. System design, installation, and certification.
C. Fire department connections.

1.2 RELATED REQUIREMENTS
A. Section 21 30 00 - Fire Pumps.

1.3 REFERENCE STANDARDS
D. UL 405 - Fire Department Connection Devices; Current Edition; Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS
A. Preinstallation Meeting: Convene one week before starting work of this section.

1.5 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
C. Shop Drawings:
   1. Submit preliminary layout of finished ceiling areas indicating only sprinkler locations coordinated with ceiling installation.
   2. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components and accessories. Indicate system controls.
   3. Submit shop drawings to authorities having jurisdiction for approval. Submit proof of approval to Architect.
D. Samples: Submit two of each style of sprinkler specified.
E. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and code requirements.
F. Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.
G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Extra Sprinklers: Type and size matching those installed, in quantity required by referenced NFPA design and installation standard.

3. Sprinkler Wrenches: For each sprinkler type.

H. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

1.6 QUALITY ASSURANCE
A. Conform to FM (AG) requirements.

B. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

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

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. Sprinklers, Valves, and Equipment:

2.2 SPRINKLER SYSTEM
A. Sprinkler System: Provide coverage for entire building.

B. Occupancy: Ordinary hazard, Group 1; comply with NFPA 13.

C. Water Supply: Determine volume and pressure from water flow test data.
   1. If test data is not available assume 1006 gpm at 30 psig. Static pressure of 60 psi
   2. Revise design when test data available prior to submittals.

D. Provide fire department connections in location as determined by owner.

E. Storage Cabinet for Spare Sprinklers and Tools: Steel, located adjacent to alarm valve.

2.3 SPRINKLERS
A. Suspended Ceiling Type: Semi-recessed pendant type with matching push on escutcheon plate.
   1. Response Type: Quick.
   2. Coverage Type: Standard.
   3. Fusible Link: Glass bulb type temperature rated for specific area hazard.

B. Exposed Area Type: Upright type with guard.
   1. Response Type: Quick.
   2. Coverage Type: Standard.
   3. Fusible Link: Glass bulb type temperature rated for specific area hazard.

C. Storage Sprinklers: Pendant type with guard.
   1. Response Type: Standard.
   2. Coverage Type: Standard.
   3. Fusible Link: Glass bulb type temperature rated for specific area hazard.
D. Guards: Finish to match sprinkler finish.

2.4 PIPING SPECIALTIES

A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm, pressure retard chamber and variable pressure trim with the following additional capabilities and features:
   1. Activate electric alarm.
   2. Test and drain valve.
   3. Replaceable internal components without removing valve from installed position.

B. Electric Alarm: Electrically operated red enameled gong with pressure alarm switch.

C. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 amp at 125 volt AC and 2.5 amp at 24 volt DC.

D. Fire Department Connections:
   1. Type: Exposed, projected wall mount made of corrosion resistant metal complying with UL 405.
      a. Inlets: Two way, 2-1/2 inch swivel fittings, internal threaded. Thread size and inlets according to NFPA 1963 or Authority Having Jurisdiction. Brass caps with gaskets, chains, and lugs.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with referenced NFPA design and installation standard.

B. Install equipment in accordance with manufacturer's instructions.

C. Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent siamese connectors to allow full swing of fire department wrench handle.

D. Locate outside alarm gong on building wall as indicated.

E. Place pipe runs to minimize obstruction to other work.

F. Place piping in concealed spaces above finished ceilings.

G. Center sprinklers in two directions in ceiling tile and provide piping offsets as required.

H. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.

I. Install and connect to fire pump system in accordance with Section 21 30 00.

J. Flush entire piping system of foreign matter.

K. Install guards on sprinklers in exposed spaces.

L. Hydrostatically test entire system.

M. Require test be witnessed by Fire Marshal.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Fire suppression system.
   B. Cylinder and valve assembly.
   C. Manual release station.
   D. Control equipment.
   E. Distribution system.
   F. Pipe and piping specialties.
   G. Miscellaneous equipment.
   H. System maintenance after closeout.

1.2 RELATED REQUIREMENTS
   A. Section 07 84 00 - Firestopping.
   B. Section 21 13 00 - Fire Suppression Sprinkler Systems.
   D. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.
   E. Section 28 31 00 - Fire Detection and Alarm.

1.3 REFERENCE STANDARDS
   C. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2013.
K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.


N. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

O. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: To bear stamp of approval of Authority Having Jurisdiction. Provide for each piece of equipment comprising the system including valves, pressure gages, detectors, release devices, actuators, thermostats, discharge nozzles, manual controls, alarm devices, annunciators, extinguishing agent containers, manifolds, and control panel.

C. Shop Drawings: To bear stamp of approval of Authority Having Jurisdiction. Indicate detailed layout of system, including piping and location of each component. Include control diagrams, wiring diagrams, and written sequence of operation.

D. Design Data: Submit design calculations bearing stamp of approval of Authority Having Jurisdiction, Fire Marshal, Owner's fire insurance underwriter, and ____. Include calculations that verify system pressures, nozzle flow rate, orifice code numbers, piping pressure losses, component flow data, and pipe sizes. Base design approach on NFPA 17A and NFPA 96.

E. Installer's Qualification Statement.

F. Certificates: Certify that products meet or exceed specified requirements.
   1. Manufacturer: Certify that system meets or exceeds specified requirements.
   2. Welders: Submit certificate indicating compliance with ASME BPVC-IX, AWS D1.1/D1.1M, and ______________.

G. Operation and Maintenance Data:
   1. Include electrical schematic written description of system design, drawings illustrating control logic and equipment locations, and technical brochures describing equipment.
   2. Include list of recommended spare parts.
   3. Include checklists and procedures for emergency situations, trouble shooting techniques, abort functions, system control panel operation, trouble procedures, and safety requirements.

1.5 QUALITY ASSURANCE

A. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this Work and licensed at the State in which the Project is located.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
PART 2 PRODUCTS

2.1 FIRE SUPPRESSION SYSTEM
   A. Provide a pre-engineered modular type, fixed pipe, automatic wet chemical fire suppression system for protection of all hazard areas associated with cooking operations, including exhaust hoods, plenums, ductwork, and cooking appliances.
   B. System to consist of manufacturer's wet chemical storage cylinders, actuation hardware, wet chemical agent distribution nozzles attached to the pipe network, and ____________.
   C. System to comply with NFPA 17A including extinguishing agent.
   D. Items Requiring Protection:

2.2 CYLINDER AND VALVE ASSEMBLY
   A. Provide steel cylinder and valve assemblies of the type and size required by the manufacturer for wet chemical storage.
   B. Specialties to consist of valves and pressure gages, including reliable and safe means of minimizing accidental discharge.
   C. Furnish pressurized assembly with the capability of being stored and operated at 0 degrees F to 120 degrees F.
   D. Provide listed bracketing for the mounting of the cylinder securely to the intended mounting surface.
   E. Furnish manufacturer's high-pressure nitrogen tubing when control system is mounted to a wet cylinder and in all cases where actuation delay is employed.

2.3 MANUAL RELEASE STATION
   A. Provide as a means of manually actuating the system from a remote location.
   B. Surface housing fitted with un-tensioned pull-to-trip that locks in position after allowing the control system to activate the cylinder and valve assembly, for mounting on electrical outlet box; addressable using manufacturer's standard monitor module.
   C. Functions:
      1. Activate all audible and visual alarms.
      2. Override any abort station or time delay function.
      3. Activate all release and shutdown functions normally triggered by detectors or alarm system.
   D. Identification:
      1. Provide engraved label for each manual release station indicating area protected and that actuation will cause discharge of fire extinguishing agent.
      2. Provide manufacturer's label directly on faceplate.

2.4 CONTROL EQUIPMENT
   A. Provide control equipment capable of automatic and manual discharge of the wet chemical agent from all cylinder and valve assemblies, including automatic shutdown of the heat source or fuel and electrical power to all protected areas upon system activation.
B. Furnish fully enclosed, integral control head and actuator for each cylinder valve assembly without exposed means for actuation.
   1. Control Head: Equip with micro-switch contacts for audible alarm and equipment shutdown.

C. All cylinders protecting one hazard area must be connected for simultaneous discharge by all methods of alarm actuation.

D. Activate control head automatically by electrical, mechanical, and __________ means.
   1. Provide rate-compensated thermostat fire detectors, conforming to NFPA 17A, with rating suitable to their expected exposure temperature, capable of detecting heat, referenced or permitted in the manufacturer's design, installation, and maintenance manual, and listed for use with the extinguishing system.
   2. Electrical Activation:
      a. Activate electric solenoid by tested and listed system control panel.
      b. Provide supervision for all detection and releasing circuits.
      c. Provide secondary, reserve power supply in accordance with NFPA 17A, Chapter 5.3.1.
   3. Mechanical Activation:
      a. Activate system control head by manufacturer supplied fire detectors incorporating mechanical thermo-bulb link systems requiring no outside power source for operation.
      b. Provide thermo-bulb links with rating suitable to their expected exposure temperature.

2.5 DISTRIBUTION SYSTEM

A. Discharge Nozzles:
   1. Provide nozzle type in accordance with manufacturer's instructions.
   2. Equip with strainers to prevent foreign matter in the agent distribution piping or tubing from clogging the nozzle orifice.
   3. Provide foil seals to be ruptured by pressure at system discharge.
   4. Identification: Permanently marked with manufacturer's identification system identifying nozzle type and listing.

2.6 PIPE AND PIPING SPECIALTIES

   1. Fittings: ASME B16.3 malleable iron class 300 for sizes 2 inch and smaller, or ASTM A234/A234M, wrought steel welding type fittings.
   2. Joints: Threaded, AWS D1.1/D1.1M welded, or grooved and shouldered pipe end couplings.

B. Pipe Hangers: ASME B31.1, listed, split clamp up to 2-1/2 inch size, riser clamps over 2-1/2 inch size, adequate to offset discharge thrust.

C. Escutcheons: Chrome plated pressed or stamped brass, one-piece or split pattern, minimum 2 inches larger than opening.

D. Gages:
   1. ASME B40.100, UL 393, UL 404, or ________ 3-1/2 inch diameter cast aluminum case, phosphor bronze bourdon tube, rotary brass movement, brass socket, front re-calibration adjustment, black figures on white background, 1 percent mid-scale accuracy, scale calibrated in psi.
2.7 MISCELLANEOUS EQUIPMENT

A. Alarm Bells: 24 volts, with supervision of circuit wiring, of modular design, red baked enamel finish, with minimum sound level of 84 dba at 10 feet, for mounting on 4 inch electrical outlet box.

B. Alarm Horns: 24 volts, with supervision of circuit wiring, with minimum sound level of 90 dba at 10 feet, for mounting on 4 inch electrical outlet box.

C. Strobe Beacon: Manufacturer's standard design, 24 volts, with system identification on strobe lens.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with the Authority Having Jurisdiction, Fire Marshal, Owner's fire insurance underwriter, manufacturer's instructions, and ______________ including the following NFPA Standards:

B. Agent Distribution Piping:
   1. Ream pipe and tube ends, remove burrs and bevel plain end ferrous pipe.
   2. Remove scale and dirt on inside and outside before assembly.
   3. Blow out pipe before nozzles or discharge devices are installed.
   4. Route piping in orderly manner, concealed, plumb and parallel to building structure, and maintain gradient.
   5. Install piping to conserve building space and not interfere with use of space and other work.
   6. Securely support piping in accordance with ASME B31.1 with allowance for fire extinguishing agent thrust forces, and thermal expansion and contraction.
   7. Install unions downstream of valves and at equipment or apparatus connections.

C. Manufactured Equipment for Field Installation:
   1. Cylinder and valve assembly with listed mounting bracket.
   2. Discharge adapter kit.
   3. Pressure switches where applicable.
   4. Vent plug.
   5. Discharge nozzles.
   6. Control System:
      a. Housed control system where indicated on the drawings.
      b. System valve actuators, cylinders, and nitrogen actuation tubing.
      c. Mechanical Detection: Detection components and cabling line(s).
      d. Microswitches and Solenoid: Wire in accordance with NFPA 70 and NFPA 72.
      e. Control box and detection cabling including accessories.
      g. Mechanical or electrical work associated with gas valves where applicable.

D. Install wiring in accordance with Section 26 27 17 requirements.

E. Install engraved plastic instruction plate, detailing emergency procedures, at control panel and at each manual discharge and abort switch location.

F. Identify control logic units, contacts, and major circuits with permanent nameplates at the control panel.
3.2 INTERFACE WITH OTHER PRODUCTS
   A. Provide signal to building fire alarm system. Refer to Section 28 31 00.

3.3 FIELD QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for additional requirements.
   B. Perform field inspection and testing in accordance with Section 01 40 00 - Quality Requirements.
   C. Pressure Testing:
   D. Upon completion of installation provide final checkout inspection by factory trained representative of manufacturer to ascertain proper system operation.
   E. Test circuits including automatic discharge, manual discharge, equipment shut-down, alarm devices, storage container pressure, and supervision of each circuit.
   F. Check each detector in accordance with manufacturer's instructions, perform any required adjustments, and include record of work in test report.
   G. Submit original copies of tests, indicating that factory trained technical representatives of the manufacturer have inspected and tested systems and are satisfied with methods of installation, connections and operation.
   H. Where applicable, pressure test enclosed, protected space with test fan, pressurizing protected area both under positive and negative conditions. Confirm that leakage is within system design allowance.

3.4 MAINTENANCE
   A. Conduct inspections at six months and 12 months from Date of Substantial Completion to verify proper operation of system, check agent container weight and pressure, and a thorough check of controls, detection and alarm systems.
   B. Remedy of all deficiencies shall be included at no extra cost to Owner except for replacement of agent due to discharge under normal use or damage due to abuse.
   C. Submit documents certifying satisfactory system conditions and include manufacturer's certificate of acceptance of inspector's qualifications.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Fire pump package, including fire pump, electric motor drive, controller, and accessories.
B. Electric jockey pump.
C. System maintenance.

1.2 RELATED REQUIREMENTS
A. Section 21 05 13 - Common Motor Requirements for Fire Suppression Equipment.
B. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS
A. NEMA MG 1 - Motors and Generators; 2014.
B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
E. UL 448 - Centrifugal Stationary Pumps for Fire-Protection Service; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS
A. Preinstallation Meeting: Convene one week before starting work of this section.

1.5 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturers literature including general assembly, pump curves showing performance characteristics with pump and system, operating point indicated, NPSH curve, controls, wiring diagrams, and service connections.
C. Shop Drawings: Indicate layout, general assembly, components, dimensions, weights, clearances, and methods of assembly.
D. Certificates: Certify that fire pumps meet or exceed specified requirements at specified operating conditions and that the installation complies with regulatory requirements. Submit summary and results of shop tests performed in accordance with NFPA 20.
E. Test Reports: Indicate results of hydrostatic test and field acceptance tests.
F. Manufacturer's Instructions: Indicate support details, connection requirements, for fire pump system.
G. Project Record Documents: Record actual locations of components and accessories.
H. Operation Data: Include manufacturers instructions, start-up data, trouble-shooting check lists, for pumps, drivers, and controllers.

I. Maintenance Data: Include manufacturers literature, cleaning procedures, replacement parts lists, and repair data for pumps, drivers and controllers.

J. Project Record Documents: Record actual locations of components and accessories.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 13 and NFPA 20; where requirements differ comply with the most stringent.

B. Design fire pump system under direct supervision of a Professional Engineer experienced in design of this Work and licensed at the State in which the Project is located.

PART 2 PRODUCTS

2.1 FIRE PUMPS

A. Manufacturers:

B. Fire Pumps: Vertical in-line type; UL 448 and UL 778; single stage, close coupled, radially or horizontally split casing, for in-line mounting, for 250 psi.
   1. Casing: Cast or ductile iron, with suction and discharge gage port, casing wear ring, seal flush connection, drain plug, flanged suction and discharge.
   2. Impeller: Bronze, fully enclosed, keyed directly to motor shaft.
   4. Seal: Carbon rotating against a stationary ceramic seat viton fitted, 225 degrees F maximum continuous operating temperature.
   5. Performance:
      a. Flow: 400 gpm, at 100 feet head.
      b. Motor: 20 hp, 208 volt, three phase, 60 Hz.

C. Accessories:
   1. Eccentric suction reducer and OS&Y gate or butterfly valve on suction side of pump.
   2. Concentric increaser and check valve in pump discharge and OS&Y gate or butterfly valve on system side of check valve.
   3. Fire pump bypass fitted with OS&Y gate or butterfly valves and check valve.
   4. Suction pressure gage, 4-1/2 inch diameter dial with snubber, valve cock and lever handle.
   5. Discharge pressure gage mounted on board attached to pump, with snubby, valve cock and lever handle.
   6. 3/4 inch casing relief valve.
   8. Hose valve manifold with 2-1/2 inch hose gate valves with caps and chains.
   9. Flow metering system for closed loop testing.

2.2 ELECTRIC MOTOR DRIVE:

A. Motor: Squirrel cage induction type, NEMA MG 1; in open drip proof NEMA 250 enclosure, 3500 rpm. Refer to Section 21 05 13.

B. Controller: Limited service type with auto-transformer starter, in NEMA 250 enclosure, including the following:
   1. Disconnect Switch: Externally operable, quick break type.
2. Circuit Breaker: Comply with NFPA 20; minimum 65,000 amperes interrupting capacity.
3. Motor Starter: Energized automatically through pressure switch or manually by externally operable handle.
4. Running Period Timer: Keeps motor in operation when started automatically, for a minimum of seven minutes.
5. Pilot Lamp: Indicates circuit breaker closed and power available.
6. Test Accessories: Ammeter test link and voltmeter test studs.
7. Alarm Relay: Energizes alarm to indicate circuit breaker open or power failure.
8. Switch Relay: For remote start.

2.3 PRESSURE BOOSTER (JOCKEY) PUMP
A. Electrically operated, horizontal turbine type with standard open drip-proof horizontal motor.
B. Control by automatic jockey pump controller with full voltage starter and minimum run timer to start pump on pressure drop in system and stay in operation for minimum period of time. Fire pump shall start automatically on further pressure drop or on jockey pump failure.

PART 3 EXECUTION

3.1 INSTALLATION
A. Install in accordance with NFPA 20.
B. Provide access space around pumps for service; no less than minimum as recommended by manufacturer.
C. Install piping in accordance with Section 21 05 00. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For base mounted pumps, provide supports under elbows on pump suction and discharge.
D. Provide drains for bases and seals, piped to and discharging into floor drains.
E. Provide for connection to electrical service. Refer to Section 26 27 17.
F. Lubricate pumps before start-up.

3.2 FIELD QUALITY CONTROL
A. Perform field inspection and testing in accordance with Section 01 40 00 - Quality Requirements.
B. Perform hydrostatic tests, flushing, and field acceptance tests as specified in NFPA 20.

3.3 CLOSEOUT ACTIVITIES
A. Demonstrate automatic operation of system including verification of pressure switch set points to Owner.
B. Use operation and maintenance data as reference during demonstration.
C. Briefly describe function, operation, and maintenance of each component.
3.4 MAINTENANCE

A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. Provide service and maintenance of equipment installed under this section for one year from the Date of Substantial Completion.

END OF SECTION
SECTION 22 05 16
EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Flexible pipe connectors.
   B. Expansion joints and compensators.
   C. Pipe alignment guides and anchors.

1.2 RELATED REQUIREMENTS
   A. Section 22 10 05 - Plumbing Piping and Specialties.
   B. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.

1.3 REFERENCE STANDARDS
   A. EJMA (STDS) - EJMA Standards; Tenth Edition.
   B. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.
   C. ASME B31.9 - American Society of Mechanical Engineers, Building Services Piping
   D. ASME Section IX - American Society of Mechanical Engineers, Boiler and Pressure Vessel
      Code - Welding and Brazing Qualifications.

1.4 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data:
      1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
      2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
   C. Design Data: Indicate criteria and show calculations.
   D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
   F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      1. See Section 01 60 00 - Product Requirements, for additional provisions.
   G. Welder's Certificate: Include welder's certificate of compliance with AWS D1.1

1.5 REGULATORY REQUIREMENTS
   A. Conform to UL (DIR) requirements.
   B. Perform work in accordance with Plumbing Code of New York State.
1.6 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
B. Installer: Company specializing in performing Work of this section with minimum three years experience.
C. Design expansion compensating system under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of New York.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.
B. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

PART 2 PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS - COPPER PIPING
A. Manufacturers:
   1. Keflex.
   2. Flexonics.
   3. Metraflex.
   4. Or Approved Equal.
   5. Substitutions: See Section 01 60 00 - Product Requirements.
B. Inner Hose: Bronze.
C. Exterior Sleeve: Braided bronze.
D. Pressure Rating: 125 psi and 450 degrees F.
E. Joint: Flanged.
F. Size: Use pipe sized units.
G. Maximum offset: 3/4 inch on each side of installed center line.
H. Application: Copper piping.

2.2 EXPANSION JOINTS - STAINLESS STEEL BELLOWS TYPE
A. Manufacturers:
   1. Metraflex Company:
   2. Mason Industries:
   3. Keflex;
   4. Or Approved Equal.
   5. Substitutions: See Section 01 60 00 - Product Requirements.
C. Maximum Extension: 1/4 inch.
D. Joint: Flanged.
E. Size: Use pipe sized units.

F. Application: Steel piping 3 inches and under.

G. Furnish five year manufacturer warranty for leak free performance of packed expansion joints.

2.3 ACCESSORIES

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

B. Swivel Joints:
   1. Fabricated steel body, double ball bearing race, field lubricated, with rubber o-ring seals.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide
   line size flexible connectors.

C. Install flexible connectors at right angles to displacement. Install one end immediately
   adjacent to isolated equipment and anchor other end. Install in horizontal plane unless
   indicated otherwise.

D. Rigidly anchor pipe to building structure. Provide pipe guides so movement is directed along
   axis of pipe only. Erect piping such that strain and weight is not on cast connections or
   apparatus.

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

F. Provide grooved piping with minimum one joint per inch pipe diameter for vibration isolated
   equipment instead of flexible connectors. Grooved piping need not be anchored.

G. Provide expansion loops as indicated on Drawings.

H. Install Work in accordance with Plumbing Code of New York State.

END OF SECTION
SECTION 22 05 48
VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Vibration isolators.
   B. Seismic snubber assemblies.
   C. Seismic restraints for suspended components and equipment.
   D. Inertia bases.

1.2 RELATED REQUIREMENTS

1.3 REFERENCE STANDARDS
   C. Section 07 90 00 - Joint Protection: Product requirements for joint sealers specified for placement by the section.
   D. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping: Product requirements for anchors and piping expansion compensation.

1.4 PERFORMANCE REQUIREMENTS
   A. Provide vibration isolation on motor driven equipment over 0.5 hp, plus connected piping.
   B. Provide minimum static deflection of isolators for equipment as follows:
      1. Upper Floors, Normal
         a. 400 - 600 rpm: 3.5 inch
         b. 600 - 800 rpm: 2 inch
         c. 800 - 900 rpm: 1 inch
         d. 1100 - 1500 rpm: 0.5 inch
         e. Over 1500 rpm: 0.2 inch
   C. Maintain sound level of spaces at levels not to exceed those listed below by utilizing acoustical devices.
   D. Maintain rooms at following maximum sound levels, in Noise Criteria (NC) as defined by ASHRAE Handbook., HVAC Applications
      1. Schools
         a. Shop: 40

1.5 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data:
      1. Provide manufacturer's product literature documenting compliance with PART 2 PRODUCTS.
2. Include seismic rating documentation for each isolator and restraint component accounting for horizontal, vertical, and combined loads.

C. Shop Drawings:
1. Provide schedule of vibration isolator type with location and load on each.
2. Fully dimensioned fabrication drawings and installation details for vibration isolation bases, member sizes, attachments to isolators, and supported equipment.
3. Include the calculations that indicate compliance with the applicable building code for seismic controls and the vibration isolator manufacturer's requirements.
4. Include the seal of the Professional Engineer registered in the State of New York in which the Project is located, on the drawings and calculations which at a minimum include the following:
   a. Seismic Restraint Details: Detailed drawings of seismic restraints and snubbers including anchorage details that indicate quantity, diameter, and depth of penetration, edge distance, and spacing of anchors.
   b. Detailed description of the equipment anchorage devices on which the certifications are based.
   c. Statement of Special Inspections: Prepared by the registered design professional in responsible charge.

D. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each. Indicate assembly, materials, thickness, dimensional data, pressure losses, acoustical performance, layout, and connection details for sound attenuation products fabricated for this project.

E. Manufacturer's Instructions: Indicate installation instructions with special procedures and setting dimensions.

F. Submitted equipment to be in conformance to New York State Building Code 2010, IBC 2006 and ASCE 7-05 for Building Codes.

1.6 QUALITY ASSURANCE
A. Perform design and installation in accordance with Building Code of New York State 2010, IBC 2006 and ASCE 7-05 for Building Codes.

B. Designer Qualifications: Perform design under direct supervision of a Professional Engineer experienced in design of this type of work and registered and licensed in the State in which the Project is located.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

D. Installer Qualifications: Company specializing in performing the work of this section with minimum 3 years of experience.

E. Manufacturer's Certificate: Certify isolators meet or exceed specified requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. Peabody Noise Control
B. Vibration Eliminator Company
C. Vibration Mounting and Controls, Inc.
D. Or Approved Equal.
E. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 PERFORMANCE REQUIREMENTS
A. General:
   1. All vibration isolators, base frames and inertia bases to conform to all uniform deflection and stability requirements under all operating loads.
   2. Steel springs to function without undue stress or overloading.
   3. All equipment mounted on vibration isolated bases to have minimum operating clearance of 2 inches between the base and floor or support beneath unless noted otherwise.

2.3 VIBRATION ISOLATORS
A. Seismic Type:
   1. Coil Springs Consisting of Single Elements:
      a. Housing: Manufactured from cast iron material.
      b. Ductile Material: Designed and rated for seismic applications.
      c. Spring: Restrained by housing without significant degradation of vibration isolation capabilities during normal equipment operating conditions.
      d. Resilient Snubbing Grommet System: Incorporated and designed with clearances of no more than 0.25 inch in any direction preventing direct metal-to-metal contact between supported member and fixed restraint housing.
      e. Resilient Pad: Located in series with spring.
      f. Coil Springs: Color coded elements to have a lateral stiffness greater than 0.8 times the rated vertical stiffness with 50 percent overload capacity.
      g. Finish: Suitable for the application.
   2. All Directional Elastomeric:
      a. Material: Molded from oil, ozone, and oxidant resistant compounds.
      b. Operating Parameters: Designed to operate within the isolator strain limits providing maximum performance and service life.
      c. Attachment Method: Encapsulated load transfer plate bolted to equipment and base plate with anchor hole bolted to supporting structure.
      d. Rating: Cast iron and aluminum housings rated for seismic restraint applications.
      e. Minimum Operating Static Deflections: Deflections indicated in project documents are not to exceed published load capacities.

2.4 SEISMIC SNUBBER ASSEMBLIES
A. Comply with:
   1. FEMA 412.
   2. FEMA 413.
   3. FEMA 414.
   4. FEMA E-74.
B. All Directional External:
   1. Application: Minimum three (3) snubbers are required for each equipment installation, oriented properly to restrain isolated equipment in all directions.
   2. Construction: Interlocking steel construction attached to the building structure and equipment in a manner consistent with anticipated design loads.
   3. Performance: Equipment movement at each snubber location limited to a maximum of 0.25 inches in any direction without significantly degrading the vibration isolation capability of the isolator during normal operating conditions.
   4. Resilient Pad: Minimum 0.25 inch thick cushions any impact and prevents metal-to-metal contact.
C. Lateral External:
   1. Application: Minimum three (3) snubbers are required for each stable equipment installation, oriented properly to restrain isolated equipment in all lateral directions where uplift forces are zero or addressed by other restraints.
   2. Construction: Steel construction attached to the building structure and equipment in a manner consistent with anticipated design loads.
   3. Performance: Equipment movement at each snubber location limited to a maximum of 0.25 inches in any direction without significantly degrading the vibration isolation capability of the isolator during normal operating conditions.
   4. Resilient Pad: Minimum 0.25 inch thick cushions any impact and prevents metal-to-metal contact.

2.5 SEISMIC RESTRAINTS FOR SUSPENDED COMPONENTS AND EQUIPMENT

A. Comply with:
   1. FEMA 412.
   2. FEMA 413.
   3. FEMA 414.
   4. FEMA E-74.

B. Cable Restraints:
   1. Wire Rope: Steel wire strand cables sized to resist seismic loads in all lateral directions.
   3. Size: Based on the lesser of cable capacity or anchor load taking into account bracket geometry.
   4. Connections:
      a. Use overlapping wire rope U clips, cable clamping bolts, swaged sleeves or seismically rated tool-less wedge insert lock connectors.
      b. Internally brace clevis hanger bracket cross bolt to prevent deformation.
   5. Vertical Suspension Rods: Attach required bracing of sufficient strength to prevent rod buckling from vertical compression forces utilizing series of attachment clips.

C. Rigid Restraints:
   1. Structural Element: Sized to resist seismic loads in all lateral directions and carry both compressive and tensile loading.
   2. Size: Based on the lesser of cable capacity or anchor load taking into account bracket geometry.
   3. Connections: Internally brace clevis hanger bracket cross bolt to prevent deformation.
   4. Static Support System: Anchorage capable of carrying additional tension loads generated by the vertical component of the rigid brace compression which is additive to any static load requirements on the system.
   5. Vertical Suspension Rods: Attached required bracing of sufficient strength to prevent rod buckling from vertical compression forces utilizing series of attachment clips.

2.6 VIBRATION ISOLATORS

A. Open Spring Isolators:
   1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
   2. Spring Mounts: Provide with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
   3. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
   4. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.
B. Restrained Spring Isolators:
1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
2. Spring Mounts: Provide with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
3. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
4. Restraint: Provide heavy mounting frame and limit stops.
5. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.
6. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
7. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
8. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance.
10. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
11. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
12. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance and limit stops.
13. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.

C. Spring Hanger:
1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
2. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.
4. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.

D. Neoprene Pad Isolators:
1. Rubber or neoprene waffle pads.
   a. Hardness: 30 durometer.
   b. Thickness: Minimum 1/2 inch.
   c. Maximum Loading: 40 psi.
   d. Rib Height: Maximum 0.7 times width.
2. Configuration: 1/2 inch thick waffle pads bonded each side of 1/4 inch thick steel plate.

E. Rubber Mount or Hanger: Molded rubber designed for 0.5 inch deflection with threaded insert.

F. Glass Fiber Pads: Neoprene jacketed pre-compressed molded glass fiber.
1. Type: Non-directional and double acting unit consisting of interlocking steel members restrained by neoprene elements.
2. Elements: Replaceable neoprene, minimum of 0.75 inch thick with minimum 1/8 inch air gap.
3. Capacity: 4 times load assigned to mount groupings at 0.4 inch deflection.
4. Attachment Points and Fasteners: Capable of withstanding 3 times rated load capacity of seismic snubber.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

A. Install in accordance with manufacturer's instructions.

B. Bases:
   1. Set concrete inertia bases for 2 inches clearance between housekeeping pad and base.
   2. Adjust equipment level.

C. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

D. Support piping connections to equipment mounted on isolators using isolators or resilient hangers for scheduled distance.
   1. Up to 4 Inches Pipe Size: First three points of support.
   2. Select three hangers closest to vibration source for minimum 1.0 inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch static deflection or 1/2 static deflection of isolated equipment.

3.2 INSTALLATION - SEISMIC

A. Comply with:
   1. FEMA 412.
   2. FEMA 413.
   3. FEMA 414.
   4. FEMA E-74.

B. Floor and Base-Mounted Equipment, Vibration Isolated Equipment and associated Vibration and Seismic Controls for Connections:
   1. Install equipment anchorage items designed to resist seismic design force in any direction.
   2. Install vibration and seismic controls designed to include base and isolator requirements.
   3. Provide flexible connections between equipment and interconnected piping.
   4. Provide isolators and restraints designed for amplified code forces per ASCE 7 and with demonstrated ability to resist required forces including gravity, operational and seismic forces.

C. Piping:
   1. Provide seismic bracing in accordance ASCE 7.
   2. Provide supports, braces, and anchors to resist gravity and seismic design forces.
   3. Provide flexible connections between floor mounted equipment and suspended piping; between unbraced piping and restrained suspended items; as required for thermal movement; at building separations and seismic joints; and wherever relative differential movements could damage pipe in an earthquake.
   4. Brace resiliently supported pipe with cable bracing or alternate means designed to prevent transmission of vibrations and noise to the structure.
   5. Brace every run 5.0 feet or more in length with two transverse and one longitudinal bracing locations.
3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect isolated equipment after installation and submit report. Include static deflections.

END OF SECTION
PART 1  GENERAL

1.1  SECTION INCLUDES
A. Nameplates.
B. Tags.
C. Stencils.
D. Pipe markers.
E. Ceiling tacks.

1.2  RELATED REQUIREMENTS
A. Section 09 91 23 - Interior Painting: Identification painting.

1.3  REFERENCE STANDARDS

1.4  SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. List: Submit list of wording, symbols, letter size, and color coding for identification.
C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
D. Operation and Maintenance, O&M, Manual Data: Record actual locations of tagged valves, and provide laminated valve chart which includes valve tag numbers, location and function in chart form for placement into Operations and Maintenance Manual.

PART 2  PRODUCTS

2.1  IDENTIFICATION APPLICATIONS
A. Piping: Pipe markers / Stencils.
B. Air Compressor, Backflow Device, Water Heater: Nameplates.
C. Domestic Pump, DP-1: Tags.
D. Valves: Tags and ceiling tacks where located above lay-in ceiling.

2.2  NAMEPLATES
A. Description: Laminated three-layer plastic with engraved letters.
   2. Letter Height: 1/4 inch.

2.3 TAGS

A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.

B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

C. Valve Tag Chart: Typewritten letter sized list, plastic laminated. Typewritten letter size list to include applied tag function description, valve tag number and location.

2.4 STENCILS (CONCEALED PIPING)

A. Stencils: With clean cut symbols and letters of following size:
   1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
   2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
   3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.

B. Stencil Paint: As specified in Section 09 91 23, semi-gloss enamel, colors conforming to ASME A13.1.

2.5 PIPE MARKERS (EXPOSED PIPING)

A. Comply with ASME A13.1.

B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

2.6 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color coded head.

B. Color code as follows:
   1. Plumbing Valves: Green.

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 09 91 23 for stencil painting.

3.2 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.
C. Apply stencil painting in accordance with Section 09 91 23.

D. Install plastic pipe markers in accordance with manufacturer's instructions.
   1. Identify service, flow direction, and pressure.
   2. Install in clear view and align with axis of piping.
   3. Locate identification not to exceed 20 feet on straight runs including risers and drops,
      adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and
      at each obstruction.

E. Locate ceiling tacks to locate valves above lay-in panel ceilings. Locate in corner of panel
   closest to equipment.

F. Identify concealed piping, with stenciled painting. Identify exposed piping with plastic pipe
   markers. Identify service, flow direction, and pressure. Install in clear view and align with axis
   of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops,
   adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at
   each obstruction.

G. Identify valves in main and branch piping with tags.

   END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Piping insulation.
   B. Jackets and accessories.

1.2 RELATED REQUIREMENTS
   A. Section 07 84 00 - Firestopping.
   B. Section 09 91 23 - Interior Painting: Painting insulation jacket.
   C. Section 22 10 05 - Plumbing Piping and Specialties: Placement of hangers and hanger inserts.
   D. Section 22 05 53 - Identification for Plumbing Piping and Equipment.

1.3 REFERENCE STANDARDS

1.4 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
   C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.
   D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
1.5 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
   B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of experience.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.
   B. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.7 FIELD CONDITIONS
   A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
   B. Maintain ambient conditions required by manufacturers of each product.
   C. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

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

2.2 GLASS FIBER
   A. Manufacturers:
      1. Armstrong.
      2. Owens Corning Corporation.
      5. Or Approved Equals.
      6. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
      1. 'K' Value: ASTM C177, 0.24 at 75 degrees F.
      2. Maximum Service Temperature: 850 degrees F.
      3. Maximum moisture absorption: 0.1 percent by volume.
   C. Vapor Retarder Jacket: ASTM C1136 Flexible, Low Permeance Vapor Retarders for Thermal Insulation, Type II. Facing: 1 inch galvanized steel hexagonal wire mesh stitched on one face of insulation.
   D. Vapor Barrier Lap Adhesive: Compatible with insulation.
   E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.3 EXPANDED POLYSTYRENE
   A. Manufacturers:
1. Armstrong.
2. Owens Corning Corporation.
5. Or Approved Equal.
6. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation: ASTM C578; rigid closed cell.
1. 'K' Value: 0.23 at 75 degrees F.
2. Maximum Service Temperature: 165 degrees F.
3. Maximum Moisture Absorption: 0.2 percent by volume.
4. Maximum Water Vapor Permeance: 5.0 perms.

2.4 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:
1. Armstrong.
2. Owens Corning Corporation.
5. Or Approved Equal.
6. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 3; use molded tubular material wherever possible.

2.5 JACKETS

A. PVC Plastic Pipe Jacket.
1. Manufacturers:
   a. Armstrong.
   b. Owens Corning.
   c. Knauf.
   d. Or Approved Equal.
e. Substitutions: See Section 01 60 00 - Product Requirements.

2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
   a. Maximum Service Temperature: 450 degrees F.
   b. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
   c. Thickness: 10 mil.
   d. Connections: Brush on welding adhesive.

4. Insulation covering cold water systems shall contain integral vapor retarder system for moisture removal and mold prevention.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.
3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Install in accordance with North American Insulation Manufacturers Association (NAIMA) National Insulation Standards.
C. Exposed Piping: Locate insulation and cover seams in least visible locations.
D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections and expansion joints.
E. Glass fiber insulated pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with insulated jacket of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
F. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
G. Glass fiber insulated pipes conveying fluids above ambient temperature:
   1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
H. Inserts and Shields:
   1. Application: Piping 1-1/2 inches diameter or larger.
   2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
   3. Insert Location: Between support shield and piping and under the finish jacket.
   4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
I. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 07 84 00 for penetrations of assemblies with fire resistance rating greater than one hour.
J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.
K. Pipe Exposed in Finished Spaces: Finish with PVC jacket and fitting covers.

3.3 SCHEDULES

A. Plumbing Systems:
   1. All sizes of Domestic Cold water, 1/2 inch to 1-1/4 inch Hot Water, 1/2 inch to 1-1/4 inch Hot Water Recirculation and 1/2 inch to 1-1/4 inch Tempered Water Piping:
      a. Glass Fiber Insulation:
         1) Pipe Size Range: As Noted.
         2) Thickness: 1 inch.
      b. Cellular Glass Insulation:
         1) Pipe Size Range: As Noted.
         2) Thickness: 1 inch.
      c. Expanded Polystyrene Insulation:
1) Pipe Size Range: As Noted.
2) Thickness: 1 inch.

d. Cellular Foam Insulation:
1) Pipe Size Range: As Noted.
2) Thickness: 1 inch.

2. 1-1/2 inch and Larger Domestic Hot Water Piping:
a. Glass Fiber Insulation:
   1) Pipe Size Range: As Noted.
   2) Thickness: 1-1/2 inch.

b. Cellular Glass Insulation:
   1) Pipe Size Range: As Noted.
   2) Thickness: 1-1/2 inch.

c. Expanded Polystyrene Insulation:
   1) Pipe Size Range: As Noted.
   2) Thickness: 1-1/2 inch.

d. Cellular Foam Insulation:
   1) Pipe Size Range: As Noted.
   2) Thickness: 1-1/2 inch.

3. Plumbing Vents Within 10 Feet of the Exterior:
a. Fiber Glass Insulation with integral vapor retarder. All pipe sizes, 1 inch thick.

b. Elastomeric Cellular Foam Insulation all pipe sizes, 1 inch thick.

c. Cellular Glass Insulation. All pipe sizes, 1 inch thick.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

A. Pipe, pipe fittings, valves, connections and specialties for:
   1. Sanitary sewer systems.
   2. Domestic water systems.
   3. Gas systems.
   4. Flanges, unions, and couplings.
   5. Pipe hangers and supports.
   6. Valves.
   7. Flow controls.

1.2 RELATED REQUIREMENTS

A. Section 33 13 00 - Disinfecting of Water Utility Distribution.
B. Section 07 84 00 - Firestopping.
C. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping.
D. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
E. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
F. Section 22 07 19 - Plumbing Piping Insulation.
G. Section 33 13 00 - Disinfecting of Water Utility Distribution.

1.3 REFERENCE STANDARDS

C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
F. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes; 2013.
G. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV; 2012.
H. ASME B31.2 - Fuel Gas Piping; The American Society of Mechanical Engineers; 1968.
I. ASME B31.9 - Building Services Piping; 2014.


R. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2013.


AB. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2009.

AC. AWWA C651 - Disinfecting Water Mains; 2005.


AG. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements; 2012.


AK. MSS SP-71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends; 2011.
AL. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010.


AO. National Sanitation Foundation: NSF 61 - Low lead pipe, Fittings and Valves.

1.4 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on pipe materials, pipe fittings, valves, hangers, supports and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
C. Project Record Documents: Record actual locations of valves.
D. Hangers and Supports: Submit manufacturers catalog information including load capacity.
E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.  
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Valve Repacking Kits: One for each type and size of valve.

1.5 QUALITY ASSURANCE
A. Perform Work in accordance with State of New York, standards.
B. Valves: Manufacturer's name and pressure rating marked on valve body.
C. Welding Materials and Procedures: Conform to ASME BPVC-IX and applicable state labor regulations.
D. Welder Qualifications: Certified in accordance with ASME BPVC-IX.
E. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.6 REGULATORY REQUIREMENTS
A. Perform Work in accordance with State of New York plumbing code.
B. Conform to applicable code for installation of backflow prevention devices.
C. Provide certificate of compliance from authority having jurisdiction indicating approval of installation of backflow prevention devices.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.8 FIELD CONDITIONS
A. Do not install underground piping when bedding is wet or frozen.
PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

2.2

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

2.3 SANITARY SEWER AND DRAIN PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cast Iron Pipe: ASTM A74 extra heavy weight.
   1. Fittings: Cast iron.
   2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.

B. PVC Pipe: ASTM D2665 or ASTM D3034.
   1. Fittings: PVC.

2.4 GREASE WASTE PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cast Iron Pipe: ASTM A74 extra heavy weight.
   1. Fittings: Cast iron.
   2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.

2.5 SANITARY SEWER AND DRAIN PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.

B. Copper Tube: ASTM B306, DWV, Type L.
   2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

C. PVC Pipe: ASTM D2665.
   1. Fittings: PVC.

2.6 GREASE WASTE PIPING, ABOVE GRADE

A. Copper Tube: ASTM B306, DWV, Type L.
   2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

2.7 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Ductile Iron Pipe: AWWA C151/A21.51, 3 inches and larger.
   1. Fittings: AWWA C110, ductile iron, standard thickness. Cement Mortar lining in conformance with AWWA C-104.

2.8 DOMESTIC WATER PIPING, ABOVE GRADE
   A. Copper Tubing for pipe 2 1/2 inches and smaller: ASTM B 88 (ASTM B 88M), Type L (B), Drawn (H)
      1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.

2.9 PROPANE GAS PIPING, ABOVE GRADE
   A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
      2. Joints: NFPA 54, Threaded for pipe size 2-1/2" inch

2.10 PROPANE GAS PIPING, ABOVE GRADE
   A. Exterior gas piping above grade:
      1. Apply one coat of rust inhibitive primer paint and one finish coat of paint per manufacterer’s recommendation. Rust preventive enamel, OSHA approved. Color to be coordinated with Owner.

2.11 FLUE AND COMBUSTION AIR PIPING
   A. CPVC Pipe: ULC S636 compliant, chlorinated polyvinyl chloride (CPVC-FGV) material.
      1. Fittings: ULC S636 compliant.
      3. All ULC S636 compliant pipes, fitting and cements to be supplied from same manufacturer.

2.12 FLANGES, UNIONS, AND COUPLINGS
   A. Unions for Pipe Sizes [2] inches and Under:
      1. Copper tube and pipe: Class 150 bronze unions with soldered joints.
      2. PVC Piping: PVC
   B. Flanges for Pipe Size Over 2 inches:
      1. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.
      2. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
      3. PVC Piping: PVC
      4. Gaskets: 1/16 inch thick preformed neoprene gaskets

2.13 PIPE HANGERS AND SUPPORTS
   A. Provide hangers and supports that comply with MSS SP-58.
      1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
      2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
      3. Trapeze Hangers: Welded steel channel frames attached to structure.
   B. Plumbing Piping - Drain, Waste, and Vent:
      2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
      3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

C. Plumbing Piping - Water:
2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
5. Multiple or Trapeze Hangers: Steel channels with welded supports or spacers and hanger rods.
6. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
8. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
10. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

D. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
5. Concrete Adhesive Type Anchors: Complying with -ES AC308.

E. INSERTS
1. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

F. FLASHING
1. Metal Flashing: 26 gage thick galvanized steel.
2. Metal Counterflashing: 22 gage thick galvanized steel.
3. Lead Flashing:
   a. Waterproofing: 5 lb./sq. ft sheet lead.
   b. Soundproofing: 1 lb./sq. ft sheet lead.
5. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

G. SLEEVES
1. Sleeves for Pipes through Non-fire Rated Floors: 18 gage thick galvanized steel.
2. Sleeves for Pipes through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
3. Sealant: refer to Section 07 90 00.

H. MECHANICAL SLEEVE SEALS
1. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

I. FORMED STEEL CHANNEL
1. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

J. FIRESTOPPING
1. Refer to Specification Section 07 84 00.

2.14 BALL VALVES
A. Construction, [3] inches and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze, two piece body, chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle, solder or threaded ends with union. Lead free.

2.15 PLUG VALVES
A. Construction 2-1/2 Inches and Larger: MSS SP-78, 175 psi CWP, cast iron body and plug, pressure lubricated, teflon or Buna N packing, flanged or grooved ends. Provide lever operator with set screw.

2.16 HORIZONTAL SWING CHECK VALVES
A. Up to 2 Inches:
  1. MSS SP-80, 150, bronze body and cap, bronze swing disc with rubber seat, solder or threaded ends. Lead free.

2.17 STEM TYPE THERMOMETERS
A. Thermometer: ASTM E1, adjustable angle, red appearing indicator, lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device.
  1. Size: 9 inch scale.
  2. Window: Clear Lexan.
  4. Accuracy: 2 percent.
  5. Calibration: Degrees F.
  6. Indicator shall be non-mercury.

2.18 WALL FAUCETS
A. Manufacturers:
  1. Chicago Faucet.
  2. T&S Brass.
  3. Elkay.
  4. Or Approved Equals.
  5. Substitutions: See Section 01 60 00 - Product Requirements.
B. Wall Faucet,(WF-1): Exposed supply type, interior use, rough chrome plated brass construction, cold water and hot water supply with cross handles, hose thread spout, wall brace, integral vacuum breaker.
C. Wall Faucet,(WF-2): Concealed supply type, interior use, rough chrome plated brass construction, cold water and hot water supply with lever handles, hose thread spout, wall brace, integral vacuum breaker.

2.19 WATER METERS
A. Obtain Water Meters from Town of Hector Water Department.

2.20 HYDRANTS
A. Manufacturers:
1. Zurn.
2. J.R. Smith.
3. Watts.
4. Or Approved Equals.
5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Wall Hydrant, (HYD-1): ASSE 1019; interior use, self-draining type with lockable recessed box
hose thread spout, locks shield and removable key, and integral vacuum breaker.

C. Wall Hydrant, (HYD-2): ASSE 1019; frost-proof, self-draining type with lockable recessed box
hose thread spout, locks shield and removable key, and integral vacuum breaker.

2.21 RECESSED EXTRACTOR VALVE BOX

A. Extractor Washing Machine: Plastic preformed rough-in box with lead free isolation valves with
wheel handles, slip in finishing cover.

2.22 BACKFLOW PREVENTERS

A. Manufacturers:
   1. Watts.
   2. Wilkins.
   3. Conbraco.
   4. Or Approved Equals.
   5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Reduced Pressure Detector Assembly Backflow Preventers, (RPDA-1) (Fire Suppression):
   1. Comply with ASSE 1047.
   2. Fused epoxy coated cast iron with bronze seat, UL listed and FM approved OSY shutoff
      valves, test cocks, relief valve and check valves.
   3. Air gap per manufacturer’s recommendation.
   4. Provide testing and document of Certification.

C. Reduced Pressure Backflow Preventers, (RPZ-1) (Truck Fill), RPZ-2 (Domestic) and
   RPZ-3 (Boiler Fill):
   2. Bronze body, with bronze internal parts and stainless steel springs.
   3. Two independently operating, spring loaded check valves; diaphragm type differential
      pressure relief valve located between check valves; third check valve opening under back
      pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate
      valves, strainer, and four test cocks.
   4. Air gap per manufacturer's recommendation.
   5. Provide testing and document of Certification.

2.23 WATER HAMMER ARRESTOR -LEAD FREE

A. Stainless steel bellow type, complies with and sized in accordance with PDI WH-201.

B. Pre-charged suitable for operation in temperature range 34 to 250 degrees F and maximum
   150 psi working pressure.

2.24 DIAPHRAGM-TYPE EXPANSION TANK

A. Manufacturers:
   1. Amtrol.
   2. Watts.
   3. Zurn-Wilkins.
   4. Or Approved Equals.
   5. Substitutions: See Section 01 60 00 - Product Requirements.
B. Expansion Tank, (ET-1, ET-2): Construction: Welded steel, tested and supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible EPDM diaphragm sealed into tank.

C. Accessories: Pressure gage and air-charging fitting, tank drain; pre-charge to 50 psig.

D. Size: as indicated on Drawing.

2.25 FLOOR DRAIN / FLOOR SINK

A. Manufacturers:
   1. Zurn.
   2. Watts.
   3. J.R. Smith.
   4. Or Approved Equals.
   5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Floor Drain, (FD-1): ASME A112.21.1; cast iron two piece body with double drainage flange, weep holes, 1/2 inch trap primer connection, reversible clamping collar, and round adjustable nickel-bronze strainer.

C. Floor Sink, (FS-1, FS-2, FS-3, FS-4): 12 inch x 12 inch x 6 inch floor receptor, full grate, enamel interior and top, interior bottom dome strainer and 1/2 inch trap primer connection.

D. Floor Drain / Floor Sink Trap Primer Valve (FD-1, FS-1, FS-2, FS-3, FS-4):
   1. Manufacturers:
      a. Precision Plumbing Products.
      b. J.R. Smith.
      c. Sioux Chief.
      d. Or Approved Equals.
   2. ASSE 1018, corrosion resistant brass, piston operated, no springs or diaphragms, adjustable in line pressure, 1/2 inch inlet and outlet openings.

2.26 CLEANOUTS

A. Manufacturers:
   1. Zurn.
   2. Watts.
   3. J.R. Smith.
   4. Or Approved Equals.
   5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Cleanout, Interior Finished Floor Area, (CO-1): cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round polished bronze scoriated cover.

C. Cleanout, Interior Unfinished Inline Accessible Area, (CO-2): cast iron body ferrule type with ABS countersunk plug.

D. Wall Cleanout, Interior Finished Wall Area, (WCO-1): cast iron body with lacquered ABS tapered threaded plug and round stainless steel wall access cover with securing screw.

2.27 TRENCH DRAIN, (TD-1):

A. Manufacturers:
   1. ABT, Inc.
   2. MultiDrain.
   3. Dura Trench.
   4. Or Approved Equals.
   5. Substitutions: See Section 01 60 00 - Product Requirements.
B. Cast in place concrete trench drain with catch basin.
C. Polystyrene trench drain forms.
D. Structural steel trench rails complete with end rails and anchoring legs.
E. Ductile iron grate with locking device

PART 3 EXECUTION

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

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

3.3 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
E. Group piping whenever practical at common elevations.
F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 05 16.
G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
H. Provide access where valves and fittings are not exposed.
I. Install vent piping penetrating roofed areas to maintain integrity of roof assembly.
J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
K. Provide support for utility meters in accordance with requirements of utility companies.
L. Excavate in accordance with Section 31 23 16 referring to paragraph 3.3 through end of section.
M. Backfill in accordance with Section 31 23 23 referring to paragraph 2.1 through end of section.
N. Install bell and spigot pipe with bell end upstream.
O. Install valves with stems upright or horizontal, not inverted. Refer to Section 22 05 23.
P. Install water piping to ASME B31.9.
Q. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.

R. Sleeve pipes passing through partitions, walls and floors.

S. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

T. PVC piping is not allowed to be installed in plenum spaces. Use cast iron or copper piping in these locations.

U. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping.

V. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to fixtures to prevent hammer or install air chambers on hot and cold water supply piping to each fixture or group of fixtures (each washroom). Fabricate same size as supply pipe or 3/4 inch minimum, and minimum 18 inches long.

W. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

X. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9.
   2. Support horizontal piping as scheduled.
   3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   4. Place hangers within 12 inches of each horizontal elbow.
   5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   8. Provide copper plated hangers and supports for copper piping.
   9. Provide hangers adjacent to motor driven equipment with vibration isolation; refer to Section 22 05 48.
  10. Support cast iron drainage piping at every joint.

Y. Equipment Bases and Supports
   1. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
   2. Construct supports of steel members or formed steel channel. Brace and fasten with flanges bolted to structure.
   3. Provide rigid anchors for pipes after vibration isolation components are installed. Refer to Section 22 05 48.

Z. Flashing
   1. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs.
   2. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked 1 inch minimum into hub, 8 inches minimum clear on sides with 24 x 24
inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter-flash, and seal.

3. Flash floor drains, floor sinks in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.

4. Seal floor, shower, and mop sink drains watertight to adjacent materials.

AA. Sleeves
1. Set sleeves in position in forms. Provide reinforcing around sleeves.
2. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
3. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
4. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent work with fire stopping, insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
5. Install chrome plated steel escutcheons at finished surfaces.

3.4 APPLICATION
A. Install unions downstream of valves and at equipment or apparatus connections.

B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

C. Provide flow controls in water recirculating systems where indicated.

3.5 TOLERANCES
A. Sanitary Drainage Piping: Establish invert elevations, slopes for drainage to 1/8 inch per foot minimum on mains 4 inches and larger. Install branch mains smaller than 4 inch with 1/4 inch per foot minimum.

3.6 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM
A. Disinfect water distribution system in accordance with Section 33 13 00.

B. Final water samples shall be sent to a New York State Department of Health approved testing lab and sample test results shall be submitted to A/E of record.

C. Prior to starting work, verify system is complete, flushed and clean.

D. Ensure acidity (pH) of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

E. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

F. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

G. Maintain disinfectant in system for 24 hours.

H. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

I. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

J. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.
3.7 SERVICE CONNECTIONS

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

B. Provide new water service complete with approved reduced pressure backflow preventer and water meter.
   1. Provide sleeve in wall for service main and support at wall with reinforced concrete bridge. Calk enlarged sleeve and make watertight with pliable material. Anchor service main inside to concrete wall.

C. Test sanitary sanitary sewer, drain and grease waste and vent piping systems in accordance with Plumbing Code of New York State.

D. Test backflow prevention devices in accordance with ASSE 5013.

E. Test domestic water piping system in accordance with Plumbing Code of New York State.

F. Provide new propane gas piping into building. Building gas service distribution piping to have pressure of \([1/2]\) psi.

G. Test gas piping system at 10 psi for one hour in accordance with Fuel Gas Code of New York State.

3.8 SCHEDULES

A. Pipe Hanger Spacing:
   1. Metal Piping:
      a. Pipe Size: 1/2 inches to 1-1/4 inches:
         1) Maximum Hanger Spacing: 6.5 ft.
         2) Hanger Rod Diameter: 3/8 inches.
      b. Pipe Size: 1-1/2 inches to 2 inches:
         1) Maximum Hanger Spacing: 10 ft.
         2) Hanger Rod Diameter: 3/8 inch.
      c. Pipe Size: 2-1/2 inches to 3 inches:
         1) Maximum Hanger Spacing: 10 ft.
         2) Hanger Rod Diameter: 1/2 inch.
      d. Pipe Size: 4 inches to 6 inches:
         1) Maximum Hanger Spacing: 10 ft.
         2) Hanger Rod Diameter: 5/8 inch.
   2. Cast Iron (All Sizes) pipe length less than 10’:
      a. Maximum hanger Spacing: 5 ft.
      b. Hanger rod diameter: 5/8 inch
   3. Cast Iron (All Sizes) with 10 foot length of pipe
      a. Maximum hanger Spacing: 10 ft.
      b. Hanger rod diameter: 5/8 inch
   4. Copper Tube, 1-1/4 inches and smaller
      b. Hanger rod diameter: 1/2 inch
   5. Copper Tube, 1-1/2 inches and larger
      a. Maximum hanger Spacing: 10 ft.
      b. Hanger rod diameter: 1/2 inch
   6. PVC (All Sizes)
      a. Maximum hanger Spacing: 4 ft.
b. Hanger rod diameter: 3/8 inch

END OF SECTION
PART 1  GENERAL

1.1 SECTION INCLUDES
   A. Pipe and pipe fittings.
   B. Air compressor.

1.2 RELATED REQUIREMENTS
   A. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
   B. Section 22 05 53 - Identification for Plumbing Piping and Equipment: Identification of piping system.
   C. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS
   A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015.
   C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.

1.4 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Manufacturer's Instructions: Indicate manufacturer's installation instructions, hoisting and setting requirements, starting procedures.
   C. Project Record Documents: Operation and Maintenance, O&M, Manual Data: Record actual locations of tagged valves and equipment; include valve tag numbers in chart format.
   D. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE
   A. Perform Work in accordance with ASME B31.1 code for installation of piping systems and ASME Section IX for welding materials and procedures.
   B. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.
C. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

D. Installer: Company specializing in performing work of this section with minimum three years documented experience approved by manufacturer.

E. Protect piping from weather and construction traffic. Maintain factory packaging and caps in place until installation.

F. Deliver fittings, valves, and other components in sealed containers and keep sealed until installation.
   1. Accept air compressor and accessories on site in factory fabricated containers with shipping skids and plastic pipe end protectors in place. Inspect for damage.

1.6 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for air compressor.

PART 2 PRODUCTS

2.1 PIPE AND PIPE FITTINGS

A. Steel Pipe: ASTM A53/A53M, Schedule 40 black.
   1. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.

B. Steel Pipe: ASTM A53/A53M Schedule 40, black, [cut] [rolled] grooved ends.
   2. Joints: Grooved mechanical couplings meeting ASTM F1476.
       b. Gasket: Elastomer composition for operating temperature range from 40 degrees F to 180 degrees F.
       c. Accessories: Stainless steel bolts, nuts, and washers.

C. Copper Tubing: ASTM B88, Type M, drawn.
   1. Fittings: ASME B16.18 cast copper alloy or ASME B16.22, wrought copper and bronze.
   2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
   3. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting temperature range 430 to 535 degrees F.

D. Copper Tubing: ASTM B88, Type M, drawn.
   2. Joints: Compression type made with manufacturer’s tool.

E. Copper Tubing: ASTM B88, Type K, annealed.

F. Copper Tubing: ASTM B88, Type M, hard drawn, rolled grooved ends.
   1. Fittings: ASME B16.18 cast copper alloy, or ASME B16.22 wrought copper and bronze.
   2. Joints: Grooved mechanical couplings meeting ASTM F1476.
a. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron, enamel coated, compatible with copper tubing sizes, to engage and lock designed to permit some angular deflection, contraction, and expansion.

b. Gasket: Elastomer composition for operating temperature range from 40 degrees F to 180 degrees F.

c. Accessories: Stainless steel bolts, nuts, and washers.

G. Stainless Steel Pipe: ASTM A312/A312M, 0.049 Wall, Type 304/304L, certified for use with compression joint system.

1. Fittings: Press type, precision cold drawn austenitic stainless steel fittings and couplings, with Nitrile O-ring seals. O-rings UL classified in accordance with NSF 61 for potable water service.

2. Joints: Compression type made with manufacturer’s tool.

2.2 AIR OUTLETs

A. Quick Connector: 3/8 inch brass, snap on connector with self closing valve, Style A.

2.3 VALVES

A. Gate Valves:

1. 2 inches and Smaller: MSS SP 80Class 150, bronze body, bronze trim, union bonnet, rising stem, inside screw with back-seating stem, wedge disc, solder or threaded ends.

B. Ball Valves:

1. 2 inches and Smaller: MSS SP 110, Class 150, bronze, two piece body, type 316 stainless steel ball, full port, teflon seats, blow-out proof stem, solder or threaded ends with union, lever handle with balancing stops.

2.4 UNIONS AND COUPLINGS

A. Unions for Pipe 2 inches and Smaller:

1. Ferrous Pipe: 150 psi malleable iron threaded unions.

2. Copper Tube and Pipe: 150 psi bronze unions with soldered joints.

3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

4. Stainless Steel Piping: 300 psig, threaded type with compression type ends.

B. Flexible Connector: Neoprene with brass threaded connectors.

2.5 FLEXIBLE CONNECTORS

A. 2 inches and Smaller: Corrugated stainless steel hose with single layer of stainless steel exterior braiding, Schedule 40 black steel ends; maximum working pressure 190 psig, threaded or soldered connections.

2.6 COMPRESSOR, AC-1

A. Manufacturers:


2. Ingersoll Rand Compressed Air Solutions.


4. Or Approved Equals.

5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Type: Vertical tank, two-stage. Refer to Plumbing Fixture Schedule on drawing for Manufacturer, Model, Trim and Remarks.
PART 3 EXECUTION

3.1 INSTALLATION - ABOVE GROUND PIPING - COMPRESSED AIR SYSTEMS

A. Install equipment in accordance with manufacturer’s instructions.
B. Install compressor unit on concrete housekeeping pad. Coordinate size, minimum 3-1/2 inches high and 6 inches larger than compressor base on each side.
C. Provide inserts for placement in concrete forms.
D. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.
E. Install compressor unit on vibration isolators. Level and bolt in place. Refer to Section 22 05 48.
F. Make air cock and drain connection on horizontal casing.
G. Install line size gate valve and check valve on compressor discharge. Refer to Section 22 05 23.
H. Connect condensate drains to nearest floor drain.
I. Install valved drip connections at low points of piping system. Refer to Section 22 05 23.
J. Install takeoffs to outlets from top of main, with shut off valve after take off. Slope take off piping to outlets.
K. Install compressed air couplings, female quick connectors, and pressure gages.
L. Install tees instead of elbows at changes in direction of piping. Fit open end of each tee with plug.
M. Cut pipe and tubing accurately and install without springing or forcing.
N. Slope piping in direction of flow.
O. Install pipe sleeves where pipes and tubing pass through walls.
P. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping.
Q. Install manual shut off valves with stem vertical and accessible for operation and maintenance.
R. Identify piping system and components. Refer to Section 22 05 53.

3.2 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Compressed Air Piping Leak Test: Prior to initial operation, clean and test compressed air piping in accordance with ASME B31.1.
C. Repair or replace compressed air piping as required to eliminate leaks, and retest to demonstrate compliance.
D. Verify for atmospheric pressure in piping systems, other than system under test.
E. Test system with dry compressed air or dry nitrogen with test pressure in piping system at 50 psi.
F. Cap and seal ends of piping when not connected to mechanical equipment.

3.3 CLEANING

A. Blow systems clear of free moisture and foreign matter.

END OF SECTION
SECTION 22 30 00
PLUMBING EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES
A. Water heater.
B. Pump.

1.2 RELATED REQUIREMENTS
A. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
B. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS
A. ANSI Z21.10.3 - Gas-Fired Water Heaters - Volume III - Storage Water Heaters with Input Ratings Above 75,000 Btu per Hour, Circulating and Instantaneous; 2014.

1.4 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittals procedures.
B. Product Data:
   1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
   2. Indicate pump type, capacity, power requirements.
   3. Provide electrical characteristics and connection requirements.
C. Shop Drawings:
   1. Indicate heat exchanger dimensions, size of tappings, and performance data.
   2. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tappings, and drains.
D. Project Record Documents: Record actual locations of components.
E. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.

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

1.6 DELIVERY, STORAGE, AND HANDLING
A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.
B. Accept water heaters on site in original labeled cartons. Inspect for damage.
1.7 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide five year manufacturer warranty for Water Heater.

PART 2 PRODUCTS

2.1 COMMERCIAL PROPANE GAS FIRED WATER HEATER, (WH-1),
   A. Manufacturers:
      1. A.O. Smith.
      2. State Water Heaters.
      4. Or Approved Equals.
      5. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Type: Automatic, fully condensing, propane-fired, vertical storage.
   C. Performance:
      2. Input: 399,900 Btuh at sea level.
      4. ASME labelled.
   D. Tank, glass lined welded steel, insulated, helical heat exchanger coil,. 
      1. Accessories: Provide:
         b. Dip tube: Brass.
         c. Drain Valve.
         d. Anode: Magnesium.
         e. Temperature and Pressure Relief Valve: ASME labelled.
         f. Neutralization Kit.
      2. Controls: All controls are located at top of heater. Microprocessor controlled ignition and water thermostat for precise setting of water temperatures ranging from 110 to 180 degrees F. A digital display panel showing operating mode, user settings and failure mode.
      4. Refer to plumbing fixture schedule on drawing for Manufacturer, Model, Trim and Remarks.
   E. Electrical requirements:
      1. Refer to Plumbing Fixture Schedule on drawing.

2.2 DOMESTIC PUMPS
   A. Manufacturers:
      1. Armstrong.
      2. Taco.
      3. Bell & Gossett
      4. Or Approved Equals.
      5. Substitutions: See Section 01 60 00 - Product Requirements.
B. Domestic Pump, Recirculation, (DP-1): UL and CSA listed, rated for 140 psig maximum working pressure, bronze or stainless steel casing, polypropylene (glass filled) impeller, stainless steel shaft, graphite bearing, EPDM gasket and aquastat

C. Electrical requirements:
   1. Refer to Plumbing Fixture Schedule on drawing.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.

B. Coordinate with plumbing piping and related fuel piping work to achieve operating system.

C. Domestic Water Heater:
   1. Install water heater on concrete housekeeping pad. Coordinate size, minimum 3-1/2 inches high and 6 inches larger than water heater on each side.
   2. Maintain manufacturer's recommended clearances around and over water heaters.
   3. Connect propane gas piping in accordance with NFPA 58.
   4. Connect propane gas piping to water heater, full size of water heater gas train inlet. Arrange piping with clearances for burner removal and service.
   5. Connect domestic hot water piping to outlet connection and connect domestic hot water recirculation piping to domestic cold water piping. Connect cold water piping to inlet connections.
   6. Install the following piping accessories.
      a. On supply:
         1) Thermometer well and thermometer.
         2) Strainer.
         3) Pressure gage.
         4) Shutoff valve.
      b. On return:
         1) Thermometer well and thermometer.
         2) Pressure gage.
         3) Shutoff valve.
      c. Install the following piping accessories on propane gas piping connections.
         1) Strainer.
         2) Pressure gage.
         3) Shutoff valve.
   7. Install discharge piping from relief valves and drain valves to nearest floor drain.
   8. Install circulator and diaphragm expansion tank on water heater.
   9. Install water heater trim and accessories furnished loose for field mounting.
  10. Install electrical devices furnished loose for field mounting.
  11. Install control wiring between water heater control panel and field mounted control devices.
  12. Connect CPVC flue to water heater outlet, full size of outlet.
  13. Install Work in accordance with Plumbing Code of New York State.

END OF SECTION
SECTION 22 40 00
PLUMBING FIXTURES

PART 1 GENERAL

1.1 SECTION INCLUDES
A. Water closets.
B. Urinal.
C. Lavatories.
D. Sink.
E. Mop Sink.
F. Electric water cooler.
G. Shower.

1.2 RELATED REQUIREMENTS
A. Section 07 92 00 - Joint Sealants: Sealing joints between fixtures and walls and floors.
B. Section 22 10 05 - Plumbing Piping and Specialties.
C. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS
D. ASME A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use; 1997 (Reaffirmed 2002).
E. ASME A112.18.1 - Plumbing Supply Fittings; 2012.
F. ASME A112.19.2 - Ceramic Plumbing Fixtures; 2013.
G. ASME A112.19.5 - Flush Valves and Spuds for Water Closets, Urinals, and Tanks; 2011.

1.4 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
C. Maintenance Data: Include fixture trim exploded view and replacement parts lists.
D. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Flush Valve Service Kits: One for each type and size.

1.5 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
   B. Perform Work in accordance with Plumbing Code of New York State.

1.6 REGULATORY REQUIREMENTS
   A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.
   B. Plumbing piping, joints, faucets, etc. must comply with the requirements, and bear the label indicating the materials comply with the definition of “lead free” requirement of the Environmental Protection Agency “Reduction of Lead in Drinking Water Act”.
   C. Lead Water Testing: Lead water testing shall be conducted at all Lavatories, Sinks and Drinking Fountains in accordance with Public Health Law section 1370-a and 1110, Subpart 67-4 of Title 10 (Health) of the Official Compilation of Codes, Rules and Regulations of the State of New York and the Environmental Protection Agency 3T’s for Reducing Lead in Drinking Water.
   D. Fire District reserves the right to accept or not accept installation unless results are not greater than the Department Of Health action level.

1.7 DELIVERY, STORAGE, AND HANDLING
   A. Accept fixtures on site in factory packaging. Inspect for damage.
   B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.8 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide five year manufacturer warranty for Plumbing Fixtures.

PART 2 PRODUCTS

2.1 GENERAL
   A. Potable Water Systems: Provide plumbing fittings and faucets that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.2 MANUFACTURERS:
   A. Refer to Plumbing Fixture Schedule on drawing for Manufacturer, Model, Trim and Remarks.
2.3 FLUSH VALVE WATER CLOSETS

A. Manufacturers:
   2. Sloan.
   4. Or Approved Equals.
   5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Water Closet Bowl (WC-1): ASME A112.19.2M; ADA compliant, wall mount, siphon jet, vitreous china closet bowl with elongated rim, 1-1/2 inch top spud and 1.6 gallon flush volume.

C. Water Closet Bowl (WC-2): ASME A112.19.2M; Wall mount, siphon jet, vitreous china closet bowl with elongated rim, 1-1/2 inch top spud and 1.6 gallon flush volume.

D. Flush Valve/ Transformer:
   1. Manufacturers:
      a. Sloan.
      c. Zurn.
      d. Or Approved Equals.
      e. Substitutions: See Section 01 60 00 - Product Requirements.

E. Electric Powered Sensor Operated (WC-1, WC-2): ADA compliant, exposed chrome plated diaphragm type with solenoid operator with one wall cover plate. Adaptive infrared sensor and true mechanical over-ride button, 24-hour sentinel flush, escutcheon, seat bumper, integral screwdriver stop, vacuum breaker and 1.6 gallon flush volume for use with 1-1/2 inch top spud.
   1. Electrical requirements:
      a. Refer to Plumbing Fixture Schedule on drawing.

F. Seats:
   1. Manufacturers:
      b. Bemis Manufacturing Company
      c. Church Seat Company
      d. Or Approved Equals.
      e. Substitutions: See Section 01 60 00 - Product Requirements.
   2. (WC-1, WC-2): Elongated solid white plastic, open front without cover, self-sustaining hinge, brass bolts.

G. Water Closet Carriers:
   1. (WC-1, WC-2): ASME A112.6.1M; floor mounted, adjustable cast iron frame, integral drain hub and vent, adjustable spud, lugs for floor attachment, threaded fixture studs with nuts and washers.

2.4 WALL HUNG URINALS

A. Manufacturers:
   2. Sloan.
   4. Or Approved Equals.
   5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Urinal, (UR-1): ASME A112.19.2; ADA compliant, wall mount, washout, vitreous china urinal with shields, integral trap, elongated 14 inch rim from finished wall, 3/4 inch top spud and 1.0 gallon flush volume.
C. Flush Valve:
   1. Manufacturers:
      a. Sloan.
      c. Zurn.
      d. Or Approved Equals.
      e. Substitutions: See Section 01 60 00 - Product Requirements.

D. Electric Powered Sensor Operated (UR-1): ADA compliant, exposed chrome plated diaphragm type with solenoid operator with one wall cover plate. Adaptive infrared sensor, true mechanical over-ride button, 24-hour sentinel flush, escutcheon, integral screwdriver stop, vacuum breaker and 1.0 gallon flush volume for use with 3/4 inch top spud.
   1. Electrical requirements:
      a. Refer to Plumbing Fixture Schedule on drawing.

E. Carriers:
   1. (UR-1): ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor attachment, threaded fixture studs for fixture hanger, bearing studs.

2.5 LAVATORY

A. Manufacturers:
   2. Sloan.
   4. Or Approved Equals.
   5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Lavatory, Vitreous China Wall Mount Basin (LAV-1): ASME A112.19.2M; ADA compliant, vitreous china wall mount, 20 x 18 inch minimum, with 4 inch high back, 3-hole faucet mount drilling, D-shaped basin with splash lip, front overflow, offset grid drain and pipe covers.

C. Faucet / Transformer (LAV-1):
   1. Manufacturers:
      a. Chicago Faucet.
      b. Sloan.
      c. American Standard.
      d. Or Approved Equals.
      e. Substitutions: See Section 01 60 00 - Product Requirements.

D. Thermostatic Mixing Valve (LAV-1):
   1. Manufacturers:
      a. Chicago Faucet.
      b. Sloan.
      c. Watts.
      d. Or Approved Equals.
      e. Substitutions: See Section 01 60 00 - Product Requirements.

E. Transformer - Per Faucet Manufacturers Recommendations.

F. Electric Powered Sensor Faucet (LAV-1): ADA compliant, low lead content, tempered water connection, chrome finish, maximum 0.5 gpm flow of 60 psig, 4 inch cover plate, transformer (hard wired) and lead-free thermostatic mixing valve.
   1. Electrical requirements:
      a. Refer to Plumbing Fixture Schedule on drawing.
G. Wall Mounted Carrier (LAV-1): ASME A112.6.1; Cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded studs for fixture hanger, concealed arm supports, bearing plate and studs.

2.6 SINKS

A. Manufacturers:
1. Advance Tabco.
2. Just Manufacturing.
3. Elkay.
4. T&S Brass.
5. Zurn.
7. Or Approved Equals.
8. Substitutions: See Section 01 60 00 - Product Requirements.

B. Three Compartments - Two Drainboards (SK-1): NSF certified, 127 x 31 x 14 inch outside dimensions with two (2) 24 inch drainboards, 14 gage thick, Type 304 stainless steel. Welded tubular stainless steel legs, gussets and channels, three (3) basket strainer drains and tailpieces and backsplash drilled for trim, three (3) twist handle drains.
1. Trim: Two (2) backsplash mounted faucets and flexible stainless steel hose and spray valve assembly.
2. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, screwdriver stop and lead free supplies.

C. Single Compartment Bowl (SK-2): ASME A112.19.3; 19 x 21 x 5-1/2 inch outside dimensions, 18 gage thick, Type 304 stainless steel. Self-rimming and undercoated, with 1-1/2 inch stainless steel offset basket strainer drain and tailpiece and ledge back drilled for trim.
1. Trim: Deck mounted mixing faucet, 11-5/8 inch high spout with 2.2 gpm aerator, chrome plated finish with 4 inch wristblade handles.
2. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, screwdriver stop and rigid supplies.

2.7 SHOWER

A. Manufacturers:
1. Bradley.
2. Acorn Engineering.
3. Willoughby.
4. Or Approved Equals.
5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Trim (SH-1): Recess-mounted ADA wall unit, stainless steel panel, adjustable showerhead, hand held shower with stainless steel hose, backflow preventer, diverter valve, grab bars, phenolic folding seat, thermostatic mixing control valve, curtain rod, curtain and holder. Valve Left / Seat Right configuration.

2.8 ELECTRIC WATER COOLERS

A. Manufacturers:
1. Elkay.
2. Oasis.
3. Halsey Taylor.
4. Or Approved Equals.
5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Water Cooler with Bottle Filler, (ECB-1): Lead-Free, ADA compliant Two-station, electric, mechanically refrigerated; surface handicapped mounted; stainless steel top, stainless steel
body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push controls located in front, left and right side of unit, mounting bracket; integral air cooled condenser, cane apron. Body and lower shroud to be stainless steel. Bottle filler with filter and electronic sensor activation, plastic components, visual monitor for filter replacement. Provide 3-pack replacement filters.

1. Capacity: Water Cooler - 8 gallons per minute of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F, when tested in accordance with ASHRAE Std 18.
   Capacity: Bottle Filler - 1.1 - 1.5 gallons per minute of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F.
2. Electrical requirements:
   a. Refer to Plumbing Fixture Schedule on drawing.

2.9 MOP SINK

A. Manufacturers:
   1. Acorn Engineering.
   2. Stern Williams.
   3. Fiat.
   4. Or Approved Equals.
   5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Bowl (MS-1): 24 x 36 x 12 inch high molded stone, floor mounted with not less that 1 1/2 inch wide shoulder, stainless steel cap, stainless steel strainer.

C. Faucet (MS-1):
   1. Manufacturers:
      a. Chicago Faucet.
      b. T&S Brass.
      c. Stern Williams.
      d. Or Approved Equals.
      e. Substitutions: See Section 01 60 00 - Product Requirements.
   2. Trim: Recessed wall type supply with handles, spout wall brace, vacuum breaker, hose end spout, integral screwdriver stops with covering caps and adjustable threaded wall flanges.
   3. Accessories:
      a. Hose clamp hanger.
      b. Mop hanger.
      c. Stainless Steel Wall Guard.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.
B. Verify that electric power is available and of the correct characteristics.

3.2 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.
3.3 INSTALLATION
   A. Install each fixture with trap, easily removable for servicing and cleaning.
   B. Provide chrome plated rigid or flexible lead free supplies to fixtures with loose key stops, reducers, and escutcheons.
   C. Install components level and plumb.
   D. Install and secure fixtures in place with wall supports and bolts.
   E. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

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

3.5 CLEANING
   A. Clean plumbing fixtures and equipment.

3.6 PROTECTION
   A. Protect installed products from damage due to subsequent construction operations.
   B. Do not permit use of fixtures by construction personnel.
   C. Repair or replace damaged products before Date of Substantial Completion.

END OF SECTION
PART 1  GENERAL

1.1  SECTION INCLUDES

A.  General Description
B.  Architecture/Communication
C.  Operator Interface
D.  Application and Control Software
E.  System Controllers
F.  Equipment Controllers
G.  Input/Output Modules
H.  Auxiliary Control Devices
I.  System Tools

PART 2  PRODUCTS

2.1  MANUFACTURERS

A.  Trane, Andover

2.2  ARCHITECTURE/COMMUNICATION

A.  This project shall be comprised of a high speed Ethernet network utilizing BACnet/IP communications between System Controllers and Workstations. Communications between System Controllers and sub-networks of Custom Application Controllers and/or Application Specific Controllers shall utilize BACnet/Zigbee communications.

1.  Each System Controller shall perform communications to a wireless network of Custom Application and Application Specific Controllers using wireless BACnet/Zigbee (802.15.4) as defined by the Zigbee Standard.
   a.  Each communication interface shall be Zigbee Building Automation Certified product as defined by the BACnet Standard and the Zigbee Alliance.
   b.  Each System Controller shall function as a BACnet Router to each unit controller providing a unique BACnet Device ID for all controllers within the system.

2.  The Owner will provide all communication media, connectors, repeaters, network switches, and routers necessary for the high speed Ethernet network. An active Ethernet port will be provided adjacent to each System Controller and building operator web interface (PC) for connection to this high speed Ethernet network.

3.  All values within the system (i.e. schedules, datalogs, points, software variables, custom program variables) shall be readable and controllable (where appropriate) by any System Controller or BACnet Workstation on the communications network via BACnet.
2.3 OPERATOR INTERFACE

A. Furnish [1] PC based building operator web interface as shown on the system drawings. Each of these operator interfaces shall be able to access all information in the system. The building operator web interface shall reside on the Enterprise wide network, which is same high-speed communications network as the System Controllers. The Enterprise wide network will be provided by the owner and supports the Internet Protocol (IP).

1. Each PC based building operator web interface shall include the following:
   a. Hardware type
      1) PC
   b. Operating Systems
      1) Windows 8
   c. Minimum Hardware
      1) Pentium Core 2 DUO or better
      2) 4 GB RAM
      3) 100 GB hard drive space
      4) Internet Browser compatible with building operator web interface requirements outlined in the building operator web interface section

2. Local Operator Interface
   a. A wall mounted touch screen display shall be provided for local access to the system.
   b. The display shall provide a single point from which to control set points from multiple pieces of equipment.
   c. The system shall group equipment so that multiple pieces of equipment can share a schedule and set point.
   d. The interface shall optionally provide scheduling with the ability to schedule events at least 1 year in advance.
   e. The interface shall optionally include pin control and limited temperature adjustments.
   f. The local operator interface should be capable of displaying Custom Graphics as outlined below.
   g. Additional Local Operator Touch Screen Display Requirements:
      1) Input power: 9-12 VDC
      2) Temperature: 0°C to 40°C
      3) Humidity: 85%
      4) Mounting Type: VESA (75 mm x 75 mm)
   h. Local Operator Touch Screen Display must meet the following Agency Compliance:
      1) ROHS
      2) FCC CFR Title 47, Part 15
      3) CE Compliant

3. Building Operator Web Interface
   a. The building operator web interface shall be accessible via a web browser.
   b. Access to the building operator web interface shall not require any "plug-ins" (i.e. JAVA Runtime Environment (JRE), Adobe Flash) in addition to the web browsers identified below.
   c. The building operator web interface shall support the following Internet web browsers:
      1) Internet Explorer 10.0+
      2) Firefox 29.0+
      3) Chrome 35.0+
   d. The building operator web interface shall support the following mobile web browsers:
      1) iOS (iPad/iPhone) V6.0+
      2) Android (Tablet) V4.3+
3) Android (Phone) V2.3+

4. Mobile App Operator Interface
   a. Mobile App Operator Interface shall support the following Operating systems
      1) Apple iOS V 7/8
      2) Android V4.3/4.4
   b. The Mobile App operator interface shall support system access on a mobile device via a mobile app to:
      1) Alarm log
      2) System Status
      3) Equipment status
      4) Space Status
      5) Standard Equipment graphics
   c. The Mobile App operator interface shall support actions on a mobile device via a mobile app to:
      1) Override set points
      2) Override occupancy
      3) Acknowledge Alarms
      4) Comment on Alarms

5. System Security
   a. Each building operator shall be required to login to the system with a user name and password in order to view, edit, add, or delete data.
   b. User Profiles shall restrict the user to only the objects, applications, and system functions as assigned by the system administrator.
   c. Each operator shall be allowed to change their user password
   d. The System Administrator shall be able to manage the security for all other users
   e. The system shall include pre-defined “roles” that allow a system administrator to quickly assign permissions to a user.
   f. User logon/logoff attempts shall be recorded.
   g. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user definable.
   h. All system security data shall be stored in an encrypted format.

6. Database
   a. Database Save. A system operator with the proper password clearance shall be able to archive the database on the designated building operator web interface PC.
   b. Database Restore. The system operator shall also be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.

7. On-Line Help and Training
   a. Provide a context sensitive, on line help system to assist the operator in operation and configuration of the system.
   b. On-line help shall be available for all system functions and shall provide the relevant data for each particular screen.

8. System Diagnostics
   a. The system shall automatically monitor the operation of all network connections, building management panels, and controllers.
   b. The failure of any device shall be annunciated to the operators.

9. Equipment & Application Pages
   a. The building operator web interface shall include standard pages for all equipment and applications. These pages shall allow an operator to obtain information relevant to the operation of the equipment and/or application, including:
      1) Animated Equipment Graphics for each major piece of equipment and floor plan in the System
         (a) Animation capabilities shall include the ability to show a sequence of images reflecting the position of analog outputs, such as valve or damper positions. Graphics shall be capable of launching other web pages.
2) Alarms relevant to the equipment or application without requiring a user to navigate to an alarm page and perform a filter.
3) Historical Data (As defined in Automatic Trend Log section below) for the equipment or application without requiring a user to navigate to a data log page and perform a filter.

   a. Point Control. Provide a method for a user to view, override, and edit if applicable, the status of any object and property in the system. The point status shall be available by menu, on graphics or through custom programs.
   b. Temporary Overrides. The user shall be able to perform a temporary override wherever an override is allowed, automatically removing the override after a specified period of time.
   c. Override Owners. The system shall convey to the user the owner of each override for all priorities that an override exists.
   d. Provide a specific icon to show timed override or operator override, when a point, unit controller or application has been overridden manually.

11. Engineering Units
   a. Allow for selection of the desired engineering units (i.e. Inch pound or SI) in the system.
   b. Unit selection shall be able to be customized by locality to select the desired units for each measurement.
   c. Engineering units on this project shall be IP.

12. Scheduling. A user shall be able to perform the following tasks utilizing the operator interface:
   a. Create a new schedule, defining the default values, events and membership.
   b. Create exceptions to a schedule for any given day.
   c. Apply an exception that spans a single day or multiple days.
   d. View a schedule by day, week and month.
   e. Exception schedules and holidays shall be shown clearly on the calendar.
   f. Modify the schedule events, members and exceptions.

13. Trend Logs
   a. Trend Logs Definition.
      1) The building operator web interface shall allow a user with the appropriate security permissions to define a trend log for any data in the system.
      2) The building operator web interface shall allow a user to define any trend log options as described in the Application and Control Software section.
   b. Trend Log Viewer.
      1) The building operator web interface shall allow Trend Log data to be viewed and printed.
      2) The building operator web interface shall allow a user to view trend log data in text-based (time – stamp/value).
      3) The operator shall be able to view the data collected by a trend log in a graphical chart in the operator interface.
      4) Trend log viewing capabilities shall include the ability to show a minimum of 5 points on a chart.
      5) Each data point trend line shall be displayed as a unique color.
      6) The operator shall be able to specify the duration of historical data to view by scrolling and zooming.
      7) The system shall provide a graphical trace display of the associated time stamp and value for any selected point along the x-axis.
   c. Export Trend Logs.
      1) The building operator web interface shall allow a user to export trend log data in CSV or PDF format for use by other industry standard word processing and spreadsheet packages.

14. Alarm/Event Notification
a. An operator shall be notified of new alarms/events as they occur while navigating through any part of the system via an alarm icon.

b. Alarm/Event Log. The operator shall be able to view all logged system alarms/events from any operator interface.
   1) The Building Operator shall be able to sort and filter alarms from events. Alarms shall be sorted in a minimum of 4 categories based on severity.
   2) Alarm/event messages shall use full language, easily recognized descriptors.
   3) An operator with the proper security level may acknowledge and clear alarms/events.
   4) All alarms/events that have not been cleared by the Building Operator shall be stored by the building controller.
   5) The alarm/event log shall include a comment field for each alarm/event that allows a user to add specific comments associated with any alarm.

c. Alarm Processing.
   1) The Building Operator shall be able to configure any object in the system to generate an alarm when transitioning in and out of a normal state.
   2) The Building Operator shall be able to configure the alarm limits, warning limits, states, and reactions for each object in the system.

15. Reports and Logs.
   a. The Building operator web interface shall provide a reporting package that allows the operator to select reports.
   b. The Building operator web interface shall provide the ability to schedule reports to run at specified intervals of time.
   c. The Building Operator web interface shall allow a user to export reports and logs from the building controller in a format that is readily accessible by other standard software applications including spreadsheets and word processing. Acceptable formats include:
      1) CSV, HTML, XML, PDF
   d. Reports and logs shall be readily printed to the system printer.
   e. Provide a means to list and access the last 10 reports viewed by the user.
   f. The following standard reports shall be available without requiring a user to manually configure the report:
      1) All Points in Alarm Report: Provide an on demand report showing all current alarms.
      2) All Points in Override Report: Provide an on demand report showing all overrides in effect.
      3) Commissioning Report: Provide a one-time report that lists all equipment with the unit configuration and present operation.
      4) Points report: Provide a report that lists the current value of all points

16. VAV Air System. An operator shall be able to view and control (where applicable) the following parameters via the Building Operator web interface:
   a. System Mode
   b. System Occupancy
   c. Ventilation (Outdoor air flow) setpoint
   d. Ventilation (Outdoor air flow) status
   e. Air Handler Static pressure setpoint
   f. Air Handler Static pressure status
   g. Air Handler occupancy status
   h. Air Handler Supply air cooling and heating set points
   i. Air Handler minimum, maximum and nominal static pressure setpoints
   j. VAV box minimum and maximum flow
   k. VAV box drive open and close overrides
   l. VAV box occupancy status
   m. VAV box Airflow to space
   n. Average space temperature
2.4 APPLICATION AND CONTROL SOFTWARE

A. Furnish the following applications software for building and energy management. All software applications shall reside and run in the system controllers. Editing of applications shall occur at the operator interface.

1. Scheduling. Provide the capability to schedule each object or group of objects in the system. Each of these schedules shall include the capability for start, stop, optimal start, optimal stop, and night economizer actions. Each schedule may consist of up to [10] events. When a group of objects are scheduled together, provide the capability to define advances and delays for each member. Each schedule shall consist of the following:
   a. Weekly Schedule. Provide separate schedules for each day of the week.
   b. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. This exception schedule shall override the standard schedule for that day. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed it will be discarded and replaced by the standard schedule for that day of the week.
   c. Holiday Schedules. Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.

2. Trend Log Application
   a. Trend log data shall be sampled and stored on the System Controller panel and shall capable of being archived to a BACnet Workstation for longer term storage.
      1) Trend logs shall include interval, start-time, and stop-time.
      2) Trend log intervals shall be configurable as frequently as 1 minute and as infrequently as 1 year.
   b. Automated Trend Logs.
      1) The system controller shall automatically create trend logs for defined key measurements for each controlled HVAC device and HVAC application.
      2) The automatic trend logs shall monitor these parameters for a minimum of 7 days at 15 minute intervals. The automatic trend logs shall be user adjustable.
      3) The following is a list of key measurements required for Automatic Trending:

3. Alarm/Event Log
   a. Any object in the system shall be configurable to generate an alarm when transitioning in and out of a normal or fault state.
   b. Any object in the system shall allow the alarm limits, warning limits, states, and reactions to be configured for each object in the system.
   c. An alarm/event shall be capable of triggering any of the following actions:
      1) Route the alarm/event to one or more alarm log
         (a) The alarm message shall include the name of the alarm location, the device that generated the alarm, and the alarm message itself.
      2) Route an e-mail message to an operator(s)
      3) Log a data point(s) for a period of time
      4) Run a custom control program

4. VAV System Coordination. Provide applications software to properly coordinate and control the VAV system to ensure equipment safety and minimize energy use. This application shall perform the following functions:
   a. Startup and shutdown the air handler safely. Ensure the VAV boxes are open sufficiently when the air handler is running, to prevent damage to the ductwork and VAV boxes due to high air pressure.
   b. Calibrate VAV boxes.
c. Fan Pressure Optimization (ASHRAE 90.1) - Minimize energy usage by controlling system static pressure to the lowest level while maintaining zone airflow requirements. System static pressure controlled to keep the “most open” zone damper between 65% and 75% open.
   1) The Fan Pressure Optimization application shall have the ability to identify and display the discharge air setpoint of the air-handler and the VAV box that serves the critical zone (e.g., the zone with the most open VAV box damper). This information shall dynamically update with changes in the location of the critical zone.
   2) During commissioning, and with the engineer/owner, the controls contractor shall confirm the performance of Fan Pressure Optimization by conducting a field functional test that demonstrates critical zone reset.

d. Ventilation Optimization (ASHRAE 62) – properly ventilate all spaces while minimizing operating energy costs, using measured outdoor air flow. Dynamically calculate the system outdoor air requirement based on “real time” conditions in the spaces (i.e., number of occupants, CO2 levels, etc.) minimizing the amount of unconditioned outdoor air that must be brought into the building.

e. Demand Controlled Ventilation – the active ventilation setpoint shall modulate between the occupied ventilation and occupied standby ventilation setpoint; Reset the setpoint based on CO2 levels in the space.

2.5 SYSTEM CONTROLLERS

A. There shall be one independent, standalone microprocessor based System Controllers to manage the global strategies described in Application and Control Software section.
   1. The System Controller shall have sufficient memory to support its operating system, database, and programming requirements.
   2. The controller shall provide a USB communications port for connection to a PC
   3. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
   4. All System Controllers shall have a real time clock.
   5. Data shall be shared between networked System Controllers.
   6. The System Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
      a. Assume a predetermined failure mode.
      b. Generate an alarm notification.
      c. Create a retrievable file of the state of all applicable memory locations at the time of the failure.
      d. Automatically reset the System Controller to return to a normal operating mode.
   7. Environment. Controller hardware shall be suitable for the anticipated ambient conditions. Controller used in conditioned ambient shall be mounted in an enclosure, and shall be rated for operation at -40 C to 50 C [-40 F to 122 F].
   8. Clock Synchronization.
      a. All System Controllers shall be able to synchronize with a NTP server for automatic time synchronization.
      b. All System Controllers shall be able to accept a BACnet time synchronization command for automatic time synchronization.
      c. All System Controllers shall automatically adjust for daylight savings time if applicable.
   9. Serviceability
      a. Provide diagnostic LEDs for power, communications, and processor.
      b. The System Controller shall have a display on the main board that indicates the current operating mode of the controller.
      c. All wiring connections shall be made to field removable, modular terminal connectors.
d. The System controller shall utilize standard DIN mounting methods for installation and replacement.

10. Memory. The System Controller shall maintain all BIOS and programming information indefinitely without power to the System controller.

11. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shut-down below 80% nominal voltage.

12. BACnet Test Labs (BTL) Listing. Each System Controller shall be listed as a Building Controller (B-BC) by the BACnet Test Labs with a minimum BACnet Protocol Revision of 14.

B. Unit Controller

1. The unit controller shall be prewired for control of at least 4 TRIAC outputs a terminal strip and one (1) universal input.

2. Input/Output:
   a. For flexibility in selection and replacement of valves, the controllers shall be capable of supporting all of the following valve control types: 0-10VDC, 0-5VDC, 4-20mA, 24VAC floating point, 24VAC - 2 position (Normally Open or Normally Closed).
   b. For flexibility in selection and replacement of sensors, the controllers shall be capable of reading sensor input ranges of 0 to 10V, 0 to 20mA, pulse counts, and 200 to 20Kohm.
   c. For flexibility in selection and replacement of binary sensors, the controller shall support dry and wetted (24VAC) binary inputs.
   d. For flexibility in selection and replacement of binary sensors, the controller shall support dry and wetted (24VAC) binary inputs.
   e. For flexibility in selection and replacement of motors, the controller shall be capable of outputting 24VAC (binary output), DC voltage (0 to 10VDC minimum range) and PWM (in the 80 to 100 Hz range).
   f. For future needs, any I/O that is unused by functionality of equipment control shall be available to be used by custom program on the controller and by another controller on the network.

3. Serviceability – The controller shall provide the following in order to improve serviceability of the controller.
   a. Diagnostic LEDs shall indicate correct operation or failures/faults for all of the following: power, sensors, BACnet communications, and I/O communications bus.
   b. All binary output shall have LED’s indicating the output state.
   c. All wiring connections shall removable without the use of a tool.
   d. Software service tool connection through all of the following methods: direct cable connection to the controller, connection through another controller on BACnet link and through the controller’s zone sensor.
   e. For safety purposes, the controller shall be capable of being powered by a portable computer for the purposes of configuration, programming, and testing programs so that this work can be accomplished with the power off to the equipment.
   f. Capabilities to temporarily override of BACnet point values with built-in time expiration in the controller.
   g. BACnet Mac Address shall be set using decimal (0-9) based rotary switches.
   h. Configuration change shall not be made in a programming environment, but rather by a configuration page utilizing dropdown list, check boxes, and numeric boxes.
   i. BACnet trending objects resident on controller
      1) Minimum of 20,000 trending points total on controller
      2) Shall be capable of trending all BACnet points used by controller
      3) Shall be capable of 1 second sample rates on all point
PART 3 EXECUTION

NOT USED

END OF SECTION
SECTION 23 05 16
EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 GENERAL

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

1.2 RELATED REQUIREMENTS
A. Section 23 21 13 - Hydronic Piping.
B. Section 23 23 00 - Refrigerant Piping.

1.3 REFERENCE STANDARDS
B. EJMA (STDS) - EJMA Standards; Tenth Edition.
C. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

1.4 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data:
   1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
   2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
C. Design Data: Indicate selection calculations.
D. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.
E. Maintenance Data: Include adjustment instructions.
F. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.

1.5 CLOSEOUT SUBMITTALS
A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
B. Project Record Documents: Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.
C. Operation and Maintenance Data: Submit adjustment instructions.
1.6 QUALITY ASSURANCE
   A. Perform Work in accordance with ASME B31.1, ASME B31.5 and ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.
   B. Perform Work in accordance with New York State Mechanical Code.
   C. Maintain one copy of each document on site.

1.7 QUALIFICATIONS
   A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
   B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.8 PRE-INSTALLATION MEETINGS
   A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

1.9 DELIVERY, STORAGE, AND HANDLING
   A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
   B. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.
   C. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.10 WARRANTY
   A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
   B. Furnish five year manufacturer warranty for leak free performance of packed expansion joints.

1.11 EXTRA MATERIALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
   B. Supply two 12 ounce containers of packing lubricant and cartridge style grease gun.

1.12 REGULATORY REQUIREMENTS
   A. Conform to UL (DIR) requirements.

PART 2 PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS - STEEL PIPING
   A. Manufacturers:
      3. _________.
4. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Inner Hose: Carbon Steel.
   D. Pressure Rating: 125 psi and 450 degrees F.
   E. Joint: Flanged.
   F. Size: Use pipe sized units.
   G. Maximum offset: 3/4 inch on each side of installed center line.

2.2 FLEXIBLE PIPE CONNECTORS - COPPER PIPING
   A. Manufacturer:
      3. ________.
      4. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Inner Hose: Bronze.
   C. Exterior Sleeve: Braided bronze.
   D. Pressure Rating: 125 psi and 450 degrees F.
   E. Joint: Flanged.
   F. Size: Use pipe sized units.
   G. Maximum offset: 3/4 inch on each side of installed center line.
   H. Application: Copper piping.

2.3 EXPANSION JOINTS - STAINLESS STEEL BELLOWS TYPE
   A. Manufacturers:
      3. ________.
      4. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Pressure Rating: 125 psi and 400 degrees F.
   D. Maximum Extension: 1/4 inch.
   E. Joint: Flanged.
   F. Size: Use pipe sized units.
   G. Application: Steel piping 3 inches and under.

2.4 EXPANSION JOINTS - EXTERNAL RING CONTROLLED STAINLESS STEEL BELLOWS TYPE
   A. Manufacturers:
      3. ________.
      4. Substitutions: See Section 01 60 00 - Product Requirements.
B. Pressure Rating: 125 psi and 400 degrees F.
C. Maximum Compression: 15/16 inch.
D. Maximum Extension: 5/16 inch.
E. Maximum Offset: 1/8 inch.
F. Joint: Flanged.
G. Size: Use pipe sized units.
H. Accessories: Internal flow liner.
I. Application: Steel piping over 2 inches.

2.5 EXPANSION JOINTS - LOW PRESSURE COMPENSATOR WITH TWO-PLY BRONZE BELLOWS
A. Manufacturers:
   3. __________.
   4. Substitutions: See Section 01 60 00 - Product Requirements.
B. Working Pressure: 75 psi.
C. Maximum Temperatures: 250 degrees F.
D. Maximum Compression: 1/2 inch.
E. Maximum Extension: 5/32 inch.
F. Joint: Soldered.
G. Size: Use pipe sized units.
H. Application: Copper or steel piping 3 inches and under.

2.6 EXPANSION JOINTS - STEEL WITH PACKED SLIDING SLEEVE
A. Manufacturers:
   1. __________.
   2. __________.
   3. __________.
   4. Substitutions: See Section 01 60 00 - Product Requirements.
B. Working Pressure and Temperature: Class 150.
C. Joint: Flanged.
D. Size: Use pipe sized units.
E. Application: Steel piping 2 inches and over.

2.7 EXPANSION JOINTS - COPPER WITH PACKED SLIDING SLEEVE
A. Working Pressure: 125 psi.
B. Maximum Temperature: 250 degrees F.
C. Joint: Flanged.
D. Size: Use pipe sized units.
E. Application: Copper or steel piping 2 inches and over.

2.8 ACCESSORIES
A. Stainless Steel Pipe: ASTM A269/A269M.
B. Pipe Alignment Guides:
   1. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inches travel.
C. Swivel Joints:
   1. Fabricated steel body, double ball bearing race, field lubricated, with rubber (Buna-N) o-ring seals.

PART 3 EXECUTION

3.1 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.
C. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
D. Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
E. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.
F. Substitute grooved piping for vibration isolated equipment instead of flexible connectors. Grooved piping need not be anchored.
G. Provide expansion loops as indicated on Drawings.

3.2 MANUFACTURER'S FIELD SERVICES
A. Section 01 40 00 - Quality Requirements: Manufacturers' field services.

END OF SECTION
SECTION 23 05 19
METERS AND GAGES FOR HVAC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES
A. Flow meters.
B. Pressure gages and pressure gage taps.
C. Thermometers and thermometer wells.
D. Static pressure gages.

1.2 RELATED REQUIREMENTS
A. Section 23 09 23 - Direct-Digital Control System for HVAC.
B. Section 23 09 93 - Sequence of Operations for HVAC Controls.
C. Section 23 21 13 - Hydronic Piping.

1.3 REFERENCE STANDARDS
A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2013.
D. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

1.4 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
C. Project Record Documents: Record actual locations of components and instrumentation.

1.5 FIELD CONDITIONS
A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.1 PRESSURE GAGES
A. Manufacturers:
4. Substitutions: See Section 01 60 00 - Product Requirements.

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

2.2 PRESSURE GAGE TAPPINGS

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

2.3 STEM TYPE THERMOMETERS

A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Thermometers - Fixed Mounting: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish.
   1. Size: 9 inch scale.
   2. Window: Clear Lexan.
   3. Accuracy: 2 percent, per ASTM E77.
   4. Calibration: Degrees F.

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

2.4 DIAL THERMOMETERS

A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Thermometers - Fixed Mounting: Dial type bimetallic actuated; ASTM E1; stainless steel case, silicone fluid damping, white with black markings and black pointer, hermetically sealed lens, stainless steel stem.
   1. Size: 5 inch diameter dial.
   2. Lens: Clear glass.
   3. Accuracy: 1 percent.
   4. Calibration: Degrees F.

C. Thermometer: ASTM E1, stainless steel case, adjustable angle with front recalibration, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
   1. Size: 3 inch diameter dial.
2. Lens: Clear glass.
3. Accuracy: 1 percent.
4. Calibration: Degrees F.

D. Thermometers: Dial type vapor or liquid actuated; ASTM E1; stainless steel case, with brass or copper bulb, copper or bronze braided capillary, white with black markings and black pointer, glass lens.
1. Size: 4-1/2 inch diameter dial.
2. Lens: Clear glass.
3. Length of Capillary: Minimum 5 feet.
4. Accuracy: 2 percent.
5. Calibration: Degrees F.

2.5 THERMOMETER SUPPORTS
A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.6 TEST PLUGS
A. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.
B. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch diameter pressure gages, one gage adapters with 1/8 inch probes, two 1 inch dial thermometers.

2.7 STATIC PRESSURE GAGES
A. Manufacturers:
   5. Substitutions: See Section 01 60 00 - Product Requirements.
B. 3-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.
C. Inclined manometer, red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.
D. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

PART 3 EXECUTION

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

D. Install thermometers in air duct systems on flanges.

E. Install thermometer sockets adjacent to controls system thermostat, transmitter, or sensor sockets. Refer to Section 23 09 43. Where thermometers are provided on local panels, duct or pipe mounted thermometers are not required.

F. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.

G. Provide instruments with scale ranges selected according to service with largest appropriate scale.

H. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

I. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

J. Locate test plugs adjacent thermometers and thermometer sockets.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Equipment support bases.
B. Vibration isolators.

1.2 RELATED REQUIREMENTS
A. Section 01 45 33 - Code-Required Special Inspections.
B. Section 03 30 00 - Cast-in-Place Concrete.

1.3 REFERENCE STANDARDS

1.4 PERFORMANCE REQUIREMENTS
A. Provide vibration isolation on motor driven equipment over 0.5 hp, plus connected piping and ductwork.
B. Provide minimum static deflection of isolators for equipment as follows:
   1. Basement, Under 20 hp
      a. 400 - 600 rpm: 1 inch
      b. 600 - 800 rpm: 0.5 inch
      c. 800 - 900 rpm: 0.2 inch
      d. 1100 - 1500 rpm: 0.14 inch
      e. Over 1500 rpm: 0.1 inch
   2. Basement, Over 20 hp
      a. 400 - 600 rpm: 2 inch
      b. 600 - 800 rpm: 1 inch
      c. 800 - 900 rpm: 0.5 inch
      d. 1100 - 1500 rpm: 0.2 inch
      e. Over 1500 rpm: 0.15 inch
   3. Upper Floors, Normal
      a. 400 - 600 rpm: 3.5 inch
      b. 600 - 800 rpm: 2 inch
      c. 800 - 900 rpm: 1 inch
      d. 1100 - 1500 rpm: 0.5 inch
      e. Over 1500 rpm: 0.2 inch
C. Maintain sound level of spaces at levels not to exceed those listed below by utilizing acoustical devices.
D. Maintain rooms at following maximum sound levels, in Room Criteria (RC) as defined by ASHRAE Handbook, HVAC Applications
   1. Halls, corridors, lobbies: 40
      a. Service/support areas: 45
   2. Offices
      a. Executive: 30
b. Conference rooms: 25
  c. Private: 35
  d. Public circulation: 40
3. Schools
  a. Lecture and classrooms: 30
4. Libraries: 30
5. Auditoriums and Theaters
  a. Theater: 20 25
  b. Stage house: 20 25

1.5 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data:
      1. Provide manufacturer's product literature documenting compliance with PART 2
         PRODUCTS.
   C. Shop Drawings:
      1. Provide schedule of vibration isolator type with location and load on each.
      2. Fully dimensioned fabrication drawings and installation details for vibration isolation
         bases, member sizes, attachments to isolators, and supported equipment.
      3. Include auxiliary motor slide bases and rails, base weights, inertia bases, concrete
         weights, equipment static loads, support points, vibration isolators, and detailed layout of
         isolator location and orientation with static and dynamic load on each isolator.
      4. Include selections from prescriptive design tables that indicate compliance with the
         applicable building code and the vibration isolator manufacturer's requirements.
      5. Clearly indicate the load and capacity assumptions selected. Include copies of any
         calculations.
   D. Product Data: Provide schedule of vibration isolator type with location and load on each.
   E. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic
      load on each. Indicate seismic control measures.
   F. Manufacturer's Instructions: Indicate installation instructions with special procedures and
      setting dimensions.

1.6 QUALITY ASSURANCE
   A. Perform design and installation in accordance with applicable codes.
   B. Designer Qualifications: Perform design under direct supervision of a Professional Engineer
      experienced in design of this type of work and registered and licensed in the State in which the
      Project is located.
   C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this
      section, with not less than three years of documented experience.
   D. Testing Agency Qualifications: Independent firm specializing in performing testing and
      inspections of the type specified in this section.
   E. Manufacturer's Certificate: Certify isolators meet or exceed specified requirements.

1.7 CLOSEOUT SUBMITTALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
   B. Project Record Documents: Record actual locations of hangers including attachment points.
1.8 QUALITY ASSURANCE
   A. Perform Work in accordance with AMCA 300 standards and recommendations of ASHRAE 68.
   B. Maintain one copy of each document on site.

1.9 QUALIFICATIONS
   A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
   B. Installer: Company specializing in performing Work of this section with minimum three years experience.
   C. Design application of seismic restraints under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location in State of New York.

1.10 PRE-INSTALLATION MEETINGS
   A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

1.11 FIELD MEASUREMENTS
   A. Verify field measurements prior to fabrication.

1.12 WARRANTY
   A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.1 MANUFACTURERS

2.2 PERFORMANCE REQUIREMENTS
   A. General:
      1. All vibration isolators, base frames and inertia bases to conform to all uniform deflection and stability requirements under all operating loads.
      2. Steel springs to function without undue stress or overloading.
      3. Steel springs to operate in the linear portion of the load versus deflection curve over deflection range of not less than 50 percent above specified deflection.
      4. Lateral to vertical stiffness ratio to not exceed 0.08 with spring deflection at minimum 75 percent of specified deflection.
      5. All equipment mounted on vibration isolated bases to have minimum operating clearance of 2 inches between the base and floor or support beneath unless noted otherwise.
2.3 EQUIPMENT SUPPORT BASES

A. Structural Bases:
1. Construction: Engineered, structural steel frames with welded brackets for side mounting of the isolators.
2. Frames: Square, rectangular or T-shaped.
3. Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers.

B. Concrete Inertia Bases:
1. Construction: Engineered, steel forms, with integrated isolator brackets and anchor bolts, welded or tied reinforcing bars running both ways in a single layer.
2. Size: 6 inches minimum depth and sized to accommodate elbow supports.
3. Mass: Minimum of 1.5 times weight of isolated equipment.
4. Connecting Point: Reinforced to connect isolators and snubbers to base including template and fastening devices for equipment.
5. Concrete: Filled on site with minimum 3000 psi concrete. See Section 03 30 00 for additional requirements.
6. Applications: Adjustable motor slide rails for centrifugal fans.

2.4 VIBRATION ISOLATORS

A. Non-Seismic Type:
1. All Elastomeric-Fiber Glass Pads:
   a. Configuration: Flat or molded.
   b. Thickness: 0.25 inch minimum.
   c. Assembly: Single or multiple layers using bonded, galvanized sheet metal separation plate between each layer with load plate providing evenly distributed load over pad surface.
2. Elastomeric Mounts:
   a. Material: Oil, ozone, and oxidant resistant compounds.
   b. Assembly: Encapsulated load transfer plate bolted to equipment and base plate with anchor hole bolted to supporting structure.
3. Steel Springs:
   a. Assembly: Freestanding, laterally stable without housing.
   b. Leveling Device: Rigidly connected to equipment or frame.
4. Restrained Steel Springs:
   a. Housing: Rigid blocking during rigging prevents equipment installed and operating height from changing during temporary weight reduction.
   b. Equipment Wind Loading: Adequate means for fastening isolator top to equipment and isolator base plate to supporting structure.
5. Elastomeric Hangers:
   a. Housing: Steel construction containing elastomeric isolation element to prevent rod contact with housing and short-circuiting of isolating function.
   b. Incorporate steel load distribution plate sandwiching elastomeric element to housing.
6. Spring Hanger:
   a. Housing: Steel construction containing stable steel spring and integral elastomeric element preventing metal to metal contact.
   b. Bottom Opening: Sized to allow plus/minus 15 degrees rod misalignment.
7. Combination Elastomeric-Spring Hanger:
   a. Housing: Steel construction containing stable steel spring with elastomeric element in series isolating upper connection of hanger box to building structure.
   b. Bottom Opening: Sized to allow plus/minus 15 degrees rod misalignment.
8. Thrust Restraints:
a. Housing: Steel construction containing stable steel spring and integral elastomeric element installed in pairs to resist air pressure thrusts.
b. Bottom Openings: Sized to allow plus/minus 15 degrees rod misalignment.

2.5 VIBRATION ISOLATORS

A. Open Spring Isolators:
1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
2. Spring Mounts: Provide with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
3. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
4. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.

B. Restrained Open Spring Isolators:
1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
2. Spring Mounts: Provide with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
3. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
4. Restraint: Provide heavy mounting frame and limit stops.
5. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.

C. Closed Spring Isolators:
1. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance.
4. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.

D. Restrained Closed Spring Isolators:
1. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance and limit stops.
4. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.

E. Spring Hangers:
1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
2. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.
4. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.

F. Neoprene Pad Isolators:
1. Rubber or neoprene waffle pads.
   a. Hardness: 30 durometer.
   b. Thickness: Minimum 1/2 inch.
   c. Maximum Loading: 50 psi.
   d. Rib Height: Maximum 0.7 times width.

G. Rubber Mount or Hanger: Molded rubber designed for 0.4 inch deflection with threaded insert.

H. Glass Fiber Pads: Neoprene jacketed pre-compressed molded glass fiber.

I. Seismic Snubbers:
1. Type: Non-directional and double acting unit consisting of interlocking steel members restrained by neoprene elements.
2. Elements: Replaceable neoprene, minimum of 0.75 inch thick with minimum 1/8 inch air gap.
3. Capacity: 4 times load assigned to mount groupings at 0.4 inch deflection.
4. Attachment Points and Fasteners: Capable of withstanding 3 times rated load capacity of seismic snubber.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL
A. Install in accordance with manufacturer's instructions.

B. Bases:
1. Set steel bases for one inch clearance between housekeeping pad and base.
2. Set concrete inertia bases for 2 inches clearance between housekeeping pad and base.
3. Adjust equipment level.

C. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

D. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

E. Support piping connections to equipment mounted on isolators using isolators or resilient hangers to nearest flexible pipe connector.
   1. Up to 4 Inches Pipe Size: First three points of support.
   2. Select three hangers closest to vibration source for minimum 1.0 inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch static deflection or 1/2 static deflection of isolated equipment.

3.2 FIELD QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect isolated equipment after installation and submit report. Include static deflections.

C. Perform testing and inspections of the installation in accordance with Section 01 45 33.

D. Refer to Section 23 05 93 for sound measurements.
E. Furnish services of testing agency to take noise measurement. Use meters meeting requirements of ANSI S1.4.

F. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

3.3 SCHEDULE

A. Pipe Isolation Schedule.
1. 1 Inch Pipe Size: Isolate 120 diameters from equipment.
2. 2 Inch Pipe Size: Isolate 90 diameters from equipment.
3. 3 Inch Pipe Size: Isolate 80 diameters from equipment.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Nameplates.
   B. Tags.
   C. Stencils.
   D. Pipe markers.
   E. Ceiling tacks.

1.2 REFERENCE STANDARDS

1.3 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
   B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
   C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
   D. Product Data: Provide manufacturers catalog literature for each product required.
   E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
   F. Project Record Documents: Record actual locations of tagged valves.

1.4 CLOSEOUT SUBMITTALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
   B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.5 QUALITY ASSURANCE
   A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.
   B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS
   A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
   B. Installer: Company specializing in performing Work of this section with minimum three years experience.
1.7 PRE-INSTALLATION MEETINGS
   A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

1.8 FIELD MEASUREMENTS
   A. Verify field measurements prior to fabrication.

1.9 EXTRA MATERIALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.

PART 2 PRODUCTS

2.1 IDENTIFICATION APPLICATIONS
   A. Air Handling Units: Nameplates.
   B. Air Terminal Units: Tags.
   C. Automatic Controls: Tags. Key to control schematic.
   D. Control Panels: Nameplates.
   E. Dampers: Ceiling tacks, where located above lay-in ceiling.
   F. Ductwork: Stencilled painting.
   H. Major Control Components: Nameplates.
   I. Piping: Pipe markers.
   J. Pumps: Nameplates.
   K. Small-sized Equipment: Tags.
   L. Tanks: Nameplates.
   M. Thermostats: Nameplates.
   N. Valves: Tags and ceiling tacks where located above lay-in ceiling.
   O. Water Treatment Devices: Nameplates.

2.2 NAMEPLATES
   A. Manufacturers:
      4. Substitutions: See Section 01 60 00 - Product Requirements.
      7. Background Color: Black.

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
Section 23 05 53 Page 2
2.3 TAGS

A. Manufacturers:
   3. Substitutions: See Section 01 60 00 - Product Requirements.

B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.

C. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

D. Valve Tag Chart: Typewritten letter size list of applied tags and locations in plastic laminated frame.

2.4 STENCILS

A. Manufacturers:
   3. Substitutions: See Section 01 60 00 - Product Requirements.

B. Stencils: With clean cut symbols and letters of following size:
   1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
   2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
   3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
   4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
   5. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.

C. Stencil Paint: As specified in Section 09 90 00, semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

2.5 PIPE MARKERS

A. Manufacturers:
   3. Substitutions: See Section 01 60 00 - Product Requirements.

B. Color and Lettering: Conform to ASME A13.1.

C. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

E. Color code as follows:
   1. Heating, Cooling, and Boiler Feedwater: Green with white letters.
   2. Toxic and Corrosive Fluids: Orange with black letters.
   3. Compressed Air: Blue with white letters.
2.6 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color coded head.

B. Color code as follows:
   1. HVAC Equipment: Yellow.
   2. Fire Dampers and Smoke Dampers: Red.
   4. Plumbing valves: Green

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 09 91 23 for stencil painting.

3.2 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Apply stencil painting in accordance with manufactures installation instructions.

D. Apply stencil painting in accordance with Section 09 91 23.

E. Install plastic pipe markers in accordance with manufacturer's instructions.

F. Install ductwork with plastic nameplates. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

G. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION
SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES
A. Testing, adjustment, and balancing of air systems.
B. Testing, adjustment, and balancing of hydronic and refrigerating systems.
C. Measurement of final operating condition of HVAC systems.
D. Sound measurement of equipment operating conditions.

1.2 RELATED REQUIREMENTS
A. Section 01 40 00 - Quality Requirements: Employment of testing agency and payment for services.
B. Section 23 08 00 - Commissioning of HVAC.

1.3 REFERENCE STANDARDS

1.4 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
   1. Submit to Architect.
   2. Submit to the project engineer / HVAC controls contractor.
   3. Submit six weeks prior to starting the testing, adjusting, and balancing work.
   4. Include certification that the plan developer has reviewed the contract documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.
   5. Include at least the following in the plan:
      a. Preface: An explanation of the intended use of the control system.
      b. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
      c. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
d. Identification and types of measurement instruments to be used and their most recent calibration date.

e. Discussion of what notations and markings will be made on the duct and piping drawings during the process.

f. Final test report forms to be used.

g. Detailed step-by-step procedures for TAB work for each system and issue, including:
   1) Terminal flow calibration (for each terminal type).
   2) Diffuser proportioning.
   3) Branch/submain proportioning.
   4) Total flow calculations.
   5) Diversity issues.

h. Procedures for formal deficiency reports, including scope, frequency and distribution.

D. Field Logs: Submit at least once a week to project engineer / Commissioning Authority.

E. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.

F. Progress Reports.

G. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
   1. Submit to the project engineer / HVAC controls contractor within two weeks after completion of testing, adjusting, and balancing.
   2. Revise TAB plan to reflect actual procedures and submit as part of final report.
   3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
   4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
   5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
   6. Units of Measure: Report data in I-P (inch-pound) units only.

H. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations of air flow measuring points balancing valves and rough setting.

C. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

B. Maintain one copy of each document on site.

C. Prior to commencing Work, calibrate each instrument to be used.
1.7 QUALIFICATIONS
   A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum three years documented experience certified by AABC or Certified by NEBB.

1.8 PRE-INSTALLATION MEETINGS
   A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

1.9 SEQUENCING
   A. Section 01 10 00 - Summary: Work sequence.
   B. Sequence balancing between completion of systems tested and Date of Substantial Completion.

1.10 SCHEDULING
   A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS
   A. Perform total system balance in accordance with one of the following:
      1. AABC MN-1, AABC National Standards for Total System Balance.
      4. SMACNA (TAB).
   B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
   C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
   D. TAB Agency Qualifications:
      1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
      2. Having minimum of three years documented experience.
      3. Certified by one of the following:
E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.2 EXAMINATION

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

B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

3.3 PREPARATION

A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
   1. Require attendance by all installers whose work will be tested, adjusted, or balanced.

B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect and project engineer / Commissioning Authority to facilitate spot checks during testing.

3.4 ADJUSTMENT TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.

B. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.5 RECORDING AND ADJUSTING

A. Field Logs: Maintain written logs including:
   1. Running log of events and issues.
   2. Discrepancies, deficient or uncompleted work by others.
   4. Lists of completed tests.

B. Ensure recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. Mark on the drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

H. Check and adjust systems approximately six months after final acceptance and submit report.

3.6 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

G. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

H. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

I. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

J. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

K. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

L. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

M. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

3.7 WATER SYSTEM PROCEDURE

A. Adjust water systems to provide required or design quantities.

B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gages to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open to heat transfer elements.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.8 SCOPE

A. Test, adjust, and balance the following:
   1. HVAC Pumps.
   2. Air Cooled Refrigerant Condensers.
   3. Unit Air Conditioners.
   4. Air Handling Units.
   5. Fans.
   6. Air Filters.
   7. Air Terminal Units.
   8. Air Inlets and Outlets.

3.9 MINIMUM DATA TO BE REPORTED

A. Electric Motors:
   1. Manufacturer.
   2. Model/Frame.
   3. HP/BHP.
   4. Phase, voltage, amperage; nameplate, actual, no load.
   5. RPM.
   7. Starter size, rating, heater elements.
   8. Sheave Make/Size/Bore.

B. V-Belt Drives:
   1. Identification/location.
   2. Required driven RPM.
   3. Driven sheave, diameter and RPM.
   4. Belt, size and quantity.
   5. Motor sheave diameter and RPM.
   6. Center to center distance, maximum, minimum, and actual.

C. Pumps:
   1. Identification/number.
   2. Manufacturer.
   3. Size/model.
   4. Impeller.
   5. Service.
   6. Design flow rate, pressure drop, BHP.
   7. Actual flow rate, pressure drop, BHP.
   8. Discharge pressure.
   10. Total operating head pressure.
   11. Shut off, discharge and suction pressures.
   12. Shut off, total head pressure.
D. Combustion Equipment:
  1. Boiler manufacturer.
  2. Model number.
  3. Serial number.
  4. Firing rate.
  5. Overfire draft.
  6. Gas meter timing dial size.
  7. Gas meter time per revolution.
  8. Gas pressure at meter outlet.
 13. Percent carbon dioxide (CO2).
 14. Percent oxygen (O2).
 15. Percent excess air.
 16. Flue gas temperature at outlet.
 17. Ambient temperature.
 18. Net stack temperature.
 20. Percent combustion efficiency.

E. Air Cooled Condensers:
  1. Identification/number.
  2. Location.
  3. Manufacturer.
  4. Model number.
  5. Serial number.
  6. Entering DB air temperature, design and actual.
  7. Leaving DB air temperature, design and actual.
  8. Number of compressors.

F. Heating Coils:
  1. Identification/number.
  2. Location.
  4. Manufacturer.
  5. Air flow, design and actual.
  6. Water flow, design and actual.
  7. Water pressure drop, design and actual.
  8. Entering water temperature, design and actual.
  9. Leaving water temperature, design and actual.
 10. Entering air temperature, design and actual.
 11. Leaving air temperature, design and actual.
 12. Air pressure drop, design and actual.

G. Return Air/Outside Air:
  1. Identification/location.
  2. Design air flow.
  3. Actual air flow.
  4. Design return air flow.
  5. Actual return air flow.
  6. Design outside air flow.
  7. Actual outside air flow.
  8. Return air temperature.
10. Required mixed air temperature.
11. Actual mixed air temperature.
12. Design outside/return air ratio.
13. Actual outside/return air ratio.

H. Exhaust Fans:
1. Location.
2. Manufacturer.
3. Model number.
4. Serial number.
5. Air flow, specified and actual.
6. Total static pressure (total external), specified and actual.
7. Inlet pressure.
8. Discharge pressure.
10. Number of Belts/Make/Size.
11. Fan RPM.

I. Duct Traverses:
1. System zone/branch.
2. Duct size.
3. Area.
4. Design velocity.
5. Design air flow.
6. Test velocity.
7. Test air flow.
8. Duct static pressure.
9. Air temperature.
10. Air correction factor.

J. Duct Leak Tests:
1. Description of ductwork under test.
2. Duct design operating pressure.
3. Duct design test static pressure.
4. Duct capacity, air flow.
5. Maximum allowable leakage duct capacity times leak factor.
6. Test apparatus:
   a. Blower.
   b. Orifice, tube size.
   c. Orifice size.
   d. Calibrated.
7. Test static pressure.
8. Test orifice differential pressure.
9. Leakage.

K. Terminal Unit Data:
1. Manufacturer.
2. Type, constant, variable, single, dual duct.
3. Identification/number.
4. Location.
5. Model number.
7. Minimum static pressure.
8. Minimum design air flow.
9. Maximum design air flow.
10. Maximum actual air flow.
11. Inlet static pressure.
L. Air Distribution Tests:
1. Air terminal number.
2. Room number/location.
3. Terminal type.
4. Terminal size.
5. Area factor.
6. Design velocity.
7. Design air flow.
8. Test (final) velocity.
9. Test (final) air flow.
10. Percent of design air flow.

M. Sound Level Reports:
1. Location.
2. Octave bands - equipment off.
3. Octave bands - equipment on.

N. Vibration Tests:
1. Location of points:
   a. Fan bearing, drive end.
   b. Fan bearing, opposite end.
   c. Motor bearing, center (if applicable).
   d. Motor bearing, drive end.
   e. Motor bearing, opposite end.
   f. Casing (bottom or top).
   g. Casing (side).
   h. Duct after flexible connection (discharge).
   i. Duct after flexible connection (suction).

2. Test readings:
   a. Horizontal, velocity and displacement.
   b. Vertical, velocity and displacement.
   c. Axial, velocity and displacement.
3. Normally acceptable readings, velocity and acceleration.
4. Unusual conditions at time of test.
5. Vibration source (if non-complying).

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Duct insulation.
B. Duct Liner.
C. Insulation jackets.

1.2 RELATED REQUIREMENTS
A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
B. Section 09 91 23 - Interior Painting: Painting insulation jackets.
C. Section 23 05 53 - Identification for HVAC Piping and Equipment.

1.3 REFERENCE STANDARDS
G. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.

1.4 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
C. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.5 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.
B. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum __________ years of experience and approved by manufacturer.

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

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

PART 2 PRODUCTS

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

2.2 GLASS FIBER, FLEXIBLE
A. Manufacturer:
B. Insulation: ASTM C553; flexible, noncombustible blanket.
   1. ‘K’ value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
   2. Maximum Service Temperature: 450 degrees F.
   3. Maximum Water Vapor Absorption: 5.0 percent by weight.
C. Vapor Barrier Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film.
   2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
   3. Secure with pressure sensitive tape.
D. Vapor Barrier Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

2.3 GLASS FIBER, RIGID
A. Manufacturer:
B. Insulation: ASTM C612; rigid, noncombustible blanket.
   1. 'K' Value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
   2. Maximum Service Temperature: 450 degrees F.
   3. Maximum Water Vapor Absorption: 5.0 percent.

C. Vapor Barrier Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film.
   2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
   3. Secure with pressure sensitive tape.

D. Vapor Barrier Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

2.4 JACKETS

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

B. Mineral Fiber (Outdoor) Jacket: Asphalt impregnated and coated sheet, 50 lb/square.

2.5 DUCT LINER

A. Manufacturers:

B. Insulation: Incombustible glass fiber complying with ASTM C 1071; flexible blanket, rigid board, and preformed round liner board; impregnated surface and edges coated with poly vinyl acetate polymer or acrylic polymer shown to be fungus and bacteria resistant by testing to ASTM G 21.
   1. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F.
   2. Service Temperature: Up to 250 degrees F.
   3. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm, minimum.
   4. Minimum Noise Reduction Coefficients:
      a. 1 inch Thickness: 0.45.

C. Adhesive: Waterproof, fire-retardant type, ASTM C916.

D. Liner Fasteners: Galvanized steel, self-adhesive pad with integral head.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that ducts have been tested before applying insulation materials.

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

3.2 INSTALLATION

A. Install in accordance with manufacturer’s instructions.
B. Insulated ducts conveying air below ambient temperature:

C. Insulated ducts conveying air above ambient temperature:

D. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces (below 10 feet above finished floor): Finish with canvas jacket sized for finish painting.

E. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with with calked aluminum jacket with seams located on bottom side of horizontal duct section.

F. External Duct Insulation Application:
   1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
   2. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
   3. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
   4. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

G. Duct and Plenum Liner Application:
   1. Adhere insulation with adhesive for 90 percent coverage.
   2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
   4. Seal liner surface penetrations with adhesive.
   5. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

3.3 SCHEDULES

A. Exhaust Ducts Within 10 ft of Exterior Openings: 1" ridged liner

B. Outside Air Intake Ducts: 2" flexible for concealed above ceilings, 2" ridged board for exposed in unconditioned spaces

C. Supply, Return & transfer Ducts: 2" flexible for concealed above ceilings, 2" ridged board for exposed in unconditioned spaces, 1" rigid liner for ductwork exposed in finished spaces.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

A. Piping insulation.
B. Flexible removable and reusable blanket insulation.
C. Jackets and accessories.

1.2 RELATED REQUIREMENTS

A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
B. Section 07 84 00 - Firestopping.
C. Section 23 21 13 - Hydronic Piping: Placement of hangers and hanger inserts.
D. Section 23 23 00 - Refrigerant Piping.

1.3 REFERENCE STANDARDS


1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum ________ years of experience.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.7 FIELD CONDITIONS
A. Maintain ambient conditions required by manufacturers of each product.
B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

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

2.2 GLASS FIBER
A. Manufacturers:
B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
   1. 'K' Value: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum Service Temperature: 850 degrees F.
   3. Maximum Moisture Absorption: 0.2 percent by volume.
C. Insulation: ASTM C547 and ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.
   1. 'K' Value: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum Service Temperature: 650 degrees F.
   3. Maximum Moisture Absorption: 0.2 percent by volume.
D. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
F. Vapor Barrier Lap Adhesive: Compatible with insulation.

2.3 CELLULAR GLASS
A. Insulation: ASTM C552, Type II.
1. Apparent Thermal Conductivity; 'K' Value: Grade 6, 0.35 at 100 degrees F.
2. Service Temperature: Up to 800 degrees F.
4. Water Absorption: 0.5 percent by volume, maximum.

2.4 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 3; use molded tubular material wherever possible.
   1. Minimum Service Temperature: Minus 40 degrees F.
   2. Maximum Service Temperature: 220 degrees F.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.5 JACKETS

A. PVC Plastic.
   1. Manufacturers:
      b. Substitutions: See Section 01 60 00 - Product Requirements.
   2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
      a. Minimum Service Temperature: 0 degrees F.
      b. Maximum Service Temperature: 150 degrees F.
      c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
      d. Thickness: 10 mil.
      e. Connections: Brush on welding adhesive.

   1. Thickness: 0.016 inch sheet.
   2. Finish: Smooth.
   4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
   5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.
B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Install in accordance with NAIMA National Insulation Standards.
C. Exposed Piping: Locate insulation and cover seams in least visible locations.

D. Insulated pipes conveying fluids below ambient temperature; insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

E. Glass fiber insulated pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied; secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.

F. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

G. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.

H. Glass fiber insulated pipes conveying fluids above ambient temperature.
   1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.

I. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.

J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.

K. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation without jacketing.

3.3 SCHEDULE

A. Heating Systems:
   1. Heating Water Supply and Return: Glass Fiber Insulation; pipe size up to 2" = 1 1/2" thick; pipe size 2" to 6" = 2" thick.

B. Cooling Systems:
   1. Condensate Drains from Cooling Coils: Flexible Elastomeric Cellular Insulation; All pipe sizes = 1 1/2" thick.
   2. Refrigerant Suction: Flexible Elastomeric Cellular Insulation; All pipe sizes = 1 1/2" thick.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section defines the manner and method by which controls function.

B. Sequence of operation for:
   1. Time Schedule Programs
   2. Alarm Points.
   3. Optimum start Program
   4. Optimum stop Program
   5. Day/Night Setbacks
   6. Maintenance Management
   7. Equipment Scheduling
   8. Heating Plant and Heating Water Temperature Control
   9. Exhaust Fan Control
   10. Domestic Water Heater
   11. Kitchen Make-Up Air Unit.
   12. Relief Hood Control.
   14. Parking garage ventilation systems.
   15. Radiation and convectors.
   16. Gas Fired Unit Heater
   17. Unit heaters.

1.2 RELATED REQUIREMENTS

A. Section 01 91 13 - General Commissioning Requirements: Commissioning requirements that apply to all types of work.

B. Section 23 09 13 - Instrumentation and Control Devices for HVAC.

C. Section 23 03 23 - Direct-Digital Control System for HVAC

D. Section 26 28 17 - Enclosed Circuit Breakers.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Sequence of Operation Documentation: Submit written sequence of operation for entire HVAC system and each piece of equipment.
   1. Preface: 1 or 2 paragraph overview narrative of the system describing its purpose, components and function.
   2. State each sequence in small segments and give each segment a unique number for referencing in Functional Test procedures; provide a complete description regardless of the completeness and clarity of the sequences specified in the contract documents.
   3. Include at least the following sequences:
      a. Start-up.
      b. Warm-up mode.
      c. Normal operating mode.
      d. Unoccupied mode.
      e. Shutdown.
f. Capacity control sequences and equipment staging.
g. Temperature and pressure control, such as setbacks, setups, resets, etc.
h. Detailed sequences for all control strategies, such as economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
i. Effects of power or equipment failure with all standby component functions.
j. Sequences for all alarms and emergency shut downs.
k. Seasonal operational differences and recommendations.
l. Interactions and interlocks with other systems.

4. Include initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.

5. For packaged controlled equipment, include manufacturer's furnished sequence of operation amplified as required to describe the relationship between the packaged controls and the control system, indicating which points are adjustable control points and which points are only monitored.

6. Include schedules, if known.

C. Control System Diagrams: Submit graphic schematic of the control system showing each control component and each component controlled, monitored, or enabled.
   1. Label with settings, adjustable range of control and limits.
   2. Include flow diagrams for each control system, graphically depicting control logic.
   3. Include the system and component layout of all equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
   4. Include draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
   5. Include all monitoring, control and virtual points specified in elsewhere.
   6. Include a key to all abbreviations.

D. Points List: Submit list of all control points indicating at least the following for each point.
   1. Name of controlled system.
   2. Point abbreviation.
   3. Point description; such as dry bulb temperature, airflow, etc.
   4. Display unit.
   5. Control point or setpoint (Yes / No); i.e. a point that controls equipment and can have its setpoint changed.
   6. Monitoring point (Yes / No); i.e. a point that does not control or contribute to the control of equipment but is used for operation, maintenance, or performance verification.
   7. Intermediate point (Yes / No); i.e. a point whose value is used to make a calculation which then controls equipment, such as space temperatures that are averaged to a virtual point to control reset.
   8. Calculated point (Yes / No); i.e. a “virtual” point generated from calculations of other point values.

E. Project Record Documents: Record actual locations of components and setpoints of controls, including changes to sequences made after submission of shop drawings.

1.4 QUALITY ASSURANCE

A. Design system under direct supervision of a Professional Engineer experienced in design of this Work and licensed at the State in which the Project is located.
PART 2  PRODUCTS - NOT USED

PART 3  EXECUTION

3.1  TIME SCHEDULE PROGRAMS
   A. The programs for the EMS shall schedule each systems operation on an hourly basis
      controlled through daily, weekly and/or monthly schedules. Schedules for each individual
      system, room or area shall be easily programmed and modified by the user on a calendar-like
      display at the host computer.
   B. The programs shall store 60 months of schedules.
   C. An internal time clock shall automatically compensate for daylight savings time and calendars
      generated by software shall automatically compensate for leap years.

3.2  ALARM POINTS
   A. All temperature inputs to the DDC system (space, return air, mixed air, discharge air) shall be
      alarmed at the host computer if the temperature is out of range 10°F (adj.) above or below
      setpoint.
   B. Fan status shall be monitored by a current sensing switch or differential pressure switch. If the
      fan is scheduled to run and the status is not proven, an alarm condition shall be shown at the
      host computer.
   C. Other alarm points are specifically addressed per individual sequences of operation.
   D. All points can be individually alarmed as required by owner's staff.

3.3  OPTIMUM START PROGRAM
   A. Each system shall have independent modular program.
   B. The program shall minimize the total energy consumption during daily start-up of each
      heating/cooling system.
   C. The start time for each system shall bring its respective zone to occupied setpoint at the time
      of occupied mode start.
   D. The optimum start program shall be adjustable to the rate structure of the local energy
      company.

3.4  OPTIMUM STOP PROGRAM
   A. Each system shall have independent modular program.
   B. The program shall minimize the total energy consumption during daily shut-down of each
      heating/cooling system. A control algorithm shall compare the outside air temperature to
      space temperature to calculate a stop time for each air handling system. At no time shall the
      unit be shut down while a space is occupied.
   C. The stop time for each system shall shut-down its respective zone as early as possible without
      letting the temperature drift out of the specified comfort range.
3.5 DAY/NIGHT SETBACK
   A. The day/night setback will consist of lowering the space heating setpoint and raising the space
      cooling setpoint during the unoccupied mode, thereby reducing the heating and cooling energy
      requirements. The occupied and unoccupied areas will be specified by the owner, and will be
      coordinated with the control system. The setback shall be 55 degrees F in the heating mode
      and 85 degrees F in the cooling mode per the NYS Energy Code. The occupied heating set
      point shall be 70 and the occupied cooling setpoint will be 76.

3.6 MAINTENANCE MANAGEMENT
   A. The control system will continuously totalize hours for selected equipment controlled and/or
      monitored for use by the maintenance management program.

3.7 EQUIPMENT SCHEDULING
   A. Equipment shall be 7 days, 24 hours schedules with separate holiday hours.
   B. There shall be capability for five different holiday schedules which can be selected from the
      occupancy schedule graphic.
   C. Holidays shall be programmed so that they shall need a minimum of manual adjustment year
      to year, and can easily be modified at front end if necessary.
   D. All schedule programming shall reside in local controllers, but shall be configurable from the
      front end.

3.8 HEATING PLANT
   A. The heating plants consist of a primary/secondary loop configurations.
      1. The loop consists of multiple boilers which fire in a lead/lag sequence and modulation to
         maintain the loop setpoint schedule. The loop set point shall be set by the DDC based on
         a reset schedule header loop. The DDC shall interface the boiler control module to enable
         and disable the plant. Schedule and monitor loop header temperature and shall monitor
         boiler functions and alarm failures. The DDC system shall keep the boiler plant in
         condensing mode as long as possible. The boiler controller shall stage and modulate
         boilers to maintain peak efficiency.
   B. Heating Plant Enable/Disable
      1. The heating plants will be enabled at an outdoor air temperature below 60° F.
         (adjustable). The heating plant will be disabled when outdoor air temperature is above 65°
         F. or when local disconnects are turned off by maintenance if so desired.
   C. Primary Hot Water Pump Control.
      1. Anytime the boiler plant is enabled the hot water pumps shall be enabled.
      2. Alternate the lead pump automatically per software schedule.
      3. Modulate system VFD as required to maintain a constant downstream static pressure.
      4. When the heating plant is enabled the lead pump will start.
      5. If after one minute, proof of flow fails lead pump will be disabled, enable the standby
         pump, and generate an alarm at operator interface.
      6. If both pumps fail, leave one pump enabled, and generate an alarm at operator interface.
         Alternate the call to start every ten minutes until a pump starts.
      7. Stop both pumps if the heating plant is disabled.
   D. Primary Hot Water Loop Temperature Control.
      1. Modulate the boiler to maintain a loop temperature based on the outdoor reset schedule.
         The outdoor reset schedule shall be based at 180 degrees at 0 degrees outdoor air
         temperature and 120 degrees at a 60 degrees outdoor air temperature.
2. If the all secondary hot water temperature setpoints are more than 10 degrees below the primary hot water temperature setting than reset the primary loop down 10 degrees. The minimum primary hot water supply temperature shall be 120 degrees.

E. SECONDARY HOT WATER CONTROL
1. Anytime the boiler primary pump is enabled the secondary pumps shall be enabled.
2. Initial starting temperature of the secondary loop shall be 10 degrees below the primary loop.
3. If the secondary valve position is above 75% open then increase the secondary water setpoint by 10 degrees. If valve position is still above 75% for more than 30 minutes then increase the set point by 10 degrees. Keep increasing the secondary temperature setpoint up by 10 degrees every 30 minutes until the secondary temperature setpoint is equal to the primary water set point or the valve position is below 75%.
4. If the secondary valve position is below 50% open then decrease the secondary water setpoint by 10 degrees. If valve position is still below 50% for more than 30 minutes then decrease the set point by an additional 10 degrees. Keep decreasing the secondary setpoint down by 10 degrees every 30 minutes until the secondary valve position is above 50%.
5. If the loop temperature differs from set point by more than 10° F. for more than 20 minutes, generate an alarm at operator interface.

3.9 ENERGY RECOVERY VENTILATOR:
A. General:
1. Unit automatically indexed to “occupied” or “unoccupied” cycle by the DDC.
B. Occupied cycle:
1. Supply air fan shall run continuously.
2. The air intake damper shall be fully open.
3. Associated duct mounted heating coil shall modulate open at an outdoor air temperature below 60 F.
4. On a rise in space temperature, associated associated duct mounted heating coil valve shall close and economizing mode shall be enabled.
5. Upon a still further rise in space temperature, economizing mode shall be disabled and mechanical cooling should start.
C. Unoccupied cycle:
1. The unit shall be disabled.
D. Fire shut down shall be provided by the EC via the fire alarm system and by the DDC. When unit is shut down, the outside air dampers shall close.
E. When the kitchen hood starts, two automatic air dampers on the return ducts shall turn closed and the air flow in return airstream changes from 1500 cfm to 500 cfm.

3.10 EXHAUST FAN CONTROL
A. Exhaust fans shall be controlled by wall mounted starters/switches, thermostats or shall be started and stopped by the DDC system. Refer to notes on equipment schedule for related control schemes.
1. If the fan to run by the DDC system and run indication is not met after 2 minutes or fan run indication fails after being proven, an alarm shall be generated at the operator workstation. The call to run shall be turned off.
2. All fans over 1000 CFM and serving more than one space shall be provided with fire shut downs provided by the EC via the fire alarm system. All fans under DDC control shall also shut-down. When the exhaust fan is shut down from fire alarm, the automatic air dampers shall close.
3.11 DOMESTIC WATER HEATING
   A. Domestic water heating mode:
      1. Domestic water heat exchanger pump shall cycle upon demand for heat by heat
         exchanger factory mounted controller. Factory mounted controller shall communicate to
         building DDC system. DDC system shall start pump when domestic water temperature
         drops below domestic water setpoint. Heat exchanger mounted 3 way valve shall
         modulate to maintain domestic water output temperature setpoint (120 degree
         Fahrenheit, owner adjustable).
   B. Domestic hot water recirculation
      1. DDC system shall power on domestic hot water recirculation pump when recirculation
         water temperature drops below 110 degrees Fahrenheit (owner adjustable). DDC shall
         cycle pump off when recirculation temperature reaches 120 degrees (owner adjustable).

3.12 KITCHEN MAKE-UP AIR UNIT
   A. The kitchen make-up air unit shall run anytime that the associated kitchen hood exhaust fan is
      running. The associated gas heat section shall modulate discharge air temperature to
      maintain a discharge air temperature within 10 degrees below the space temperature.
   B. Fire shutdown shall be by the E.C. and also interlocked with the kitchen hood fire suppression
      system.

3.13 RELIEF HOOD CONTROL
   A. The DDC system shall modulate the relief hood dampers to match the outside air damper
      position of the associated air delivery equipment.

3.14 EMERGENCY GENERATORS
   A. When the generator is not running, outside and exhaust dampers are closed and recirculation
      damper is open.
   B. When generator is running, dampers are controlled and operate with outside and exhaust
      dampers opening, and recirculating dampers closing, to maintain room temperature of 85
      degrees F.
   C. On room temperatures above 95 degrees F open intake damper and start exhaust fan.
   D. Provide solenoid valve to shut off fuel supply when generator is not operating.

3.15 PARKING GARAGE VENTILATION SYSTEMS
   A. Time Schedule: Stop exhaust fan at night.
   B. Carbon Monoxide (CO) detector maintains maximum CO level of 50 ppm by cycling exhaust
      fan. When CO level exceeds 100 ppm, signal alarm.
   C. When exhaust fan starts, start make-up unit.

3.16 RADIATION AND CONVECTORS
   A. Single temperature thermostat set at 75 degrees F maintains constant space temperature
      during the day and 15 degrees F cooler at night by modulating two-way control heating valve
      with spring range of 3 to 7 psig.
3.17 GAS FIRED UNIT HEATERS
   A. Single temperature room thermostat maintains constant space temperature of 68 degrees F by
cycling unit.

3.18 UNIT HEATERS
   A. Single temperature electric room thermostat maintains constant space temperature of 68
degrees F by modulating hot water supply to the unit.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

A. Hydronic system requirements.
B. Heating water piping, above grade.
C. Pipe and pipe fittings for:
   1. Heating water piping system.
   2. Equipment drains and overflows.
   3. Pipe hangers and supports.
   4. Unions, flanges, mechanical couplings, and dielectric connections.
D. Valves:
   1. Globe or angle valves.
   2. Ball valves.
   3. Plug valves.
   5. Check valves.
E. Flow controls.

1.2 RELATED REQUIREMENTS

A. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping.
B. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
C. Section 23 05 53 - Identification for HVAC Piping and Equipment.
D. Section 23 07 19 - HVAC Piping Insulation.
E. Section 23 21 14 - Hydronic Specialties.
F. Section 23 25 00 - HVAC Water Treatment: Pipe cleaning.

1.3 REFERENCE STANDARDS

C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
E. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; 2013.
F. ASME B31.9 - Building Services Piping; 2014.
G. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005).
H. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; The American Society of Mechanical Engineers; 2006.
I. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2008 (ANSI/ASME B31.9).


N. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2013.


W. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.

X. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society; 2004 and errata.


Z. AWWA C606 - Grooved and Shouldered Joints; 2011.


1.4 ADMINISTRATIVE REQUIREMENTS


1.5 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
C. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.
D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
E. Project Record Documents: Record actual locations of valves.
F. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Valve Repacking Kits: One for each type and size of valve.

1.6 CLOSEOUT SUBMITTALS
A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
B. Project Record Documents: Record actual locations of valves, equipment and accessories.
C. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.7 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.
B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with minimum five years of experience.

1.8 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years experience.

1.9 PRE-INSTALLATION MEETINGS
A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
B. Convene minimum one week prior to commencing work of this section.

1.10 DELIVERY, STORAGE, AND HANDLING
A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
1.11 FIELD CONDITIONS
   A. Do not install underground piping when bedding is wet or frozen.

1.12 FIELD MEASUREMENTS
   A. Verify field measurements prior to fabrication.

1.13 COORDINATION
   A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

1.14 WARRANTY
   A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
   B. Furnish five year manufacturer warranty for valves excluding packing.

1.15 EXTRA MATERIALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
   B. Furnish two packing kits for each size and valve type.

PART 2 PRODUCTS

2.1 HYDRONIC SYSTEM REQUIREMENTS
   A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
   B. Piping: Provide piping, fittings, hangers and supports as required, as indicated, and as follows:
      1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
      2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
      3. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
      4. Provide pipe hangers and supports in accordance with ASME B31.9 unless indicated otherwise.
   C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
   D. Valves: Provide valves where indicated:
      1. Provide drain valves where indicated, and if not indicated provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch gate valves with cap; pipe to nearest floor drain.
      2. Isolate equipment using butterfly valves with lug end flanges or grooved mechanical couplings.
      3. For throttling, bypass, or manual flow control services, use globe, ball, or butterfly valves.
      4. In heating water, chilled water, or condenser water systems, butterfly valves may be used interchangeably with gate and globe valves.
5. For shut-off and to isolate parts of systems or vertical risers, use gate, ball, or butterfly valves.

E. Welding Materials and Procedures: Conform to ASME BPVC-IX.

2.2 HEATING WATER AND GLYCOL PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:

B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn, using one of the following joint types:
      a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
      b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
   2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.

2.3 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn; using one of the following joint types:
      a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
   2. Fittings: ASTM D2466 or D2467, PVC.

2.4 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
   1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.

B. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron, adjustable swivel, split ring.

C. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.

D. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.

E. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

F. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.

G. Vertical Support: Steel riser clamp.

H. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

I. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

J. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

K. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

L. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
M. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.

2.5 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

A. Unions for Pipe 2 Inches and Less:
   1. Ferrous Piping: 150 psig malleable iron, threaded.
   2. Copper Pipe: Bronze, soldered joints.

B. Flanges for Pipe 2 Inches and Greater:
   1. Ferrous Piping: 150 psig forged steel, slip-on.
   2. Copper Piping: Bronze.
   3. Gaskets: 1/16 inch thick preformed neoprene.

C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
   1. Dimensions and Testing: In accordance with AWWA C606.
   2. Mechanical Couplings: Comply with ASTM F1476.
   3. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
   4. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
   5. When pipe is field grooved, provide coupling manufacturer's grooving tools.

2.6 GLOBE OR ANGLE VALVES

A. Up To and Including 2 Inches:
   1. Bronze body, bronze trim, screwed bonnet, rising stem and handwheel, inside screw with backseating stem, renewable composition disc and bronze seat, solder ends.

B. Over 2 Inches:
   1. Iron body, bronze trim, bolted bonnet, rising stem, handwheel, outside screw and yoke, rotating plug-type disc with renewable seat ring and disc, flanged ends.

2.7 BALL VALVES

A. Up To and Including 2 Inches:
   1. Bronze one piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder ends with union.

B. Over 2 Inches:
   1. Ductile iron body, chrome plated stainless steel ball, teflon, Virgin TFE, or _________ seat and stuffing box seals, lever handle, gear operated, or _________, flanged ends, rated to 800 psi.

2.8 PLUG VALVES

A. Up To and Including 2 Inches:
   1. Bronze body, bronze tapered plug, 40 percent port opening, non-lubricated, teflon packing, threaded ends.
   2. Operator: One plug valve wrench for every ten plug valves minimum of one.
2.9 BUTTERFLY VALVES
   A. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer, lug, grooved, or ______ ends, extended neck.
   B. Disc: Construct of aluminum bronze, chrome plated ductile iron, stainless steel, ductile iron with EPDM encapsulation, Buna-N encapsulation, or ________________.
   C. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer or lug ends, extended neck.
   D. Disc: Elastomer coated ductile iron.
   E. Stem: Stainless steel with stem offset from the centerline to provide full 360 degree circumferential setting.
   F. Operator: 10 position lever handle.
   G. Seat: Resilient replaceable EPDM.

2.10 SWING CHECK VALVES
   A. Up To and Including 2 Inches:
      1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder or threaded ends.
   B. Over 2 Inches:
      1. Iron body, bronze or ________ trim, stainless steel, bronze, bronze faced rotating, or _______________ swing disc, renewable disc and seat, flanged, grooved, or __________ ends.
      2. Iron body, bronze trim, bronze or bronze faced rotating swing disc, renewable disc and seat, flanged ends.

2.11 SPRING LOADED CHECK VALVES
   A. 2 inches and Smaller: MSS SP 80, Class 250, bronze body, in-line spring lift check, silent closing, Buna-N disc, integral seat, solder or threaded ends.
   B. 2-1/2 inches and Larger: MSS SP 71, Class 125, wafer style, cast iron body, bronze seat, center guided bronze disc, stainless steel spring and screws, flanged ends.

2.12 FLOW CONTROLS
   A. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
   B. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi.

PART 3 EXECUTION

3.1 PREPARATION
   A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
   B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
   C. Remove scale and dirt on inside and outside before assembly.
D. Prepare piping connections to equipment using jointing system specified.
E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
F. After completion, fill, clean, and treat systems. Refer to Section 23 25 00 for additional requirements.

3.2 INSTALLATION
A. Install in accordance with manufacturer’s instructions.
B. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
C. Route piping in orderly manner, parallel to building structure, and maintain gradient.
D. Install piping to conserve building space and to avoid interfere with use of space.
E. Group piping whenever practical at common elevations.
F. Sleeve pipe passing through partitions, walls and floors.
G. Slope piping and arrange to drain at low points.
H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.
I. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
   2. Support horizontal piping as scheduled.
   3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   4. Place hangers within 12 inches of each horizontal elbow.
   5. Use hangers with 1 1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   8. Provide copper plated hangers and supports for copper piping.
   9. Prime coat exposed steel hangers and supports. Refer to Section 09 91 23. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 07 19.
K. Use eccentric reducers to maintain top of pipe level.
L. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
M. Install valves with stems upright or horizontal, not inverted.

3.3 SCHEDULES
A. Hanger Spacing for Copper Tubing.
   1. 1/2 inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
   2. 1 inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
   3. 1-1/2 inch and 2 inch: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   4. 2-1/2 inch: Maximum span, 9 feet; minimum rod size, 3/8 inch.
5. 3 inch: Maximum span, 10 feet; minimum rod size, 3/8 inch.

B. Hanger Spacing for Steel Piping.
   1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
   2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   5. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
   6. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.

C. Hanger Spacing for Plastic Piping.
   1. 1/2 inch: Maximum span, 42 inches; minimum rod size, 1/4 inch.
   2. 3/4 inch: Maximum span, 45 inches; minimum rod size, 1/4 inch.
   3. 1 inch: Maximum span, 51 inches; minimum rod size, 1/4 inch.
   4. 1-1/4 inches: Maximum span, 57 inches; minimum rod size, 3/8 inch.
   5. 1-1/2 inches: Maximum span, 63 inches; minimum rod size, 3/8 inch.
   6. 2 inches: Maximum span, 69 inches; minimum rod size, 3/8 inch.
   7. 3 inches: Maximum span, 7 feet; minimum rod size, 3/8 inch.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Expansion tanks.
B. Expansion tanks.
C. Air vents.
D. Air separators.
E. Strainers.
F. Suction diffusers.
G. Combination flow controls.
H. Flow indicators, controls, meters.
I. Radiator valves.
J. Relief valves.

1.2 RELATED REQUIREMENTS
A. Section 23 21 13 - Hydronic Piping.

1.3 REFERENCE STANDARDS
A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; 2015.

1.4 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.
C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
D. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.5 CLOSEOUT SUBMITTALS
A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
B. Project Record Documents: Record actual locations of actual locations of components and instrumentation, flow controls and flow meters.
C. Operation and Maintenance Data: Submit instructions for calibrating instruments, installation instructions, assembly views, servicing requirements, lubrication instruction, and replacement parts list.
1.6 PRE-INSTALLATION MEETINGS
   A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
   B. Convene minimum week prior to commencing work of this section.

1.7 ENVIRONMENTAL REQUIREMENTS
   A. Section 01 60 00 - Product Requirements.
   B. Do not install instruments when areas are under construction, except rough in, taps, supports and test plugs.

1.8 FIELD MEASUREMENTS
   A. Verify field measurements before fabrication.

1.9 WARRANTY
   A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
   B. Furnish [five] year manufacturer warranty for [piping specialties].

1.10 MAINTENANCE SERVICE
   A. Section 01 70 00 - Execution and Closeout Requirements: Maintenance service.
   B. Furnish service and maintenance of glycol fluid and glycol charging components for [two] years from Date of Substantial Completion.
   C. Furnish [monthly] visit for [one year] starting from Date of Substantial Completion to make glycol fluid concentration analysis on site with refractive index measurement instrument. Detail findings with maintenance personnel in writing of corrective actions needed including analysis and amounts of glycol or water added.

1.11 MAINTENANCE MATERIALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance materials.
   B. Furnish [two] bottles of red gage oil for static pressure gages.

1.12 EXTRA MATERIALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
   B. Furnish [two] [pressure gages with pulsation damper and two thermometers].

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

1.14 DELIVERY, STORAGE, AND HANDLING
   A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.1 EXPANSION TANKS

A. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, rated for working pressure of 125 psi, with flexible EPDM diaphragm or bladder sealed into tank, and steel support stand.

B. Accessories: Pressure gage and air-charging fitting, tank drain; precharge to 12 psi.

C. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check back flow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

2.2 AIR VENTS

A. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.

B. Float Type:
   1. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

2.3 AIR SEPARATORS

A. Centrifugal Air Separators/Strainers:
   1. Steel, tested and stamped in accordance with ASME BPVC-VIII-1; for 125 psi operating pressure, with integral bronze strainer, tangential inlet and outlet connections, and internal stainless steel air collector tube.

2.4 STRAINERS

A. Size 2 inch and Under:
   1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

B. Size 2-1/2 inch to 4 inch:
   1. Flanged iron body for 175 psi working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

C. Size 5 inch and Larger:
   1. Flanged iron body for 175 psi working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.5 SUCTION DIFFUSERS

A. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable 5/32 inch mesh strainer to fit over cylinder strainer, 20 mesh start up screen, and permanent magnet located in flow stream and removable for cleaning.
B. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning.

C. Accessories: Adjustable foot support, blowdown tapping in bottom, gage tapping in side.

2.6 COMBINATION FLOW CONTROLS
A. Construction: Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet with blowdown/backflush drain.
B. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi.
C. Control Mechanism: Stainless steel or nickel plated brass piston or regulator cup, operating against stainless steel helical or wave formed spring.
D. Accessories: In-line strainer on inlet and ball valve on outlet.

2.7 RELIEF VALVES
A. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

PART 3 EXECUTION

3.1 MAINTENANCE
A. See Section 01 70 00 - Execution Requirements, for additional requirements relating to maintenance service.
B. Provide service and maintenance of glycol system for one year from date of Substantial Completion at no extra charge to Owner.
C. Perform monthly visit to make glycol fluid concentration analysis on site with refractive index measurement instrument. Report findings in detail in writing, including analysis and amounts of glycol or water added.
D. Explain corrective actions to Owner's maintenance personnel in person.

3.2 INSTALLATION - HYDRONIC PIPING SPECIALTIES
A. Refer to drawing for required specialties.
B. Locate test plugs adjacent to thermometers and thermometer sockets and adjacent to pressure gages and pressure gage
C. Where large air quantities accumulate, provide enlarged air collection standpipes.
D. Install manual air vents at system high points.
E. For automatic air vents in ceiling spaces or other concealed locations, install vent tubing to nearest drain.
F. Provide air separator on suction side of system circulation pump
G. Connect to expansion tank to system by pipe connected of the bottom of the pump suction line.
H. Provide drain and hose connection with valve on strainer blow down connection.
I. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems.
J. Support pump fittings with floor mounted pipe and flange supports.
K. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.
L. Select system relief valve capacity greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
M. Pipe relief valve outlet to nearest floor drain.
N. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.
O. Feed glycol solution to system through make-up line with pressure regulator, venting system high points. Set to fill at 15 psig.

3.3 FIELD QUALITY CONTROL
A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
B. Test for strength of glycol and water solution and submit written test results.

3.4 CLEANING
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
B. Clean and flush glycol system before adding glycol solution.

3.5 PROTECTION OF INSTALLED CONSTRUCTION
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting installed construction.
B. Do not install hydronic pressure gauges until after systems are pressure tested.

END OF SECTION
PART 1  GENERAL

1.1  SECTION INCLUDES
   A.  In-line circulators.
   B.  Vertical in-line pumps.

1.2  RELATED REQUIREMENTS
   A.  Section 03 30 00 - Cast-in-Place Concrete.
   B.  Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
   C.  Section 23 07 16 - HVAC Equipment Insulation.
   D.  Section 23 07 19 - HVAC Piping Insulation.
   E.  Section 23 21 13 - Hydronic Piping.
   F.  Section 23 21 14 - Hydronic Specialties.

1.3  REFERENCE STANDARDS
   A.  NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4  SUBMITTALS
   A.  See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B.  Product Data:  Provide certified pump curves showing performance characteristics with pump and system operating point plotted.  Include NPSH curve when applicable.  Include electrical characteristics and connection requirements.
   C.  Manufacturer's Installation Instructions:  Indicate hanging and support requirements and recommendations.
   D.  Operation and Maintenance Data:  Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.5  QUALITY ASSURANCE
   A.  Manufacturer Qualifications:  Company specializing in manufacture, assembly, and field performance of pumps, with minimum three years of documented experience.

1.6  CLOSEOUT SUBMITTALS
   A.  Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
   B.  Operation and Maintenance Data: Submit installation instructions, servicing requirements, assembly views, lubrication instructions, and replacement parts list.
   C.  Maintain one copy of each document on site.
1.7 QUALIFICATIONS
   A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
   B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.8 PRE-INSTALLATION MEETINGS
   A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

1.9 DELIVERY, STORAGE, AND HANDLING
   A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
   B. Protect systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.10 FIELD MEASUREMENTS
   A. Verify field measurements prior to fabrication.

1.11 WARRANTY
   A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
   B. Furnish five year manufacturer warranty for pump motors.

1.12 EXTRA MATERIALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
   B. Furnish one set of mechanical seals for each pump.

PART 2 PRODUCTS

2.1 MANUFACTURERS
   A. Armstrong Pumps Inc; ______: www.armstrongpumps.com.
   B. Bell & Gossett, a Xylem Inc. brand; ______: www.bellgossett.com.

2.2 IN-LINE CIRCULATORS
   A. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 125 psi maximum working pressure.
   B. Casing: Bronze, with flanged pump connections.
   C. Impeller: Bronze keyed to shaft.
   D. Bearings: Oil-lubricated bronze sleeve.
   E. Shaft: Carbon Steel with bronze sleeve, integral thrust collar.
2.3 VERTICAL IN-LINE PUMPS

A. Type: Vertical, single stage, close coupled, radially or horizontally split casing, for in-line mounting, for 175 psi working pressure.

B. Casing: Cast iron, with suction and discharge gage port, casing wear ring, seal flush connection, drain plug, flanged suction and discharge

C. Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.

D. Shaft: Carbon steel with stainless steel impeller cap screw or nut and bronze sleeve.

E. Performance: As scheduled on drawings.

F. Electrical Characteristics:
   1. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.

C. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.

D. Provide air cock and drain connection on horizontal pump casings.

E. Check, align, and certify alignment of base-mounted pumps prior to start-up.

F. Install close-coupled and base-mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Refer to Section 03 30 00.

G. Lubricate pumps before start-up.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Piping.
B. Refrigerant.
C. Moisture and liquid indicators.
D. Valves.
E. Strainers.
F. Check valves.
G. Filter-driers.
H. Solenoid valves.
I. Expansion valves.
J. Flexible connections.

1.2 RELATED REQUIREMENTS
A. Section 08 31 00 - Access Doors and Panels.
B. Section 23 07 19 - HVAC Piping Insulation.

1.3 REFERENCE STANDARDS
A. AHRI 710 - Performance Rating of Liquid-Line Driers; 2009.
F. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants; 2013.
K. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2013.
M. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.
N. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2003.

1.4 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.
C. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.
D. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
E. Test Reports: Indicate results of leak test, acid test.
F. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.
G. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.5 CLOSEOUT SUBMITTALS
A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
B. Project Record Documents: Record actual locations of valves, equipment and refrigerant accessories.
C. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.6 QUALITY ASSURANCE
A. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum __________ years of documented experience.

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

1.8 ENVIRONMENTAL REQUIREMENTS
A. Section 01 60 00 - Product Requirements.

1.9 FIELD MEASUREMENTS
A. Verify field measurements prior to fabrication.
1.10 WARRANTY
   A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
   B. Furnish five year manufacturer warranty for valves excluding packing.

1.11 MAINTENANCE MATERIALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
   B. Furnish two refrigerant oil test kits each containing everything required for conducting one test.

1.12 EXTRA MATERIALS
   A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
   B. Furnish two refrigerant filter-dryer cartridges of each type.

PART 2 PRODUCTS

2.1 PIPING
   A. Copper Tube: ASTM B280, H58 hard drawn or O60 soft annealed.
      2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.
   B. Copper Tube to 7/8 inch OD: ASTM B88 (ASTM B88M), Type K (A), annealed.
   C. Pipe Supports and Anchors:
      1. Conform to ASME B31.5.
      2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron adjustable swivel, split ring.
      5. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

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

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

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

2.5 CHECK VALVES
A. Globe Type:
   1. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum temperature of 300 degrees F and maximum working pressure of 500 psi.
   B. Straight Through Type:
      1. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psi and maximum temperature of 250 degrees F.

2.6 FILTER-DRIERS
A. Performance:
B. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.
C. Construction: UL listed.
   1. Connections: As specified for applicable pipe type.

2.7 SOLENOID VALVES
A. Valve: AHRI 760 I-P, pilot operated, copper, brass or steel body and internal parts, synthetic seat, stainless steel stem and plunger assembly (permitting manual operation in case of coil failure), integral strainer, with flared, solder, or threaded ends; for maximum working pressure of 500 psi.

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

2.9 FLEXIBLE CONNECTORS
A. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure of 500 psi.
PART 3 EXECUTION

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

3.2 INSTALLATION
A. Install refrigeration specialties in accordance with manufacturer's instructions.
B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
C. Install piping to conserve building space and avoid interference with use of space.
D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
E. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.5.
   2. Support horizontal piping as scheduled.
   3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   4. Place hangers within 12 inches of each horizontal elbow.
F. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
G. Provide clearance for installation of insulation and access to valves and fittings.
H. Provide access to concealed valves and fittings. Coordinate size and location of access doors with Section 08 31 00.
I. Fully charge completed system with refrigerant after testing.

3.3 FIELD QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Test refrigeration system in accordance with ASME B31.5.
C. Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using halide torch. Test to no leakage.

3.4 SCHEDULES
A. Hanger Spacing for Copper Tubing.
   1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 1/4 inch.
   2. 1-1/8 inch OD: Maximum span, 6 feet; minimum rod size, 1/4 inch.
   3. 1-3/8 inch OD: Maximum span, 7 feet; minimum rod size, 3/8 inch.
   4. 1-5/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   5. 2-1/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   6. 2-5/8 inch OD: Maximum span, 9 feet; minimum rod size, 3/8 inch.

END OF SECTION
SECTION 23 31 00
HVAC DUCTS AND CASINGS

PART 1  GENERAL

1.1  SECTION INCLUDES
A. Metal ductwork.
B. Nonmetal ductwork.
C. Casing and plenums.
D. Kitchen hood ductwork.
E. Duct cleaning.

1.2  RELATED REQUIREMENTS
A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
B. Section 09 91 13 - Exterior Painting: Weld priming, weather resistant, paint or coating.
C. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.
D. Section 23 07 13 - Duct Insulation: External insulation and duct liner.
E. Section 23 33 00 - Air Duct Accessories.

1.3  REFERENCE STANDARDS
B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.
I. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements; 2012.
1.4 PERFORMANCE REQUIREMENTS
A. No variation of duct configuration or sizes permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.5 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data for duct materials.
C. Shop Drawings: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work for all modifications / systems.
D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK).
E. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.6 CLOSEOUT SUBMITTALS
A. Section 01 70 00 - Execution and Closeout Requirements 01700 - Execution Requirements: Closeout procedures.
B. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.7 QUALITY ASSURANCE
A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.
B. Construct ductwork to NFPA 90A standards.
C. Maintain one copy of each document on site.
1.8 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.
   B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum ___ years of documented experience.

1.9 REGULATORY REQUIREMENTS
   A. Construct ductwork to NFPA 90A, NFPA 90B and NFPA 96 standards.

1.10 FIELD CONDITIONS
   A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
   B. Maintain temperatures within acceptable range during and after installation of duct sealants.

1.11 FIELD MEASUREMENTS
   A. Verify field measurements of all duct installations prior to fabrication.

1.12 WARRANTY
   A. Section 01 70 00 - Execution and Closeout Requirements 01700 - Execution Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.1 DUCT ASSEMBLIES
   A. Regulatory Requirements: Construct ductwork to NFPA 90A standards.
   B. Ducts: Galvanized steel, unless otherwise indicated.

2.2 MATERIALS
   A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating.
   C. Stainless Steel for Ducts: ASTM A666, Type 304.
   D. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
      1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
      2. VOC Content: Not more than 250 g/L, excluding water.
      3. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
      4. For Use With Flexible Ducts: UL labeled.
E. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

F. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
   3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
   5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.

G. Insulated Flexible Ducts:
   1. Two ply vinyl film supported by helically wound spring steel wire; fiberglass insulation; polyethylene vapor barrier film.
      a. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.
      b. Maximum Velocity: 4000 fpm.
      c. Temperature Range: -10 degrees F to 160 degrees F.

2.3 DUCTWORK FABRICATION

A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.

B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

C. Construct T’s, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.

D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

E. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).

F. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.

G. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.4 MANUFACTURED DUCTWORK AND FITTINGS

A. Flexible Ducts: Black polymer film supported by helically wound spring steel wire.
   1. Pressure Rating: 4 inches WG positive and 0.5 inches WG negative.
   3. Temperature Range: Minus 20 degrees F to 175 degrees F.

2.5 CASINGS

A. Fabricate casings in accordance with SMACNA (DCS) and construct for operating pressures indicated.

B. Mount floor mounted casings on 4 inch high concrete curbs. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner of galvanized 18 gage, 0.0478 inch expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.
C. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.

2.6 KITCHEN HOOD EXHAUST DUCTWORK

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

2.7 INSULATED FLEXIBLE DUCTS

A. Product Description: Black polymer film supported by helical-wound spring steel wire; fiberglass insulation; aluminized vapor barrier film.
   1. Pressure Rating: 4 inches wg positive and 0.5 inches wg negative.
      b. Temperature Range: -20 degrees F to 175 degrees F.
      c. Thermal Resistance: 4.2 square feet-hour-degree F per BTU.

2.8 SINGLE WALL SPIRAL ROUND DUCTS

A. Manufacturers:
      a. Semco Incorporated.
      b. Tangent Air Corp.
      c. Spiral Mfg. Co., Inc.

B. Product Description: UL 181, Class 1, round spiral lockseam duct constructed of galvanized steel.

C. Duct Coating: Provided where indicated on drawings. Polyvinyl chloride plastic, 4 mil thick on both sides. Temperature range: minus 30 degrees F to 200 degrees F.

D. Construct duct with the following minimum gages:
   1. Diameter    Gauge
      2. 3 inches to 14 inches  26
      3. 15 inches to 26 inches  24
      4. 28 inches to 36 inches  22
      5. 38 inches to 50 inches  20
      6. 52 inches to 84 inches  18

E. Construct fittings with the following minimum gages:
   1. Diameter    Gauge
      2. 3 inches to 14 inches  24
      3. 15 inches to 26 inches  22
      4. 28 inches to 36 inches  20
      5. 38 inches to 50 inches  20
      6. 52 inches to 60 inches  18
      7. 62 inches to 84 inches  16

2.9 TRANSVERSE DUCT CONNECTION SYSTEM

A. Product Description: SMACNA "F" rated rigidity class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.
2.10 DUCTWORK FABRICATION

A. Fabricate and support rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and as indicated on Drawings. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

B. Fabricate and support round ducts with longitudinal seams in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible (Round Duct Construction Standards), and as indicated on Drawings. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

C. Construct T's, bends, and elbows with minimum radius 1-1/2 times centerline duct width. Where not possible and where rectangular elbows are used, provide airfoil turning vanes. Where acoustical lining is indicated, furnish turning vanes of perforated metal with glass fiber insulation.

D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

E. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.

F. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoff, use 90-degree conical tee connections.

2.11 KITCHEN AND DISHWASHER HOOD, DISHWASHER DIRECT CONNECT, FUME HOOD, AND CHEMICAL CABINET EXHAUST DUCTWORK FABRICATION

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and NFPA 96.


D. Where indicated to be solid double wall by schedule in this section: Inner and outer wall shall be constructed of same material as specified above (2.11 B or C, per application). Insulation shall be provided in inner space per section 23 07 00.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA (DCS).

B. Install in accordance with manufacturer's instructions.

C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

D. Fibrous Glass Ducts: Install in accordance with SMACNA (FGD). Obtain manufacturer's inspection and acceptance of fabrication and installation at beginning of installation.
E. Kitchen Hood Exhaust: Provide residue traps at base of vertical risers with provisions for clean out.

F. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.

G. Install and seal metal and flexible ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

H. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

I. Use double nuts and lock washers on threaded rod supports.

J. Connect terminal units to supply ducts directly or with one foot maximum length of flexible duct. Do not use flexible duct to change direction.

K. Connect diffusers or light troffer boots to low pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.

L. Connect flexible ducts to metal ducts with adhesive.

M. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.

N. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

O. At exterior wall louvers, seal duct to louver frame and install blank-out panels.

3.2 CLEANING

A. Clean duct systems with high power vacuum machines. Protect equipment that could be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.

3.3 SCHEDULES

A. Ductwork Material:
   2. Low Pressure Supply (System with Cooling Coils): Galvanized or Galvannealed Steel.
   3. Return and Relief: Galvanized Steel.
   5. Dishwasher Exhaust: Type 304 Stainless Steel.
   6. Outside Air Intake: Galvanized Steel.

B. Ductwork Pressure Class:
   1. Supply (Heating Systems): 4 inch
   2. Supply (System with Cooling Coils): 4 inch.
   3. Return and Relief: 2 inch.
   4. General Exhaust: 2 inch.
   5. Dishwasher Exhaust: 2 inch.
   6. Outside Air Intake: 2 inch.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Backdraft dampers - metal.
B. Duct test holes.
C. Volume control dampers.

1.2 RELATED REQUIREMENTS
A. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
B. Section 23 31 00 - HVAC Ducts and Casings.

1.3 REFERENCE STANDARDS
C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.
D. UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.

1.4 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.
C. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, duct access doors, and duct test holes.
D. Manufacturer's Installation Instructions: Provide instructions for fire dampers and combination fire and smoke dampers.
E. Project Record Drawings: Record actual locations of access doors and test holes.

1.5 CLOSEOUT SUBMITTALS
A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
B. Project Record Documents: Record actual locations of access doors and test holes.
C. Operation and Maintenance Data: Submit for Fire Dampers.

1.6 QUALITY ASSURANCE
A. Dampers tested, rated and labeled in accordance with the latest UL requirements.
B. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.
C. Maintain one copy of each document on site.

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

1.8 DELIVERY, STORAGE, AND HANDLING
A. Protect dampers from damage to operating linkages and blades.
B. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.
C. Storage: Store materials in a dry area indoor, protected from damage.
D. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

1.9 FIELD MEASUREMENTS
A. Verify field measurements prior to fabrication.

1.10 COORDINATION
A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
B. Coordinate Work where appropriate with building control Work.

1.11 EXTRA MATERIALS
A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
B. Furnish two of each size and type of fusible link.

PART 2 PRODUCTS

2.1 BACKDRAFT DAMPERS - METAL
A. Manufacturers:
B. Gravity Backdraft Dampers, Size 18 x 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.
C. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.
2.2 DUCT ACCESS DOORS
   A. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick
      fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with
      sheet metal cover.

2.3 DUCT TEST HOLES
   A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene
      plugs, threaded plugs, or threaded or twist-on metal caps.
   B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide
      extended neck fittings to clear insulation.

2.4 VOLUME CONTROL DAMPERS
   A. Fabricate in accordance with SMACNA (DCS) and as indicated.
   B. Single Blade Dampers: Fabricate for duct sizes up to 6 by 30 inch.
      1. Fabricate for duct sizes up to 6 by 30 inch.
      2. Blade: 24 gage, 0.0239 inch, minimum.
   C. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 by 72
      inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame
      with suitable hardware.
   D. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On
      multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered
      bronze bearings.

PART 3 EXECUTION

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

3.2 INSTALLATION
   A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow
      SMACNA (DCS). Refer to Section 23 31 00 for duct construction and pressure class.
   B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where
      indicated.
   C. Provide duct test holes where indicated and required for testing and balancing purposes.
   D. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations
      indicated, where ducts and outlets pass through fire rated components, and where required by
      Authorities Having Jurisdiction. Install with required perimeter mounting angles, sleeves,
      breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
   E. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.
   F. Demonstrate re-setting of fire dampers to Owner's representative.
G. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.

H. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Roof exhausters.
B. Wall exhausters.
C. Cabinet exhaust fans.
D. Kitchen hood upblast roof exhausters.

1.2 RELATED REQUIREMENTS
A. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
B. Section 23 33 00 - Air Duct Accessories: Backdraft dampers.

1.3 REFERENCE STANDARDS
C. AMCA 204 - Balance Quality and Vibration Levels for Fans; 2005.
F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2014.

1.4 ADMINISTRATIVE REQUIREMENTS
A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.5 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.
C. Manufacturer's Instructions: Indicate installation instructions.
D. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.
1.6 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.1 MANUFACTURERS

2.2 POWER VENTILATORS - GENERAL
   A. Static and Dynamically Balanced: AMCA 204 - Balance Quality and Vibration Levels for Fans.
   B. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
   C. Sound Ratings: AMCA 301, tested to AMCA 300 and bearing AMCA Certified Sound Rating Seal.
   D. Fabrication: Conform to AMCA 99.
   E. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
   F. Kitchen Hood Exhaust Fans: Comply with requirements of NFPA 96 and UL 762.

2.3 ROOF EXHAUSTERS
   A. Performance Ratings:
   B. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.
   C. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.
   D. Roof Curb: 16 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips.
   E. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor and wall mounted multiple speed switch.
   F. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.
   G. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
2.4 WALL EXHAUSTERS

A. Fan Unit: V-belt or direct driven with spun aluminum housing; resiliently mounted motor; 1/2 inch mesh, 0.062 inch thick aluminum wire bird screen.

B. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor, and wall mounted multiple speed switch.

C. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.

D. Sheaves: For V-belt drives, provide cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.5 CABINET AND CEILING EXHAUST FANS

A. Centrifugal Fan Unit: V-belt or direct driven with galvanized steel housing lined with acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge.

B. Grille: Molded white plastic.

C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.6 KITCHEN HOOD UPBLAST ROOF EXHAUSTERS

A. Belt Drive Fan:
   1. Fan Wheel:
      a. Type: Non-overloading, backward inclined centrifugal.
      b. Material: Aluminum.
   2. Statically and dynamically balanced.
   3. Motors:
      a. Open drip-proof (ODP).
      b. Heavy duty ball bearing type.
      c. Mount on vibration isolators or resilient cradle mounts, out of air stream.
      d. Fully accessible for maintenance.
   4. Housing:
      a. Construct of heavy gage aluminum including curb cap, windband, and motor compartment.
      b. Rigid internal support structure.
      c. One-piece fabricated or fully welded curb-cap base to windband for leak proof construction.
      d. Construct drive frame assembly of heavy gage steel, mounted on vibration isolators.
      e. Provide breather tube for fresh air motor cooling and wiring.

B. Shafts and Bearings:
   1. Fan Shaft:
      a. Ground and polished steel with anti-corrosive coating.
      b. First critical speed at least 25 percent over maximum cataloged operating speed.
   2. Bearings:
      a. Permanently sealed or pillow block type.
      b. Minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
      c. 100 percent factory tested.
C. Drive Assembly:
1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
2. Belts: Static free and oil resistant.
3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
4. Motor pulley adjustable for final system balancing.
5. Readily accessible for maintenance.

D. Roof Curb: 16 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips, insulation and curb bottom, curb bottom, ventilated double wall, and factory installed nailer strip.

E. Drain Trough: Allows for single-point drainage of water, grease, and other residues.

F. Options/Accessories:
1. Automatic Belt Tensioner: Automatic device that adjusts for correct belt tension for single drives.
2. Birdscreen:
   a. Provide galvanized steel construction.
   b. Protects fan discharge.
3. Clean Out Port: Removable grease repellent compression rubber plug allows access for cleaning wheel through windband.
4. Roof Curb Extension: Vented curb extension where required for compliance with minimum clearances required by NFPA 96.
5. Grease Trap:
   a. Aluminum.
6. Hinge Kit:
   a. Aluminum hinges.
   b. Hinges and restraint cables mounted to base (sleeve).
   c. Allows fan to tilt away for access to wheel and ductwork for inspection and cleaning.

PART 3  EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Extend ducts to roof exhausters into roof curb. Counterflash duct to roof opening.

C. Hung Cabinet Fans:
   1. Install fans with resilient mountings and flexible electrical leads. Refer to Section 22 05 48.
   2. Install flexible connections specified in Section 23 33 00 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

D. Provide sheaves required for final air balance.

E. Install backdraft dampers on inlet to roof and wall exhausters.

F. Provide backdraft dampers on outlet from cabinet and ceiling exhauster fans and as indicated.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Registers/grilles.
   B. Louvers.
   C. Louvered penthouses.
   D. Roof hoods.

1.2 RELATED REQUIREMENTS
   A. Section 09 91 23 - Interior Painting: Painting of ducts visible behind outlets and inlets.

1.3 REFERENCE STANDARDS
   C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.

1.4 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
   B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
   C. Project Record Documents: Record actual locations of air outlets and inlets.

1.5 QUALITY ASSURANCE
   A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
   B. Test and rate louver performance in accordance with AMCA 500-L.

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

PART 2 PRODUCTS

2.1 MANUFACTURERS
Part 2

2.2 Ceiling Egg Crate Exhaust and Return Grilles

A. Type: Egg crate style face consisting of 1/2 by 1/2 by 1/2 inch, 1/2 by 1/2 by 1 inch, 1 by 1 by 1 inch, and ____________ grid core.

B. Fabrication: Grid core consists of aluminum with mill aluminum finish.

C. Color: To be selected by Architect from manufacturer's standard range.

D. Frame: 1-1/4 inch margin with countersunk screw mounting.

E. Frame: Channel lay-in frame for suspended grid ceilings.

F. Accessories: Provide integral, gang & face operated opposed blade damper, 2 inch filter frame, plaster frame, square mesh insect screen, square mesh debris screen, prescored molded fiberglass back, 45 degree angled eggcrate or other similar provisions for visual blocking such as angled louver, 90 degree duct elbow, etc., and ____________.

2.3 Louvers

A. Type: 4 inch deep with blades on 45 degree slope with center baffle and return bend, heavy channel frame, 1/2 inch square mesh screen over exhaust and 1/2 inch square mesh screen over intake.

B. Color: To be selected by Architect from manufacturer's standard range.

C. Fabrication: 12 gage, 0.1046 inch thick extruded aluminum, welded assembly, with factory prime coat finish.

D. Mounting: Furnish with screw holes in jambs for installation.

2.4 Louver Penthouse

A. Type: All welded assembly with 4 inch deep louvers, mitered corners, sheet aluminum roof, with factory prime coat finish.

B. Color: To be selected by Architect from manufacturer's standard range.

2.5 Roof Hoods

A. Fabricate air inlet or exhaust hoods in accordance with SMACNA (DCS).

Part 3

3.1 Installation

A. Install in accordance with manufacturer's instructions.
B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

C. Install diffusers to ductwork with air tight connection.

D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.

E. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 91 23.

END OF SECTION
SECTION 23 38 13
COMMERCIAL-KITCHEN HOODS

PART 1 GENERAL

1.1 SECTION INCLUDES
A. Cooking hoods.

1.2 RELATED REQUIREMENTS
A. Section 10 44 00 - Fire Protection Specialties: Hand held fire extinguishers.
B. Section 11 40 00 - Foodservice Equipment: General provisions for hoods.
C. Section 23 31 00 - HVAC Ducts and Casings: Exhaust and make-up air ducts.
D. Section 23 34 16 - Centrifugal HVAC Fans: Kitchen exhaust fans.

1.3 REFERENCE STANDARDS
A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.

1.4 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation instructions, adjusting and balancing methods.
C. Shop Drawings: For each custom fabricated unit, provide drawings showing details of construction, dimensions, and interfaces with adjacent construction.
D. Test Reports for Grease Extracting Hoods: Provide test reports substantiating exhaust volume ratings and grease extraction performance.
E. Operation and Maintenance Data.
F. Warranty: Submit manufacturer's warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE
A. Manufacturer Qualifications:
1. At least five years experience in the design and manufacture of products of similar type to
   those specified.
2. For grease extracting hoods, able to provide test data showing performance of hoods to
   be provided.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Store products in manufacturer's unopened packaging until ready for installation.

PART 2 PRODUCTS

2.1 HOOD CONSTRUCTION
A. Provide products that comply with NFPA 96, the requirements and recommendations of
   SMACNA (KVS), and the requirements of the Authorities Having Jurisdiction.
B. Cooking Hoods: Provide Type I hoods, with all external joints and seams continuously welded,
   liquid-tight, and all internal joints, seams, and attachments sealed liquid-tight and grease-tight.
   1.Provide fire extinguishing system for all cooking hoods.
   2. Provide complete assemblies listed and labeled by UL under UL 710 for its intended use.
C. Construction: Materials, inside and out, are stainless steel complying with ASTM A666, Type
   304, stretcher leveled; unless otherwise indicated.
   1. Sheet Thickness: 18 gage, 0.048 inch, minimum.
   2. Fabrication: Fabricate each individual hood in one piece, with all welds ground and
      finished to match (inside and out); fabricate flat surfaces exposed to view as double-pan
      formed panels with internal stiffener members.
   3. Finish on Surfaces Exposed to View: No.4 (brushed directional); provide stainless steel
      faces on all sides exposed to view.
   4. Finish on Concealed Surfaces: No.4 or No.2B (dull, matte).
   5. Multiple Hoods: Where total hood length in one run is over 12 feet, provide multiple
      hoods, complete in all respects, of the largest size available and of approximately equal
      length, mounted end to end.
      a. Provide junction boxes for field interconnection of wiring.
      b. Provide pre-drilled holes for field connections, with stainless steel fasteners; if field
         welding is necessary, grind and polish welds to match adjacent finish.
   6. Duct Collars: For exhaust and make-up air openings, provide duct collar welded to hood
      unit; minimum of 8 inches extension from top or back face of unit, with minimum one inch
      90 degree flange, unless otherwise indicated.
   7. Access Panels: Provide removable or hinged access panels sufficient for maintenance
      and replacement of operating components inside unit; maximum width of 40 inches.
   8. Electrical: Run electrical wiring in conduit or raceways, factory pre-wired, with single
      connection point per hood.
      b. Hanger Spacing: 48 inches on center, maximum.
      c. Attachment to Structure: Mechanical fittings or inserts, stainless steel.

2.2 HOOD ACCESSORIES
A. Fire Extinguishing System: Comply with NFPA 96.
   1. Exposed Piping Under Hood: Stainless steel or chrome plated.
   2. Nozzles: Stainless steel or chrome plated brass.
3. Electrical Components: Provide all components required for properly operating system, including but not limited to wiring, raceways, contactors, circuit breakers, switches and solenoids.

4. Fire Alarm System: Provide connection point for building fire alarm system capable of signaling system readiness and to generate signal when system is actuated.

5. Manual Actuators: Wall-mounted pull stations; provide one near each hood and one near exit door.

B. Controls:
   1. Fans: Provide manual push button controls for starting and stopping fans and labeled indicator lights showing fan status.
   2. Fire Extinguishing System: Provide automatic actuation complying with NFPA 96; provide local and remote manual actuating stations clearly labeled "Hood Fire Protection"; upon actuation of fire extinguishing system, automatically:
      a. Shut off fans serving that hood.
      b. Shut off electric power to equipment under hood; actuate shunt trip breakers in KP-1, provided as part of electrical work. Controller shall output 0V in normal state and apply 120V upon alarm.
      c. Signal building fire alarm system; normally-open contacts.

C. Control Panels: Factory assembled and pre-wired, ready for utility connections.
   1. UL listed for use with specific hood.
   2. Provide a single control panel combining all control functions for a particular hood, unless otherwise indicated.
   3. Provide a single control panel for each group of hoods served by a single exhaust fan.
   4. Enclosures: Surface-mounted; stainless steel, to match hood.
   5. Provide indicator lights on control panel door showing status of fans and power supply.

D. Lights Inside Hoods: ______ LED lights in vapor tight enclosures, wired to a single junction box.

E. Grease Filters: Stainless steel, washable, complying with UL 1046, UL listed and labeled;

PART 3 EXECUTION

3.1 EXAMINATION
   A. Verify that overhead supports are installed in correct locations.
   B. Do not begin installation until substrates have been properly prepared.
   C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 INSTALLATION
   A. Install in accordance with manufacturer's instructions and NFPA 96.
   B. Install hoods level and plumb, securely fastened, with seismic restraints as specified, and free of vibration during normal operation.
   C. Weld hood duct collars to ductwork, liquid-tight.
   D. Connect to utilities.
3.3 SYSTEM STARTUP

A. Obtain the services of the manufacturer’s representative experienced in the installation, adjustment, and operation of the equipment to supervise the starting and adjusting of equipment.

B. Prepare equipment for startup, start and operate equipment for sufficient period to verify proper operation; correct equipment not operating correctly.

C. Demonstrate operation to Owner’s designated personnel.

D. Report deficiencies in writing to Architect.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

A. Manufactured breechings.
B. Double wall metal stacks.

1.2 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.
B. Section 23 07 16 - HVAC Equipment Insulation.

1.3 REFERENCE STANDARDS

C. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges; 2011.
D. ASME B31.9 - Building Services Piping; 2014.
G. ASTM A193/A193M - Standard Specification for Alloy - Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications; 2014.
H. ASTM A194/A194M - Standard Specification for Carbon and Alloy Nuts for Bolts for High Pressure or High Temperature Service, or Both; 2015.
N. NEMA MG 1 - Motors and Generators; 2014.
1.4 DEFINITIONS
A. Breeching: Vent Connector.
B. Chimney: Primarily vertical shaft enclosing at least one vent for conducting flue gases outdoors.
C. Vent: That portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.
D. Vent Connector: That part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.

1.5 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.
C. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breechings. Submit layout drawings indicating plan view and elevations where factory built units are used.
D. Manufacturer's Instructions: Include installation instructions, and indicate assembly, support details, and connection requirements.

1.6 QUALITY ASSURANCE
A. Designer Qualifications: Design stacks under direct supervision of a Professional Structural Engineer experienced in design of the type of work specified and licensed in the State in which the Project is located.
B. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
PART 2  PRODUCTS

2.1 BREECHINGS, CHIMNEYS, AND STACKS - GENERAL REQUIREMENTS
   A. Regulatory Requirements:
      1. Conform to applicable code for installation of natural gas burning appliances and equipment.

2.2 DOUBLE WALL METAL STACKS
   A. Provide double wall metal stacks, tested to UL 103 and UL listed with positive pressure rating, for use with building heating equipment, in compliance with NFPA 211.
   B. Fabricate with 1 inch minimum air space between walls and construct inner liner of 304 stainless steel and outer jacket of 304 stainless steel.
      1. Protect aluminized steel surfaces exposed to the elements with a minimum of one base coat of primer and one finish coat of corrosion resistant paint suitable for outer jacket skin temperatures of the application.
   C. Accessories, UL labeled:
      1. Ventilated Roof Thimble: Consists of roof penetration, vent flashing with spacers and storm collar.
      2. Exit Cone: Consists of inner cone, and outer jacket, to increase stack exit velocity 1.5 times.

PART 3  EXECUTION

3.1 INSTALLATION
   A. Install in accordance with manufacturer’s instructions.
   B. Install in accordance with NFPA 54.
   C. Install breechings with minimum of joints. Align accurately at connections, with internal surfaces smooth.
   D. Support breechings from building structure, rigidly with suitable ties, braces, hangers and anchors to hold to shape and prevent buckling. Support vertical breechings, chimneys, and stacks at 12 foot spacing, to adjacent structural surfaces, or at floor penetrations. Refer to SMACNA (DCS) for equivalent duct support configuration and size.
   E. Assemble and install stack sections in accordance with NFPA 82, industry practices, and in compliance with UL listing. Join sections with acid-resistant joint cement. Connect base section to foundation using anchor lugs.
   F. Level and plumb chimney and stacks.

END OF SECTION
SECTION 23 52 16.13
ESTEEM 399 MBTU CONDENSING BOILERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

B. SUMMARY

1. This Section includes packaged, factory-fabricated and -assembled, gas-fired, fire-tube condensing boilers, trim and accessories for generating hot water.

C. SUBMITTALS

1. Product Data: Include performance data, operating characteristics, furnished specialties and accessories.
   a. Prior to flue vent installation, engineered calculations and drawings must be submitted to Architect/Engineer to thoroughly demonstrate that size and configuration conform to recommended size, length and footprint for each submitted boiler.

2. Pressure Drop Curve: Submit pressure drop curve for flows ranging from 0 GPM to maximum value of boiler
   a. If submitted material is different from that of the design basis, boiler manufacture shall incur all costs associated with reselection of necessary pumps. Possible differences include, but are not limited to, the pump type, pump pad size, electrical characteristics and piping changes.

3. Shop Drawings: For boilers, boiler trim and accessories, include:
   a. Plans, elevations, sections, details and attachments to other work
   b. Wiring Diagrams for power, signal and control wiring

4. Source Quality Control Test Reports: Reports shall be included in submittals.

5. Field Quality Control Test Reports: Reports shall be included in submittals.

6. Operation and Maintenance Data: Data to be included in boiler emergency, operation and maintenance manuals.

7. Warranty: Standard warranty specified in this Section

8. Other Informational Submittals
   a. ASME Stamp Certification and Report: Submit “A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

D. QUALITY ASSURANCE

1. Electrical Components, Devices and Accessories: Boilers must be 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. I=B=R Performance Compliance: Condensing boilers must be rated in accordance with applicable federal testing methods and verified by AHRI as capable of achieving the energy efficiency and performance ratings as tested within prescribed tolerances.

3. ASME Compliance: Condensing boilers must be constructed in accordance with ASME Boiler and Pressure Vessel Code, Section IV “Heating Boilers”.

4. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to “Gas and Oil Fired Boilers - Minimum Efficiency Requirements.”


6. ETL Certified and Listed to ANSI Z21.13/CSA 4.9 test standards for US and Canada
7. **NOx Emission Standards.** When installed and operated in accordance with manufacturer’s instructions, condensing boilers shall comply with the NOx emission standards outlined in South Coast Air Quality Management District (SCAQMD), Rule 1146.2; and the Texas Commission on Environmental Quality (TCEQ), Title 30, Chapter 117, Rule 117.465.

8. **COORDINATION**

9. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement and formwork requirements are specified in Division 03. (If the floor mount kit is supplied)

**E. WARRANTY**

1. Standard Warranty: Boilers shall include manufacturer’s standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
   a. **Warranty Period for Fire-Tube Condensing Boilers**
      1) The pressure vessel/heat exchanger shall carry a 10-year from shipment, prorated, limited warranty against any failure due to condensate corrosion, thermal stress, mechanical defects or workmanship.
      2) All other components, with the exception of the igniter and flame detector, are conditionally guaranteed against any failure for 18 months from shipment

**PART 2 PRODUCTS**

2.1 **MANUFACTURERS**

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

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

C. Basis-of-Design Product: Subject to compliance with requirements, provide AERCO International, EST 399 or a comparable product by one of the following:
   1. AERCO International
   2. Buderus

D. **CONSTRUCTION**

1. Description: Boiler shall be natural gas fired fully condensing, and fire tube design. Power burner shall have full modulation (the minimum firing rate shall not exceed 112,000 BTU/HR input. Boilers that have an input greater than 112,000 BTU/Hr at minimum fire will not be considered) and discharge into a positive pressure vent. Boiler efficiency shall increase with decreasing load (output), while maintaining setpoint. Boiler shall be factory-fabricated, factory-assembled and factory-tested, fire-tube condensing boiler with heat exchanger sealed pressure-tight, built on a steel base, including insulated jacket, flue-gas vent, combustion-air intake connections, water supply, return and condensate drain connections, and controls.

2. Heat Exchanger: The heat exchanger shall be constructed of 439 stainless steel fire tubes and tubesheets, with a one-pass combustion gas flow design. The fire tubes shall be a flatten 0.976” x 0.256” Channel, with no less than 0.0394” wall thickness. The upper and lower 439 stainless steel tube sheet shall be no less than 0.0984” thick. The pressure vessel/heat exchanger shall be welded construction. The heat exchanger shall be ASME stamped for a working pressure not less than 30 psig. Access to the tubesheets and heat exchanger shall be available by burner and exhaust manifold removal. Minimum access opening shall be no less than 4-inch diameter.
3. Pressure Vessel: The pressure vessel shall have a maximum water volume of 7 gallons. The boiler water pressure drop shall not exceed 3.0 psig at 38 gpm. The boiler water connections shall be 1 ½-inch male NPT threaded connection. The pressure vessel shall be constructed of 439 stainless steel, with a .0984-inch (2.5MM) thick wall. Inspection openings in the pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases.

4. Modulating Gas Venturi, Burner, and Pre-Mix Blower. The boiler burner shall be capable of a 3.6-to-1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves. The burner shall produce less than 12 ppm of NOx corrected to 3% excess oxygen. The unit shall be certified by the South Coast Air Quality Management District (SCAQMD) as compliant with Rule 1146.2 for boilers and water heaters less than or equal to 2 MBTU, and the Texas Commission on Environmental Quality (TCEQ) as being compliant with Section 117.465 for boilers and water heaters less than or equal to 2 MBTU. The burner shall be metal-fiber mesh covering a stainless steel body with spark ignition and flame rectification. All burner material exposed to the combustion zone shall be of stainless steel construction. There shall be no moving parts within the burner itself. A variable speed pre-mix blower and gas venturi shall meter the air and fuel input. The pre-mix blower shall be used to ensure the optimum mixing of air and fuel before the burner.

5. Minimum IBR boiler efficiency shall be 95.1%

6. The exhaust manifold shall be constructed of corrosion resistant 316 stainless steel with a four-inch diameter flue connection. The exhaust manifold shall have a collecting reservoir and a gravity drain for the elimination of condensation.

7. Blower. The boiler shall include a variable-speed, DC centrifugal fan to operate during the burner firing sequence and pre-purge the combustion chamber.
   a. Motors: Blower motors shall comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
      1) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require a motor to operate in the service factor range above 1.0.

8. Ignition: Ignition shall be via spark ignition with 100 percent main-valve shutoff and electronic flame supervision.

2.2 CONTROLS
A. Refer to Division 23, Section "Instrumentation and Control of HVAC."

B. The boiler control system shall be a TriMax Control Panel.

C. The combustion safeguard/flame monitoring system shall use spark ignition and a rectification-type flame sensor.

D. The control panel hardware shall support remote communications via MODBUS.

E. The controls shall annunciate boiler and sensor status and include extensive self-diagnostic capabilities that incorporate a minimum of eight separate status messages and 18 separate fault messages that can be sent to a building automation system

F. TriMax Controller shall have a built-in sequencing function and be capable of controlling up to 6 units. The controller shall have the ability to vary the firing rate and energy input of each individual boiler throughout its full modulating range to maximize the condensing capability and thermal efficiency output of the entire heating plant. The ACS shall control the boiler outlet header temperature within +6°F. The controller shall be a PID type controller and uses Ramp Up/Ramp Down control algorithm for accurate temperature control with excellent variable load response. The TriMax controller shall provide contact closure for auxiliary equipment such as system pumps and combustion air inlet dampers based upon outdoor air temperature.

G. Boiler Control Modes
1. **Internal Set Point**: The boiler shall include integral factory wired operating controls to control all operation and energy input of the boiler. Control of discharge water temperature shall be set through an internal set point with an adjustment of 60ºF to 194ºF. The controller shall have the ability to vary boiler input throughout its full range to maximize the condensing capability of the boiler and without header temperature swings. The boiler will operate to maintain a constant header temperature outlet to +6ºF.
   
   a. Maximum efficiency shall be achieved at minimum firing input. Controls shall be fully field adjustable from 60ºF to 194ºF in operation. Main Header outlet temperature shall not be more than +6ºF from set point at any point of operation. The boiler shall have LCD display for monitoring of all sensors.
   
   b. **Outdoor Reset**: The boiler shall include integral factory wired operating controls to control all operation and energy input of the boiler plant. The controller shall have the ability to vary boiler input throughout its full range to maximize the condensing capability of the boiler and without header temperature swings. The boiler will operate to vary header temperature set point on an inverse ratio in response to outdoor temperature to control discharge temperature +6ºF.
   
   c. **0VDC to 10VDC BMS Control**: A Boiler Management System (BMS) shall send a 0VDC to 10 VDC signal to control all operation and energy input of the boiler. The boiler will operate to vary firing rate linearly as an externally applied 0VDC to 10VDC mA signal is supplied to the Controller.

2. The Boiler Control System shall have a Boost Feature that if the call for heat is not satisfied in an adjustable time setting the set point will be raised by 18 ºF for each time period that the call for heat is not satisfied until the maximum boiler operating set point is reached.

3. The boiler control system shall incorporate the following additional features for enhanced external system interface:
   
   a. **Domestic Water Priority Feature**
   
   b. **Domestic Water Pump Control**
   
   c. **Primary Pump Control**
      
      1) Continuous operation
      
      2) Activation when there is a call for heat
   
   d. **Inlet temperature sensor**
   
   e. **Optional External limits - auto reset**
   
   f. **Optional External Limits — manual reset**
   
   g. **Fault relay for remote fault alarm**

2.3 **ELECTRICAL POWER**

   A. **Controllers, Electrical Devices and Wiring**: Electrical devices and connections are specified in Division 26 sections.

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

   C. **Electrical Characteristics**:
      
      1. Voltage: 120 V
      
      2. Phase: Single
      
      3. Frequency: 60 Hz
      
      4. 15 Amp Service

2.4 **VENTING**

   A. The exhaust vent shall be PVC, CPVC, PPs Polypropylene or UL-listed vents of Al 29-4C stainless steel must be used with boilers.

   B. The minimum exhaust vent duct size for each boiler is four-inch diameter.
C. Combustion-Air Intake: Boilers shall be capable of drawing combustion air from the outdoors via a metal or PVC duct connected between the boiler and the outdoors.

D. The minimum sealed combustion air duct size for each boiler is four-inch diameter.

E. Follow guidelines specified in manufacturer’s venting guide.

2.5 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions and carbon monoxide in flue gas, and to achieve combustion efficiency. Perform hydrostatic testing.

B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
   1. If boilers are not factory assembled and fire-tested, the local vendor is responsible for all field assembly and testing.
   2. Allow Owner access to source quality-control testing of boilers. Notify Architect fourteen days in advance of testing.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine piping and electrical connections to verify actual locations, sizes and other conditions affecting boiler performance, maintenance and operations.
   1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
   2. Examine mechanical spaces for suitable conditions where boilers will be installed.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

A. Install boilers level on concrete bases. (If the floor mount kit is supplied) Concrete base is specified in Division 23 Section “Common Work Results for HVAC,” and concrete materials and installation requirements are specified in Division 03.

B. Install gas-fired boilers according to NFPA 54.

C. Assemble and install boiler trim.

D. Install electrical devices furnished with boiler but not specified to be factory mounted.

E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings and specialties.

B. Install piping adjacent to boiler to permit service and maintenance.

C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect gas piping to boiler gas-train inlet with unions. Piping shall be at least full size of gas train connection. Provide a reducer if required.
E. Connect hot-water piping to supply and return boiler tappings with shutoff valve and union or flange at each connection.

F. Install piping from safety relief valves to nearest floor drain.

G. Boiler Venting
   1. Install flue venting kit and combustion-air intake.
   2. Connect venting full size to boiler connections. [Comply with requirements in Division 23 Section "Breechings, Chimneys and Stacks."]
   3. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
   4. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 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 installations, including connections, and to assist in testing.
   2. Tests and Inspections
      a. Installation and Startup Test: Perform installation and startup checks according to manufacturer’s written instructions.
      b. Leak Test: Perform hydrostatic test. Repair leaks and retest until no leaks exist.
      c. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
      d. Controls and Safeties: Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
         1) Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
         2) Set field-adjustable switches and circuit-breaker trip ranges as indicated.
   3. Remove and replace malfunctioning units and retest as specified above.
   4. Occupancy Adjustments: When requested within 2 months of date of Substantial Completion, provide on-site assistance adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Gas fired unit heaters.
   B. Room thermostats.

1.2 RELATED REQUIREMENTS
   A. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
   B. Section 23 09 13 - Instrumentation and Control Devices for HVAC: Thermostats, time clocks.
   C. Section 23 51 00 - Breechings, Chimneys, and Stacks.

1.3 REFERENCE STANDARDS
   B. ASHRAE Std 103 - Methods of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers; 2007, Including All Amendments.

1.4 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide manufacturer's literature and data indicating rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
   C. Shop Drawings: Indicate assembly, required clearances, and locations and sizes of field connections.
   D. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.
   E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listing.
   F. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
1.6 REGULATORY REQUIREMENTS
A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.7 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Provide five year manufacturers warranty for heat exchangers.

PART 2 PRODUCTS

2.1 GAS FIRED UNIT HEATERS
A. Unit Heaters: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heat exchanger, burner, controls, and accessories:
   2. Discharge Louvers: Individually adjustable horizontal and vertical louvers to match cabinet finish.
B. Cabinet: Galvanized steel with baked enamel finish, easily removed and secured access doors, glass fiber insulation and reflective liner.
C. Supply Fan: Propeller type with direct drive, variable pitch motor pulley.
D. Heat Exchanger: Type 321 stainless steel welded construction.
E. Gas Burner:
   1. Gas valve provides 100 percent safety gas shut-off; 24 volt combining pressure regulation, safety pilot, manual set (On-Off), pilot filtration, automatic electric valve.
   2. Electronic pilot ignition, with electric spark igniter.
   3. Combustion air damper with synchronous spring return damper motor.
   4. Non-corrosive combustion air blower with permanently lubricated motor.
F. Gas Burner Safety Controls:
   1. Thermocouple sensor: Prevents opening of gas valve until pilot flame is proven and stops gas flow on ignition failure.
   2. Vent safety shutoff sensor: Temperature sensor installed on draft hood and prevents operation, manual reset.
G. Operating Controls
   1. Room Thermostat: Cycles burner to maintain room temperature setting.
H. Performance:
   1. Ratings: Energy Efficiency Rating (EER)/Coefficient of Performance (COP) not less than requirements of ASHRAE Std 90.1; seasonal efficiency to ASHRAE Std 103.

2.2 ROOM THERMOSTATS
A. Manufacturers:
B. Room Thermostat: Adjustable, low voltage, to control burner operation, compressor and condenser fan and supply fan to maintain temperature setting. Include system selector switch (heat-off-cool) and fan control switch (auto-on).
PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that space is ready for installation of units and openings are as indicated on shop drawings.
B. Verify that proper power supply is available.
C. Verify that proper fuel supply is available for connection.

3.2 INSTALLATION

A. Install in accordance with NFPA 90A.
B. Install gas fired units in accordance with NFPA 54 and applicable codes.
C. Provide vent connections in accordance with NFPA 211. Refer to Section 23 51 00.
D. Install unit heaters with vibration isolation. Refer to Section 23 05 48.

END OF SECTION
PART 1 - GENERAL

1.1 1.1 SUMMARY
A. This section includes Air-to-Air Energy Recovery Ventilators for indoor installation.
B. Within this document, these units may be referred to as Energy Recovery Ventilator (ERV) for brevity.

1.2 1.2 RELATED
A. Drawing and general provisions of the contract, including General Requirements Division 01, Division 23, Division 23 Specifications Sections, and common work requirements for HVAC apply to work specified in this section.
B. Section 23 09 00: Controls and Instrumentation

1.3 1.3 SUBMITTALS
A. Product data: For each type or model of Energy Recovery Ventilator, include the following:
1. Unit performance data for both Supply Air and Exhaust Air, with system operating conditions indicated.
2. Enthalpy plate performance data for both summer and winter operation.
3. Motor ratings and unit electrical characteristics.
4. Dimensioned drawings for each type of installation, showing isometric and plan views, to include location of attached ductwork and service clearance requirements.
5. Estimated gross weight of each installed unit.
6. Filter types, quantities, and sizes
7. Installation, Operating and Maintenance manual (IOM) for each model.

B. LEED Submittals:
1. Provide data for prerequisite E01: Documentation indicating that units comply with ASHRAE 62.1-2010, Section 5 - "Systems and Equipment".

C. Shop Drawings: For air-to-air energy recovery ventilators, include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

D. Operation and maintenance data for air-to-air energy recovery ventilator

1.4 1.4 QUALITY ASSURANCE
A. Source Limitations: Obtain Air-to-Air Energy Recovery Ventilator with all appurtenant components or accessories from a single manufacturer.

B. For the actual fabrication, installation, and testing of work under this section, use only thoroughly trained and experienced workers completely familiar with the items required and with the manufacturer's current recommended methods of installation.

C. The ERV core shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of ten (10) years
from the date of purchase. The balance-of-unit shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of two (2) years from the date of purchase.

D. Manufacturer shall be able to provide evidence of independent testing of the core by Underwriters Laboratory (UL), verifying a maximum flame spread index (FSI) of 25 and a maximum smoke developed index (SDI) of 50 thereby meeting NFPA90A and NFPA 90B requirements for materials in a compartment handling air intended for circulation through a duct system. The method of test shall be UL Standard 723.

E. Certifications:
1. The energy recovery cores used in these products shall be third party Certified by AHRI under its Standard 1060 for Energy Recovery Ventilators. AHRI published certifications shall confirm manufacturer’s published performance for airflow, static pressure, temperature and total effectiveness, purge air (OACF) and exhaust air leakage (EATR). Products that are not currently AHRI certified will not be accepted. OACF shall be no more than 1.02 and EATR shall be at 0% against balanced airflow.

F. Every unit to be factory tested prior to shipping: Motor Dielectric Voltage-Withstand Bench Test, Unit Dielectric Voltage-Withstand Test, Continuity of External Control Circuits Test, Unit Amperage Test

1.5 1.5 COORDINATION
A. Coordinate size and location of all building penetrations required for installation of each Energy Recovery Ventilator and associated electrical systems.
B. Coordinate sequencing of construction for associated plumbing, HVAC, electrical supply.

PART 2 - PRODUCTS

2.1 2.1 MANUFACTURERS
A. Available Manufacturers: Subject to compliance with specifications contained within this document, manufacturers offering products that may be incorporated into the work include, but are not limited to:
   1. RenewAire
B. Manufacturer should be in business for minimum 10 years manufacturing energy recovery ventilators.

2.2 2.2 MANUFACTURED UNITS
A. Air-to-Air Energy Recovery Ventilators shall be fully assembled at the factory and consist of a fixed-plate cross-flow heat exchanger with no moving parts, an insulated [single][double] wall [G90 galvanized][painted] 20-gauge steel cabinet, [motorized outside air intake damper,] filter assemblies for both intake and exhaust air, enthalpy core, supply air blower assembly, [motorized exhaust air damper,] exhaust air blower assembly and electrical control box with all specified components and internal accessories factory installed and tested and prepared for single-point high voltage connection. Entire unit with the exception of field-installed components shall be assembled and test operated at the factory.

2.3 2.3 CABINET
A. Materials: Formed [single][double] wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
B. Outside casing: 20 gauge, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish. [Painted components as supplied by the factory shall have polyester urethane paint on 20 gauge G90 galvanized steel.]

C. Access doors shall be hinged with airtight closed cell foam gaskets. Door pressure taps, with captive plugs, shall be provided for cross-core pressure measurement allowing for accurate airflow measurement.

D. Unit shall have factory-installed duct flanges on all duct openings.

E. Cabinet Insulation: Unit walls and doors shall be insulated with 1 inch, 4 pound density, foil/scrim faced, high density fiberglass board insulation, providing a cleanable surface and eliminating the possibility of exposing the fresh air to glass fibers, and with a minimum R-value of 4.3 (hr-ft²·°F/BTU).

F. Enthalpy core: Energy recovery core shall be of the total enthalpy type, capable of transferring both sensible and latent energy between airstreams. Latent energy transfer shall be accomplished by direct water vapor transfer from one airstream to the other, without exposing transfer media in succeeding cycles directly to the exhaust air and then to the fresh air. No condensate drains shall be allowed. The energy recovery core shall be designed and constructed to permit cleaning and removal for servicing. The energy recovery core shall have a ten year warranty. Performance criteria are to be as specified in AHRI Standard 1060.

G. Control center / connections: Energy Recovery Ventilator shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections to the [non-fused][fused] disconnect.

H. Passive Frost Control: [None required.][Automated shutdown of outside air blower.]

I. Motorized Isolation Damper(s): [None included.][Exhaust Air][and][Fresh Air][motorized damper(s)][of an AMCA Class I leakage type shall be factory installed.]

2.4 BLOWER SECTION

A. Blower section construction, Supply Air and Exhaust Air: Blower assemblies consist of a [120V][208-230V][460V][575V][1 Phase][3 Phase] 60 HZ, TEFC motor, and a belt driven forward-curved blower.

B. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.

2.5 MOTORS

A. General: Blower motors greater than ¾ horsepower shall be “NEMA Premium™” unless otherwise indicated. Minimum compliance with EPAct minimum energy-efficiency standards for single speed ODP and TE enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure. Drives shall be sized for a minimum of 150% of driven horsepower and pulleys shall be fully machined cast-type, keyed and fully secured to the fan wheel and motor shafts.

2.6 UNIT CONTROLS

A. Fan control: [Motor starter and contactor][Onboard VFD][fresh air stream.][exhaust air stream.][both airstreams.]

B. Bypass economizer control: [Dry bulb][Differential enthalpy] control, 2 position dampers with 100% airflow through the core or 100% airflow bypassing the core.
C. Sensors: [None.] [Dirty filter monitor for both airstreams.]

D. Timeclock: Digital Time Clock [wall mount] [mounting in outdoor, enclosed NEMA 3R enclosure], with up to 8 on/off cycles per day or 50 per week, 24VAC power, with battery backup protection of program settings against power failure to energize unit

E. Motion (Occupancy) Sensor: Passive infrared sensor for [wall] [ceiling] mounting with adjustable time-off delay to 30 minutes, 24VAC power to energize unit

F. Carbon Dioxide: Adjustable control from 600 - 2000 PPM for [wall] [duct] mounting with digital display

G. Factory-installed microprocessor controller and sensors, [Enhanced] [Premium] ERV controls that:
   1. Comply with requirements in Division 23 Section "Sequence of Operations for HVAC Controls"
   2. Has factory-installed hardware and software to enable the building automation interface via [Modbus] [BACnet] to monitor, control, and display status and alarms
   3. The microprocessor controller shall be capable of operating at temperatures between -20F to 160F
   4. The microprocessor controller shall be a DIN rail mounting type
   5. Factory-installed microprocessor controller shall come with backlit display that allows menu-driven display for navigation and control of unit
   6. The microprocessor controller shall have the ability to communicate with the BMS via Modbus RTU/TCP and BACnet MSTP/IP
   7. The microprocessor controller shall have integrated ethernet interface and a web server for displaying unit parameters
   8. The microprocessor shall have near field communication (NFC) capability for android devices
   9. The microprocessor controller shall have an internal programmable time clock that will allow the user to add up to different occupancy schedules and add holidays
   10. The microprocessor control shall be capable of integral diagnostics
   11. The microprocessor control shall be capable of IP or SI unit display
   12. The microprocessor controller shall have a battery powered clock
   13. The microprocessor controller shall at a minimum offer the ability for three modes of determining occupancy: a dry contact, the internal time clock or the BMS
   14. A remote user terminal to allow for remote monitoring and adjustment of parameters, allowing ease of control access without going outdoors or into the mechanical room if desired by the user
   15. The microprocessor controller shall have at a minimum (10) universal inputs/outputs (AI, DI, AO) and have (6) six relay outputs (DO)
   16. The microprocessor controller shall have an integrated fieldbus port
   17. The microprocessor controller shall have the capability for I/O expansion
   18. The microprocessor controller shall have a micro USB port to load the application program, the unit parameters, saving logs, etc.
   19. The sensors that will be required for control are:
      a. (2) Temperature sensor for fresh air and exhaust air
      b. (2) Temperature and humidity sensor for outside air, return air
      c. (2) Differential pressure sensors for filter alarms
      d. [(2) Differential pressure sensors for measuring pressure drop across energy recovery core and for determining airflow in both airstreams]
      e. (2) Adjustable current switches
      f. [Field-installed duct or room IAQ sensor]
      g. [Field-installed duct or room CO2 sensor]
      h. [Field-installed duct static sensor]
      i. [Field-installed room pressurization sensor]
The microprocessor controller shall have the capability to monitor the unit conditions for alarm conditions. Upon detecting an alarm, the microprocessor controller shall have the capability to record the alarm description, time, date, available temperatures, and unit status for user review. A digital output shall be reserved for remote alarm indication. Alarms to be also communicated via BMS as applicable. Provide the following alarm functions:

1) Outside air temperature sensor alarm
2) Outside air humidity sensor alarm
3) Return air temperature sensor alarm
4) Return air humidity sensor alarm
5) Fresh air sensor alarm
6) Exhaust air sensor alarm
7) Dirty filter alarm
8) Supply and exhaust air proving alarm
9) Outside airflow sensor alarm
10) Exhaust airflow sensor alarm
11) Duct static pressure sensor alarm
12) Room pressurization sensor alarm
13) CO2 sensor alarm
14) TVOC sensor alarm
15) Airflow out of range alarm

Display the following on the face of microprocessor controller:

1) Unit on
2) Unit economizer/bypass mode
3) Heating status
4) Outdoor air temperature
5) Outdoor air humidity
6) Return air temperature
7) Return air humidity
8) Supply air temperature
9) Airflows in both airstreams
10) Unit on/off
11) Fan on/off
12) Damper status
13) Alarm digital display

The microprocessor controller shall have factory pre-programmed multiple operating sequences for control of the ERV. Factory default settings shall be fully adjustable in the field. Available factory pre-programmed sequences on operations are:

2.7 SEQUENCE OF OPERATIONS

2.8 DDC CONTROLLER:

A. Controller with integral LCD readout for changing set points and monitoring unit operation.
B. Provided with required sensors and programming.
C. Factory programmed, mounted, and tested.
D. Integral USB and Ethernet ports for updating programs and retrieving log files.

2.9 BMS INTERFACE:

A. [BACnet MS/TP]
B. [BACnet IP]
C. [Modbus RTU]
D. [Modbus TCP]

2.10 GENERAL OPERATION

2.11 POWER UP:
A. When the unit main disconnect is closed a delay of 10 seconds (adjustable) occurs for the controller to come online.

2.12 ERV UNIT START COMMAND:
A. An input signal is required to enable the unit operation. The unit will be commanded on by:
   1. [Digital input]
   2. [BMS command]
   3. [Internal time clock]
   4. [Enable via controller display]
B. All types of input that are enabled must be true before the unit will start.
   1. The exhaust fan starts after a 3 second delay (adjustable). The exhaust fan will not start until the damper actuator end switch closes.
   2. The supply fan starts after a 6 second delay (adjustable). The supply fan will not start until the damper actuator end switch closes.
   3. The supply fan, exhaust fan, [economizer], [heating] are controlled based on the chosen unit operating modes and air conditions.

2.13 ERV UNIT STOP COMMAND (OR DE-ENERGIZED):
A. The unit can then be commanded off by:
   1. [Digital input]
   2. [BMS command]
   3. [Internal time clock]
   4. [Disable via controller display]
B. Supply fan and exhaust fan are de-energized.
C. All dampers are unpowered and spring return to their default position after a 10 second delay (adjustable).

2.14 SUPPLY FAN OPERATION:
A. [The supply fan will operate at a constant speed.]
B. [The supply fan speed will be controlled for:]  
   1. [Fixed percentage of max speed (0%-100%)]  
   2. [Supply air flow (CFM)]
   3. [Supply duct static pressure]
   4. [Room pressure]
   5. [IAQ (TVOC)]
   6. [Fixed CO2]
   7. [CO2 flow]
C. The unit will attempt to start the supply fan when the supply fan delay timer expires. When the supply fan starts the supply fan adjustable current switch should close and remain closed until the fan is turned off.
2.15 SUPPLY FAN STATUS:
   A. Once the supply fan current switch closes [heating] operation is allowed. After a delay of 90
      seconds (adjustable) from supply fan start signal, if the supply fan current switch is still open
      the supply fan alarm should be set to true and [heating] operation shall be prohibited. The
      supply fan status shall be set to true only when the supply fan output is on and supply fan
      current switch is closed. The supply fan status shall be false in all other circumstances.

2.16 FIXED FAN SPEED OPTION:
   A. The analog voltage command to the supply fan VFD can be set from the unit controller display
      [or by the BMS]. The adjustable range of 0% to 100% correspond to the minimum and
      maximum fan operating speed. This supply fan operation mode can be used to field balance
      the supply air flow rate.

2.17 SUPPLY AIR FLOW CONTROL OPTION:
   A. The controller will adjust the supply fan VFD command to maintain the supply air flow rate at a
      set point. The supply air flow rate set point is entered and adjusted from the unit controller
      display [or provided by the BMS]. The minimum and maximum values for supply air flow rate
      set point are unit dependent. An adjustable PI (proportional & integral) loop will compare the
      measured supply air flow to the air flow rate set point and adjust the fan speed. If the
      measured supply air flow rate varies from the desired air flow rate by more than 10%
      (adjustable) for more than 60 seconds (adjustable) a supply air flow rate alarm will be set to
      true. This supply fan operation mode can be used to provide a constant supply air flow rate as
      the unit filters become loaded.

2.18 SUPPLY DUCT STATIC PRESSURE CONTROL OPTION:
   A. The controller will adjust the supply fan VFD command to maintain the supply duct static
      pressure at a set point. The supply air duct static pressure set point is entered and adjusted from the unit controller
      display [or provided by the BMS]. The minimum and maximum values for supply air duct static pressure set point are unit dependent. An adjustable PI (proportional & integral) loop will compare the measured supply air duct static pressure to the static
      pressure set point and adjust the fan speed. If the measured static pressure varies from the desired static pressure by more than 0.05 inches water gauge (adjustable) for more than 60
      seconds (adjustable) a supply air static pressure alarm will be set to true. This supply fan
      operation mode can be used to provide a constant supply duct pressure for VAV systems.

2.19 ROOM STATIC PRESSURE CONTROL OPTION:
   A. The controller will adjust the supply fan VFD command to maintain the room static pressure at
      a set point. The room static pressure measurement is typically a differential pressure
      measurement between the room and an adjacent space or outdoors. The room static pressure
      set point is entered and adjusted from the unit controller display [or provided by the BMS]. An
      adjustable PI (proportional & integral) loop will compare the measured room static pressure to the
      static pressure set point and adjust the supply fan speed. If the measured static pressure varies from the desired static pressure by more than 0.05 inches water gauge (adjustable) for
      more than 60 seconds (adjustable) a supply air static pressure alarm will be set to true. This supply fan
      operation mode can be used to provide a constant static pressure in an area to
      control infiltration or exfiltration from an adjacent area or outdoors.

2.20 IAQ (TVOC) CONTROL OPTION:
   A. The controller will adjust the supply fan VFD command to maintain the room or return air VOC
      level at a set point. The VOC set point is entered and adjusted from the unit controller display
[or provided by the BMS]. An adjustable PI (proportional & integral) loop will compare the measured VOC level to the VOC set point and adjust the fan speed. The minimum and maximum fan speed commands are adjustable. If the measured VOC level exceeds 1000 ppm (CO2 equivalent, adjustable) for more than 60 seconds (adjustable) a VOC alarm will be set to true. This supply fan operation mode can be used to provide demand controlled ventilation of a space. The minimum fan speed will provide the required minimum outdoor air when the VOC level is at or below the VOC set point.

2.21 CO2 CONTROL OPTION:
A. The controller will adjust the supply fan VFD command to maintain the room or return air CO2 level at a set point. The CO2 set point is entered and adjusted from the unit controller display [or provided by the BMS]. An adjustable PI (proportional & integral) loop will compare the measured CO2 level to the CO2 set point and adjust the fan speed. The minimum and maximum fan speed commands are adjustable. If the measured CO2 level exceeds 1000 ppm (adjustable) for more than 60 seconds (adjustable) a CO2 alarm will be set to true. This supply fan operation mode can be used to provide demand controlled ventilation of a space. The minimum fan speed will provide the required minimum outdoor air when the CO2 level is at or below the CO2 set point.

2.22 CO2 FLOW CONTROL OPTION:
A. The controller will adjust the supply fan VFD command based on the measured room or return air CO2 level. The supply air flow set point is derived from the user entered minimum and maximum CO2 levels and minimum and maximum desired air flow rates. When the CO2 level is at or below the minimum CO2 level the air flow set point is at the minimum and when the CO2 level is at or above the maximum CO2 level the air flow set point is at the maximum. Between the minimum and maximum CO2 levels the air flow set point is linearly scaled. If the measured CO2 level exceeds 1000 ppm (adjustable) for more than 60 seconds (adjustable) a CO2 alarm will be set to true. This supply fan operation mode can be used to provide demand controlled ventilation of a space. The minimum fan speed will provide the required minimum outdoor air when the CO2 level is at or below the CO2 set point.

2.23 EXHAUST FAN OPERATION:
A. [The exhaust fan will operate at a constant speed.]
B. [The exhaust fan speed will be controlled for:]
   1. [Fixed percentage of max speed (0%-100%)]
   2. [Exhaust air flow (CFM)]
   3. [Supply fan command tracking]
   4. [Supply fan flow rate tracking]
   5. [Room static pressure]
C. The unit will attempt to start the exhaust fan when the exhaust fan delay timer expires. When the exhaust fan starts the exhaust fan adjustable current switch should close and remain closed until the fan is turned off.

2.24 EXHAUST FAN STATUS:
A. After a delay of 90 seconds (adjustable) from exhaust fan start signal, if exhaust fan current switch is still open the exhaust fan alarm should be set to true. The exhaust fan status shall be set to true only when the exhaust fan output is on and exhaust fan current switch is closed. The exhaust fan status shall be false in all other circumstances.
2.25 FIXED FAN SPEED OPTION:
   A. The analog voltage command to the exhaust fan VFD can be set from the unit controller display [or provided by the BMS]. The adjustable range of 0% to 100% correspond to the minimum and maximum fan operating speed (0 VDC minimum to 10 VDC maximum, adjustable). This exhaust fan operation mode can be used to field balance the exhaust air flow rate.

2.26 EXHAUST AIR FLOW CONTROL OPTION:
   A. The controller will adjust the exhaust fan VFD command to maintain the exhaust air flow rate at a set point. The exhaust air flow rate set point is entered and adjusted from the unit controller display [or provided by the BMS]. The minimum and maximum values for the exhaust air flow rate set point are unit dependent. An adjustable PI (proportional & integral) loop will compare the measured exhaust air flow to the air flow rate set point and adjust the fan speed. If the measured exhaust air flow rate varies from the desired air flow rate by more than 10% (adjustable) for more than 60 seconds (adjustable) an exhaust air flow rate alarm will be set to true. This exhaust fan operation mode can be used to provide a constant exhaust air flow rate as the unit filters become loaded.

2.27 SUPPLY FAN COMMAND TRACKING CONTROL OPTION:
   A. The controller will adjust the exhaust fan VFD command to track the supply fan command. The minimum (50%) and maximum (200%) tracking rates are adjustable. This exhaust fan operation mode can be used to maintain proportional supply and exhaust fan commands as the supply fan modulates.

2.28 SUPPLY FAN FLOW TRACKING CONTROL OPTION:
   A. The controller will adjust the exhaust fan VFD command to track the supply fan air flow rate. The offset from the supply air flow rate is adjustable from -25% to +25%. An adjustable PI (proportional & integral) loop will compare the measured exhaust air flow to the air flow rate set point and adjust the fan speed. If the measured exhaust air flow rate varies from the desired air flow rate by more than 10% (adjustable) for more than 60 seconds (adjustable) an exhaust air flow rate alarm will be set to true. This exhaust fan operation mode can be used to maintain proportional supply and exhaust air flows as the supply fan modulates and as the unit filters become loaded.

2.29 ROOM STATIC PRESSURE CONTROL OPTION:
   A. The controller will adjust the exhaust fan VFD command to maintain the room static pressure at a set point. The room static pressure measurement is typically a differential pressure measurement between the room and an adjacent space or outdoors. The room static pressure set point is entered and adjusted from the unit controller display [or provided by the BMS]. The minimum and maximum values for the exhaust fan speeds are adjustable. An adjustable PI (proportional & integral) loop will compare the measured room static pressure to the static pressure set point and adjust the exhaust fan speed. If the measured static pressure varies from the desired static pressure by more than 0.05 inches water gauge (adjustable) for more than 60 seconds (adjustable) an exhaust air static pressure alarm will be set to true. This exhaust fan operation mode can be used to provide a constant static pressure in an area to control infiltration or exfiltration from an adjacent area or outdoors.

2.30 ECONOMIZER (BYPASS) OPERATION:
   A. During normal operation the bypass damper shall remain closed and the face damper open to allow full energy recovery. During economizer operation the bypass damper will be open and
the face damper will close to bypass the core. The economizer state can be controlled by
temperature or enthalpy.

2.31 TEMPERATURE:
A. The economizer will be locked out when:
   1. The outside air temperature is less than the economizer adjustable low lockout.
   2. The outside air temperature is greater than the economizer adjustable high lockout.

2.32 ENTHALPY:
A. The economizer will be locked out when:
   1. The outside air enthalpy is greater than return air enthalpy.
   2. The outside air temperature is less than the economizer field adjustable low lockout.

2.33 HEATING OPERATION:
A. Heating will be locked out if the outdoor air temperature is above 70 degrees (adjustable). The
temperature set point can be configured as constant (adjustable) or can be reset by the
outside air temperature. Heating will be controlled using the supply air temperature or return air
temperature.

2.34 CONSTANT TEMPERATURE OPTION:
A. The controller will stage the heaters or adjust the 0 to 10 VDC analog output to the heating
device to maintain the air temperature at a set point. The air temperature set point is entered
and adjusted from the unit controller display [or provided by the BMS]. The minimum and
maximum values for the air temperature set point are unit dependent and are adjustable. An
adjustable PI (proportional & integral) loop will compare the measured air temperature to the
air temperature set point and adjust the analog output. A digital output that indicates a call for
heating will also be provided. The analog and digital output can be used to control a hot water
valve, electric heater, gas heater, or heat pump.

2.35 RESET AIR TEMPERATURE OPTION:
A. The controller will adjust the 0 to 10 VDC analog output to the heating device to maintain the
air temperature at a set point. The air temperature set point is calculated based on the outdoor
air temperature. The air set point is adjusted between the 100 degree F maximum (adjustable)
and the 70 degree F minimum (adjustable) as the measured temperature varies from the 20
degree F minimum (adjustable) to the 70 degree F maximum (adjustable). These values are
entered and adjusted from the unit controller display [or provided by the BMS]. An adjustable
PI (proportional & integral) loop will compare the measured supply air temperature to the
supply air temperature set point and adjust the 0 to 10 VDC analog output. A digital output that
indicates a call for heating will also be provided. The analog and digital output can be used to
control a hot water valve, electric heater, gas heater, or heat pump. Coil freeze protection must
be provided by others in the field.

2.36 2.7 FILTER SECTION
A. ERV shall have 2” thick [MERV 8][MERV 13] disposable pleated filters located in the outdoor
air and exhaust airstreams. All filters shall be accessible from the exterior of the unit.
PART 3 - EXECUTION

3.1 3.1 EXAMINATION
A. Prior to start of installation, examine area and conditions to verify correct location for compliance with installation tolerances and other conditions affecting unit performance. See unit IOM.
B. Examine roughing-in of plumbing, electrical and HVAC services to verify actual location and compliance with unit requirements. See unit IOM.
C. Proceed with installation only after all unsatisfactory conditions have been corrected.

3.2 3.2 INSTALLATION
A. Installation shall be accomplished in accordance with these written specifications, project drawings, manufacturer’s installation instructions as documented in manufacturer’s IOM, Best Practices and all applicable building codes.
B. Install unit with clearances for service and maintenance.

3.3 3.3 CONNECTIONS
A. In all cases, industry Best Practices shall be incorporated. Connections are to be made subject to the installation requirements shown above.
B. Duct installation and connection requirements are specified in Division 23 of this document.
C. Electrical installation requirements are specified in Division 26 of this document.

3.4 3.4 FIELD QUALITY CONTROL
A. Manufacturer’s Field Service: Engage a factory authorized service representative to inspect field assembled components and equipment installation, to include electrical and piping connections. Report results to A / E in writing. Inspection must include a complete startup checklist to include (as a minimum) the following: Completed Start-Up Checklists as found in manufacturer’s IOM. Insert any other requirements here.

3.5 3.5 START-UP SERVICE
A. Engage a factory authorized service representative to perform startup service. Clean entire unit, comb coil fins as necessary, and install clean filters. Verify water source for compliance with manufacturer’s requirements for flow and temperature. Measure and record electrical values for voltage and amperage. Refer to Division 23 “Testing, Adjusting and Balancing” and comply with provisions therein.

3.6 3.6 DEMONSTRATION AND TRAINING
A. Engage a factory authorized service representative to train owner’s maintenance personnel to adjust, operate and maintain the entire Make-Up Air unit. Refer to Division 01 Section Closeout Procedures and Demonstration and Training.

END OF SECTION
SECTION 23 81 29
VARIABLE REFRIGERANT FLOW HVAC SYSTEM

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

A. The variable capacity heat pump heat recovery air conditioning system shall be a Mitsubishi Electric CITY MULTI VRF (Variable Refrigerant Flow) zoning system.

B. The system shall consist of Hyper-Heat simultaneous heating and cooling outdoor units, BC (Branch Circuit) controllers, multiple indoor units, and M-NET DDC (Direct Digital Controls), per equipment schedules. Each indoor unit or group of indoor units shall be capable of operating in any mode independently of other indoor units or groups. System shall be capable of changing mode (cooling to heating, heating to cooling) with no interruption to system operation. To ensure Owner comfort, each indoor unit or group of indoor units shall be independently controlled and capable of changing mode automatically when zone temperature strays 1.8°F from setpoint for ten (10) minutes. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of outdoor rated capacity.

C. Basis of Design: Mitsubishi Electric

D. Alternate Manufacturer: Daikin, Trane

E. The basis of design system is a two-pipe system. If an alternate manufacturer is selected, any additional material, cost, and labor to install additional refrigerant lines, branch controllers, fittings, or other required components shall be incurred by the installing contractor. The installing contractor shall be responsible for additional costs incurred by other contractors and subcontractors as a result of installing an alternate manufacturer’s system. The installing contractor must provide complete drawings and documentation identifying all differences between the alternate manufacturer and the basis-of-design system, subject to Engineer’s approval. All costs associated with reviewing and approving these drawings and documentation shall be incurred by the installing contractor at the Engineer’s hourly rate.

F. This is a performance specification. Other manufacturers are named as acceptable in quality and services, providing the other named manufacturers comply fully with all construction details, scheduled performance requirements, and the full intent of these specifications. This does not necessarily mean that the other named manufacturers equipment will fit the available space or the dimensional or design requirements. It shall be the responsibility of this contractor to be sure that the system provided fully meets or exceeds the specified requirements, and should any changes or additional apparatus be required for other named manufacturers, this contractor shall be fully responsible for the material and installation cost, to complete the installation to comply fully with the systems as outlined in the plans and specifications.

G. The engineer shall determine compliance with the specification and whether or not the proposed manufacturer’s equipment is acceptable for bid submission. Any deviation from this procedure is not acceptable and shall disqualify the proposed manufacturer. Acceptance and approval of any proposed equipment by the engineer for bid submission shall not be interpreted to imply that the proposed equipment will fit the available space or the dimensional or design requirements. If acceptance of the proposed equipment is granted by the engineer, an addendum will be issued adding that manufacturer’s name. If not added by addendum, that manufacturer’s equipment shall not be allowed.

H. It shall be the responsibility of this contractor to be sure that the system provided fully meets all the specified requirements, and should any changes or additional apparatus be required, this contractor is fully responsible for the material and installation cost, and to complete the
installation to fully conform to the specifications. A request for a substitution shall constitute a representation that the contractor:

1. Has investigated the proposed product and determined that it is equal to or superior in all respects to that specified.
2. Will provide the same warranties or bonds for the substitution as for the product specified.
3. Will coordinate the installation of an accepted substitution in the work, and make such other changes in the work as may be required for installation to make the work complete and equal in all respects.
4. Will be responsible for all additional costs including all claims by associated trades, which may subsequently become apparent.
5. The engineer will review requests for substitutions with reasonable promptness, and notify the contractor, in writing, of the decision to accept or reject the requested substitution. The engineer may request additional information, such as local area installation sites, which can be visited, and names and phone numbers of prior users who can be contacted.

1.2 QUALITY ASSURANCE

A. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.
B. All wiring shall be in accordance with the National Electrical Code (NEC).
C. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001, which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
D. All units must meet or exceed the ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standards 340/360, 1230 and ISO Standard 13256-1.
E. Manufacturer shall have a minimum of ten (10) years of VRF experience in the U.S. market and must have a minimum of ten (10) installed heat recovery VRF systems within 25 miles of the project site. Alternate manufacturers must provide a reference list of ten (10) installed heat recovery systems within 25 miles of the project site, including Owner contact information.
F. At Owner and Engineer discretion, manufacturer shall provide factory witness testing to confirm unit operation and performance at conditions stated in this specification. Testing shall be provided in a controlled environment. Manufacturer shall cover all expenses associated with the factory witness testing.

1.3 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer’s recommendation.
B. A full charge of R-410A for the condensing unit only shall be provided in the condensing unit.

1.4 WARRANTY AND REQUIRED TRAINING

A. The entire system shall be covered by an extended manufacturer’s limited parts warranty for a period of ten (10) years from date of installation. In addition, the compressor shall have a manufacturer’s limited parts warranty for a period of ten (10) years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. A manufacturer’s written warranty statement must be provided prior to system approval.
B. The VRF system shall be installed by a contractor with extensive VRF installation and service training. The mandatory contractor service and install training must be performed by the manufacturer prior to submittal approval. Training must be a minimum of three (3) days at a manufacturer’s approved training facility with equipment present. The Contractor shall submit
a copy of successful training certification in compliance with these requirements. All travel and training expenses are the responsibility of the Contractor.

C. Manufacturer must provide startup assistance, controls-integration assistance, system commissioning assistance, and a minimum of eight (8) hours of Owner’s training.

D. Manufacturer must provide VRF service, maintenance, and diagnostic tool and all software for the owner and installing contractor. The tool shall allow service and maintenance personnel to monitor and record real-time operating data. The tool shall allow monitoring and recording of operating data by connecting at the control board of any VRF system component, indoor or outdoor.

PART 2 - PRODUCTS

2.1 HYPER-HEATING OUTDOOR UNIT

A. General:
   1. The outdoor units shall be used specifically with VRF components. The outdoor units shall be equipped with multiple circuit boards that interface to the VRF controls system and shall perform all functions necessary for operation. Each outdoor unit module shall be completely factory assembled, piped and wired, and run tested at the factory.
      a. All units requiring factory-supplied twinning kits shall be piped together in the field without the need for equalizing line(s). If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the Contractor.
      b. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of outdoor-rated capacity.
      c. Outdoor unit shall be capable of up to 150% connected capacity for future expansion.
      d. Outdoor unit shall have a sound rating no higher than 58 dB(A) individually or 61 dB(A) twinned. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the Contractor.
      e. Both refrigerant lines from the outdoor unit to the BC (Branch Circuit) controllers shall be insulated.
      f. Outdoor unit shall be able to connect to up to 50 indoor units depending upon model.
      g. The outdoor unit shall have an accumulator with refrigerant level sensors and controls.
      h. The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.
      i. The outdoor unit shall have the ability to operate with a maximum height difference of 164 ft. and have total refrigerant tubing length of 1,804 to 2,625 ft. The greatest length is not to exceed 541 ft. between outdoor unit and the indoor units without the need for line size changes or traps.
      j. The outdoor unit shall have rated performance of heating operation at -13°F ambient temperatures and cooling mode down to 23°F ambient temperatures, without additional low ambient controls. The unit shall maintain 100% heat output at 0°F and 85% heat output at -13°F without a supplemental heat source or a second compressor to boost low ambient heating performance. Systems shall be capable of providing indoor unit high fan speed supply air temperatures as indicated on the equipment schedules. If an alternate manufacturer is selected, any additional material, cost, and labor to meet low ambient operating condition and performance shall be incurred by the Contractor and subject to Owner and Engineer approval.
      k. The outdoor unit shall be capable of simultaneous cooling and heating operation down to -4°F.
l. The outdoor unit shut-off temperature shall be able to operate in heating mode down to outdoor temperature of -25°F.
m. The outdoor unit shall be provided with Intelligent Heat Mode in order to reduce power consumption and peak kW draw. During Intelligent Heat Mode compressor inverter driven speed will be at a reduced speed compared to maximum inverter thresholds. This will allow full load power input savings at low outdoor air temperatures. The user shall have the capability of switching between Intelligent Heat Mode and standard operation.
n. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.
o. The outdoor unit shall be provided with a manufacturer-supplied 20 gauge hot-dipped galvanized snow/hail guard and snow hood. The snow/hail guard and snow hood protect the outdoor coil surfaces from hail damage and snow build-up in severe climates.
p. Unit must defrost all circuits simultaneously in order to resume full heating more quickly. Partial defrost, which may extend "no or reduced heating" periods, shall not be allowed.
q. Manufacturer to provide minimum 24” high, open base support system similar to Quick-Sling Super Stand Model QSSS – or approved equal.

B. Outdoor Unit Sizing
1. The outdoor units must be sized to match the nominal heating and cooling capacities as scheduled and shall meet or exceed the scheduled performance values. Upsizing of the outdoor units, which will affect system performance and operation, shall not be acceptable.

C. Heat Interchanger Circuit:
1. The outdoor unit shall contain a heat interchanger circuit for sub-cooling liquid prior to entering the outdoor coil during the heating mode.
2. The interchanger shall be of a copper tube within a tube construction.
3. The interchanger circuit refrigerant flow shall be controlled by an electronic expansion valve.

D. Unit Cabinet:
1. The casing(s) shall be fabricated of galvanized steel, bonderized and finished.

E. Fan:
1. Each outdoor unit module shall be furnished with one (1) direct drive, variable speed propeller-type fan. The fan shall be factory set for operation under 0 in. WG external static pressure but capable of normal operation under a maximum of 0.24 in. WG external static pressure via dipswitch.
2. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
3. All fan motors shall be mounted for quiet operation.
4. All fans shall be provided with a raised guard to prevent contact with moving parts.
5. The outdoor unit shall have vertical discharge airflow.

F. Refrigerant:
1. R410A refrigerant shall be required.
2. Polyolester (POE) oil shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two (2) weeks prior to bidding.

G. Coil:
1. The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
2. The coil fins shall have a factory applied, corrosion resistant blue-fin finish.
3. The coil shall be protected with an integral metal guard.
4. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter-driven compressor.
5. The outdoor coil shall include four (4) circuits with two-position valves for each circuit, except for the last stage.

H. Basepan Heater:
1. Each outdoor unit module shall be equipped with a basepan heater. Basepan heater shall activate only when compressor is operating in heating mode at an outdoor ambient temperature of 39°F or below. If an alternate manufacturer is selected, any additional material, cost, and labor to meet basepan heater condition and performance shall be incurred by the Contractor.
2. Basepan heaters shall be installed in the unit base pan, on both the inside and outside of the outdoor unit heat exchanger coil.
3. The basepan heater must be an electric resistance type heater forming solid contact with the unit basepan and shall operate independently of the unit’s refrigeration circuit.

I. Compressor:
1. Each outdoor unit module shall be equipped with one (1) inverter-driven scroll hermetic compressor. Non-inverter-driven compressors, which cause inrush current (demand charges) and require larger wire sizing, shall not be allowed.
2. A crankcase heater(s) shall be factory mounted on the compressor(s).
3. The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable with a turndown of 6% of rated capacity.
4. The compressor will be equipped with an internal thermal overload.
5. The compressor shall be mounted to avoid the transmission of vibration.
6. Field-installed oil equalization lines between modules are not allowed. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.

J. Controls:
1. The outdoor unit shall have the capability of up to eight (8) levels of demand control for each refrigerant system.

K. Electrical:
1. The outdoor unit electrical power shall be as scheduled.
2. The outdoor unit shall be controlled by integral microprocessors.
3. The control circuit between the indoor units, BC Controller and the outdoor unit shall be 24VDC completed using a two-conductor, twisted-pair shielded cable to provide total integration of the system.

2.2 BRANCH CONTROLLERS (BRANCH DEVICES)

A. General:
1. The branch controller shall include multiple branches to allow simultaneous heating and cooling by allowing either hot gas refrigerant to flow to indoor unit(s) for heating or sub-cooled liquid refrigerant to flow to indoor unit(s) for cooling.
2. The units shall be equipped with a circuit board that interfaces to the controls system and shall perform all functions necessary for operation. The unit shall have a galvanized steel finish. The branch controllers shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory. The units shall be mounted indoors, with access and service clearance provided for each controller.
3. Each branch device, regardless of manufacturer, must be installed in the designated areas as indicated on the project drawings. Installation of branch devices outside of these areas is not allowed.
4. Each branch device shall include a minimum of three (3) unused branch for future use. If the manufacturer does not offer spare branches, three (3) additional branch devices must
be provided and installed for each refrigeration system. Branches shall be fully installed and wired in designated areas with capped service shutoff valve and service port.

5. Each port on the branch devices shall be provided with a ball valve.

B. Unit Cabinet:
1. The casing shall be fabricated of galvanized steel.
2. Each cabinet shall house a liquid-gas separator, multiple refrigeration control valves, and tube-in-tube heat exchanger(s).

C. Refrigerant Valves:
1. The unit shall be furnished with multiple two-position refrigerant valves.
2. When connecting a 54,000 BTU/h or larger indoor unit section, two (2) branch circuits shall be joined together at the branch controller to deliver an appropriate amount of refrigerant. The two (2) refrigerant valves shall operate simultaneously.
3. Linear electronic expansion valves shall be used to control the variable refrigerant flow.

D. Integral Drain Pan:
1. An integral condensate pan and drain connection shall be provided.

E. Electrical:
1. The unit electrical power shall be 208/230 volts, one-phase, 60 Hz.
2. The unit shall be capable of satisfactory operation within voltage limits of 187 to 228 volts (208V/60 Hz) or 207-253V (230V/60 Hz).
3. The unit shall be controlled by integral microprocessors.

2.3 FOUR-WAY CEILING-RECESSED CASSETTE WITH GRILLE INDOOR UNIT (LARGE)

A. General:
1. The unit shall be a four-way cassette style indoor unit that recesses into the ceiling with a ceiling grille. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, three (3) minute time delay mechanism, an auto restart function, an emergency operation function, a test run switch, and the ability to adjust airflow patterns for different ceiling heights. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

B. Unit Cabinet:
1. The cabinet shall be space-saving ceiling-recessed cassette.
2. The cabinet panel shall have provisions for a field-installed, filtered outside air intake.
3. Branch ducting shall be allowed from cabinet.
4. Four-way grille shall be fixed to bottom of cabinet allowing two, three or four-way blow.
5. The grille vane angles shall be individually adjustable from the wired remote controller to customize the airflow pattern for the conditioned space.

C. Fan:
1. The indoor fan shall be an assembly with a turbo fan direct driven by a single motor.
2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
3. The indoor fan shall consist of five (5) speed settings, Low, Mid1, Mid2, High and Auto.
4. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller setpoint and space temperature.
5. The indoor unit shall have an adjustable air outlet system offering four-way airflow, three-way airflow, or two-way airflow.
6. The indoor unit shall have switches that can be set to provide optimum airflow based on ceiling height and number of outlets used.
7. The indoor unit vanes shall have five (5) fixed positions and a swing feature that shall be capable of automatically swinging the vanes up and down for uniform air distribution.
8. The vanes shall have an Auto-Wave selectable option in the heating mode that shall randomly cycle the vanes up and down to evenly heat the space.

D. Filter:
1. Return air shall be filtered by means of a long-life washable filter.

E. Coil:
1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.
6. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water 33 in. above the condensate pan.
7. Both refrigerant lines to the indoor units shall be insulated.

F. Electrical:
1. The unit electrical power shall be 208/230 volts, one-phase, 60 Hz.
2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60 Hz) or 207-253 volts (230V/60 Hz).

G. Controls:
1. This unit shall use controls provided by Mitsubishi Electric to perform necessary to operate the system.
2. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in heat mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
3. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F to 9.0°F adjustable deadband from setpoint.
4. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
5. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

2.4 ONE-WAY CEILING-RECESSED CASSETTE WITH GRILLE INDOOR UNIT (SMALL)

A. General:
1. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

B. Unit Cabinet:
1. The cabinet shall be space-saving ceiling recessed.
2. The cabinet panel shall have provisions for a field installed filtered outside air intake.
3. Branch ducting shall be allowed from cabinet.
4. The one-way grille shall be fixed to bottom of cabinet allowing for one-way airflow

C. Fan:
1. The indoor fan shall be an assembly with one line-flow fan direct driven by a single motor.
2. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
3. The indoor fan shall consist of four (4) speeds, Low, Mid1, Mid2, and High.
D. Filter:
1. Return air shall be filtered by means of a long-life washable permanent filter.

E. Coil:
1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
2. The tubing shall have inner grooves for high efficiency heat exchange.
3. All tube joints shall be brazed with phos-copper or silver alloy.
4. The coils shall be pressure tested at the factory.
5. A condensate pan and drain shall be provided under the coil.
6. The unit shall be provided with an integral condensate lift mechanism able to raise drain water 23 inches above the condensate pan.
7. Both refrigerant lines to the PMFY indoor units shall be insulated in accordance with the installation manual.

F. Electrical:
1. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
2. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

G. Controls:
1. This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.
2. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
3. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
4. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
5. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

PART 3 - CONTROLS

3.1 OVERVIEW
A. General:
1. The CITY MULTI Controls Network (CMCN) shall be capable of supporting remote controllers, centralized controllers, an integrated web-based interface, graphical user workstation, and system integration to Building Management Systems via BACnet.

3.2 ELECTRICAL CHARACTERISTICS
A. General:
1. The CMCN shall operate at 30VDC. Controller power and communications shall be via a common non-polar communications bus.

B. Wiring:
1. Control wiring shall be installed in a daisy-chain configuration from indoor unit to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control
wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.

2. Control wiring for the Smart ME remote controller shall be from the remote controller to the first associated indoor unit (TB-5) M-NET connection. The Smart ME remote controller shall be assigned an M-NET address.

3. Control wiring for the Simple MA remote controllers shall be from the remote controller (receiver) to the first associated indoor unit (TB-15) then to the remaining associated indoor units (TB-15) in a daisy-chain configuration.

4. Control wiring for centralized controllers shall be installed in a daisy-chain configuration from outdoor unit to outdoor unit, to the system controllers (centralized controllers and/or integrated web-based interface), to the power supply.

5. The centralized controller shall be capable of being networked with other centralized controllers.

C. Wiring Type:
   1. Wiring shall be two-conductor (#16 AWG), twisted, stranded, shielded wire as defined by the Diamond System Builder output.
   2. Network wiring shall be CAT-5 with RJ-45 connection.

3.3 REMOTE CONTROLLER

A. Remote Controller (Non-Programmable)
   1. The Backlit Simple MA Remote Controller shall be capable of controlling up to 16 indoor units (defined as one (1) group). The Backlit Simple MA Remote Controller shall be compact in size, approximately 3 in. x 5 in. and have limited user functionality. The Backlit Simple MA supports temperature display selection of Fahrenheit or Celsius. The Backlit Simple MA Remote Controller shall allow the user to change on/off, mode (cool, heat, auto, dry, setback (R2/WR2-Series only) and fan), temperature setting, and fan speed setting and airflow direction. The Backlit Simple MA Remote Controller shall be able to limit the set temperature range from the Backlit Simple MA. The Backlit Simple MA Remote controller shall be capable of night setback control with upper and lower set temperature settings. The room temperature shall be sensed at either the Backlit Simple MA Remote Controller or the Indoor Unit dependent on the indoor unit dipswitch setting. The Backlit Simple MA Remote Controller shall display a four-digit error code in the event of system abnormality/error. The Backlit Simple MA Remote Controller shall be capable of up to two (2) remote controllers per group. The Backlit Simple MA Remote Controller shall require no addressing. The Backlit Simple MA Remote Controller shall connect using two-wire, stranded, non-polar control wire to the connection terminal on the indoor unit. The Simple MA Remote Controller shall require cross-over wiring for grouping across indoor units.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Operation</th>
<th>Display</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON/OFF</td>
<td>Run and stop operation for a single group</td>
<td>Each</td>
<td>Each</td>
</tr>
<tr>
<td>Operation Mode</td>
<td>Switches between Cool/Drying/Auto/Fan/Heat/Setback.</td>
<td>Each</td>
<td>Each</td>
</tr>
<tr>
<td></td>
<td>Operation modes vary depending on the air conditioner unit.</td>
<td>Group</td>
<td>Group</td>
</tr>
<tr>
<td>Temperature Setting</td>
<td>Sets the temperature from 40°F to 95°F depending on operation mode and indoor unit. Separate COOL and HEAT mode setpoints available depending on central controller and connected mechanical equipment.</td>
<td>Each</td>
<td>Each</td>
</tr>
<tr>
<td>Fan Speed Setting</td>
<td>Available fan speed settings depending on indoor unit.</td>
<td>Each</td>
<td>Each</td>
</tr>
<tr>
<td>Airflow Direction Setting</td>
<td>Airflow direction settings vary depending on the indoor unit model.</td>
<td>Each</td>
<td>Each</td>
</tr>
</tbody>
</table>

VARIABLE REFRIGERANT FLOW HVAC SYSTEM
Section 23 81 29 Page 9
### Permit / Prohibit

Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter).

<table>
<thead>
<tr>
<th>Permit / Prohibit Local Operation</th>
<th>Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter).</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>Each Group</td>
</tr>
</tbody>
</table>

*1: Centrally Controlled is displayed on the remote controller for prohibited functions.

### Display

Measures and displays the intake temperature of the indoor unit when the indoor unit is operating.

<table>
<thead>
<tr>
<th>Display</th>
<th>N/A Each Group</th>
</tr>
</thead>
</table>

### Indoor Unit Intake Temp Display

Pressing the button lights up a backlight. The light automatically turns off after a certain period of time. (The brightness settings can be selected from Bright, Dark, and Light off.)

<table>
<thead>
<tr>
<th>Display</th>
<th>N/A Each Unit</th>
</tr>
</thead>
</table>

### Error

When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed.

<table>
<thead>
<tr>
<th>Error</th>
<th>N/A Each Unit</th>
</tr>
</thead>
</table>

### Test Run

Operates air conditioner units in test run mode.

<table>
<thead>
<tr>
<th>Test Run</th>
<th>Each Group</th>
</tr>
</thead>
</table>

*2: The display for test run mode will be the same as for normal start/stop (does not display “test run”).

### Ventilation Equipment

Up to 16 indoor units can be connected to an interlocked system that has one (1) LOSSNAY unit.

<table>
<thead>
<tr>
<th>Ventilation Equipment</th>
<th>N/A Each Group</th>
</tr>
</thead>
</table>

### Set Temperature Range Limit

Setting temperature range limit for cooling, heating, or auto mode.

<table>
<thead>
<tr>
<th>Temperature Range Limit</th>
<th>Group Group</th>
</tr>
</thead>
</table>

### B. Touch-Screen Central Controller (Non-Web)

1. The TC-24 Touch Controller features a 5 inch wide color LCD touch panel. The settings for air conditioning units can be changed by touching the corresponding icons on the display. There are 3 buttons on the panel of TC-24; ON/OFF, SET BACK and HOLD enabling simple and quick batch operation. One TC-24 can control up to 24 groups/units of air conditioners. Operation status is displayed on easy-to-read LCD. The group currently operating can be seen at a glance with the operation status display. TC-24 can perform functions such as ON/OFF, Operation mode changeover, temperature setting and prohibit operation by local remote controller. Up to 12 patterns of weekly schedule can be set. "ON/OFF", "Operation mode", "Set Temperature", "Fan speed", "Air flow direction" and "Permit / Prohibit local operation" can be scheduled with up to 16 settings in one pattern. Up to 5 patterns of today’s schedule can be set. Independent LOSSNAY operation is possible. Automatic ventilation, Normal ventilation and Ventilation with heat exchanger can be switched from the system controller. TC-24 is equipped with a system changeover function which an operation mode can be switched to an optimal mode depending on indoor temperature setting and target temperature of each group or a representative indoor unit.

#### TC-24 (Touch Controller)

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Operation</th>
<th>Display</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON/OFF</td>
<td>ON and OFF operation for the air conditioner units. Even when only a single indoor unit connected to the group remote controller will operate and collective ON/OFF lamp will light up.</td>
<td>Group or Collective</td>
<td>Group or Collective</td>
</tr>
<tr>
<td>Operation Mode</td>
<td>Switches between Cool / Dry / Auto / Fan / Heat / Setback. Operation modes vary depending on the air conditioner unit. Auto mode is for CITY MULTI R2 and WR2 series only.</td>
<td>Group or Collective</td>
<td>Group or Collective</td>
</tr>
</tbody>
</table>
### Temperature Setting
- Set temperature from 57° F - 87° F depending on operation mode and indoor unit.
- Separate COOL and HEAT mode set points available depending on remote controller and connected mechanical equipment.

### Fan Speed Setting
- Available fan speed settings depending on indoor unit.

### Air Flow Direction Setting
- Air flow direction angles 4-angle or 5-angle, Swing, Auto Louver ON/OFF
- *Air flow direction settings vary depending on the indoor unit model.*

### Hold
- Prohibits the scheduled operation from being executed.
  - a. ON/OFF timer
  - b. Auto-OFF timer
  - c. Weekly timer
  - d. Automatic return to the preset temperature
- *While an operation is prohibited by Hold function, the operation icon lights up.*

### Permit / Prohibit
- When set as the master, the ON/OFF, operation mode, setting temperature and filter sign reset operations using the local remote controllers can be prohibited.
- Only ON/OFF and filter reset can be prohibited for the LOSSNAY group.

### Operation Lock
- (ON/OFF, operation mode, setting temperature, fan speed, Air flow direction)

### Room Temperature Display
- The room temperature can be displayed.

### Error
- When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed.
- *When an error occurs, the "ON/OFF" LED flashes. The operation monitor screen show abnormal icon over the unit. The error monitor screen shows the abnormal unit address, error code and source of detection. The error log monitor screen shows the time and date, the abnormal unit address, error code and source of detection.*

### Schedule Operation
- Weekly schedule setting up to 12 patterns is available. In one pattern, up to 16 setting of "ON/OFF", "Operation mode", "Set Temperature", "Fan speed", "Air flow direction" and "Permit / Prohibit local operation" can be scheduled. Today's schedule setting up to 5 pattern is available.
- *Time setting unit: 5 minute /unit*

### Ventilation Operation (Independent)
- Group operation of only the free plan LOSSNAY is possible. The operation mode of these groups is automatic ventilation, ventilation with heat exchanger and normal ventilation.

### Ventilation Operation (Interlocked) Set Temperature Range Limit
- The LOSSNAY will run in interlock with the operation of indoor unit. The mode cannot be changed. The LED will turn ON during operation after interlocking.
- The range of room temperature setting can be limited by the initial setting. The lowest limit temperature can be made higher than the usual (67°F) in cool/dry mode, while the upper limit temperature lower than the usual (83°F) in heat mode.
External Input / Output

By using accessory cables you can set and monitor the following.

Input
By level: “Batch start/stop”, “Batch emergency stop”
By pulse: “batch start/stop”, “Enable/disable remote controller”
Output: “start/stop”, “error/Normal”

*5: Requires the external I/O cables (PAC-YG10HA-E) sold separately.

C. Touch-Screen Centralized Controller (Web-enabled):
1. The Centralized Controller shall be capable of controlling a maximum of 50 indoor units across multiple outdoor units. The Centralized Controller shall be approximately 8-1/2 in. x 10 in. in size and shall be powered from the external power supply. Multiple centralized controllers shall be provided as indicated on the drawings for future system expansion. The Centralized Controller shall support system configuration, daily/weekly scheduling, monitoring of operation status, night setback settings, free contact interlock configuration and malfunction monitoring. The Centralized Controller shall have five (5) basic operation controls which can be applied to an individual indoor unit, a group of indoor units (up to 50 indoor units), or all indoor units (collective batch operation). This basic set of operation controls for the Centralized Controller shall include on/off, operation mode selection (cool, heat, auto, dry, setback and fan), temperature setting, fan speed setting, and airflow direction setting. Since the controller provides centralized control it shall be able to enable or disable operation of local remote controllers. In terms of scheduling, the Centralized Controller shall allow the user to define both daily and weekly schedules with operations consisting of ON/OFF, mode selection, temperature setting, airflow (vane) direction, fan speed, and permit/prohibit of remote controllers.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
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</tr>
</thead>
<tbody>
<tr>
<td>ON/OFF</td>
<td>Run and stop operation.</td>
<td>Each Block, Group or Collective</td>
<td>Each</td>
</tr>
<tr>
<td>Operation Mode</td>
<td>Indoor unit modes:</td>
<td>Each Block, Group or Collective</td>
<td>Each</td>
</tr>
<tr>
<td>Temperature Setting</td>
<td>Sets the temperature from 40°F to 95°F depending</td>
<td>Group or Collective</td>
<td>Group</td>
</tr>
<tr>
<td></td>
<td>on operation mode and indoor unit model.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Separate COOL and HEAT mode setpoints available</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>depending on remote controller and connected</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>mechanical equipment.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set Temperature Range Limit</td>
<td>The range of room temperature setting can be limited by the initial setting depending on the indoor unit connected.</td>
<td>Each Group</td>
<td>Each Group</td>
</tr>
<tr>
<td>Fan Speed Setting</td>
<td>Available fan speed settings depend on indoor unit model.</td>
<td>Each Block, Group or Collective</td>
<td>Each Group</td>
</tr>
<tr>
<td>Air Flow Direction Setting</td>
<td>*Airflow direction settings vary depending on the indoor unit model.</td>
<td>*1 Each Block, Group or Collective</td>
<td>Each Group</td>
</tr>
<tr>
<td></td>
<td>*1. Louver cannot be set.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Schedule</strong></td>
<td>Annual/weekly/today schedule can be set for each group of air conditioning units. Optimized start setting is also available.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Operation</strong></td>
<td>*2. The system follows either the current day, annual schedule, or weekly, which are in the descending order of overriding priority. Twenty-four (24) events can scheduled per day, including ON/OFF, Mode, Temperature Setting, Air Direction, Fan Speed and Operation Prohibition. Five (5) types of weekly schedule (seasonal) can be set. Settable items depend on the functions that a given air conditioning unit supports.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **Hold** | Disables scheduled functions for indoor unit groups and their associated remote controller timers. |
| **Optimized Start** | Unit starts 5 to 60 minutes before the scheduled time based on the operation data history in order to reach the scheduled temperature at the scheduled time. |
| **Night Setback Setting** | The function helps keep the indoor temperature in the temperature range while the units are stopped and during the time this function is effective. |
| **Permit / Prohibit Local Operation** | Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Fan Speed, Air Direction and Reset filter). |
| **Room Temp** | Displays the room temperature of the group. |
| **Room Humidity** | Displays the percent relative humidity in the space as sensed by the Smart ME Remote Controller |
| **Occupancy Sensor** | Displays the occupancy icon on the group icon in the condition list page when the room is occupied (blue) or vacant (gray). |
| **Brightness Sensor** | Displays the brightness icon on the group icon in the condition list when the space is determined to be bright (yellow) or dark (gray). |
| **Error** | When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed. |

*2 Each Block, Group or Collective  
*3 Each Block, Group or Collective  
*4 Each Unit or Collective
Ventilation Equipment

This interlocked system settings can be performed by the master system controller. When setting the interlocked system, use the ventilation switch the free plan LOSSNAY settings between "Hi", "Low" and "Stop".

When setting a group of only free plan LOSSNAY units, you can switch between "Normal ventilation", "Interchange ventilation" and "Automatic ventilation".

Multiple Language

Other than English, the following language can be chosen. Spanish, French, Japanese, German, Italian, Russian, Chinese, and Portuguese are available.

External Input / Output

By using accessory cables you can set and monitor the following.

Input: By level: "Batch start/stop", "Batch emergency stop"; By pulse: "batch start/stop", "Enable/disable remote controller".

Output: "start/stop", "error/Normal"

*5. Requires the external I/O cables (PAC-YG10HA-E)

M-NET

The "M-NET" LED lights, when AC power supply is turned ON. The LED blinks while M-NET is communicating.

Collective ON/OFF Measurement

All the units can be operated/stopped with a dipswitch.

AHC Status

Displays the status of the of the inputs and outputs of each Advanced HVAC Controller (DC-A2IO)

Free Contact Status

Displays the input/output status of the Free Contacts on the indoor units

Free Contact Interlock

Operation of indoor groups, general equipment or free contact outputs based on group(s) conditions or free contact(s) input states.

Data Back-up (PC)

Initial setting data can be exported to a PC.

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2. All Centralized Controllers shall be equipped with one (1) RJ-45 Ethernet port to support interconnection with a network PC via a closed/direct Local Area Network (LAN). The Centralized Controller shall be capable of performing initial settings via a PC using the Centralized Controller's initial setting browser.

3. Standard software functions shall be available so that the building manager can securely log into each centralized controller via the PC's web browser to support operation monitoring, scheduling, error email, interlocking and online maintenance diagnostics. Standard software functions shall not expire. Additional optional software functions of personal browser for PCs and MACs and Tenant Billing shall be available.

3.4 BUILDING MANAGEMENT SYSTEM INTEGRATION

A. The interface shall be compliant with BACnet Protocol (ANSI/ASHRAE 135-2004) and be Certified by the (BTL) BACnet Testing Laboratories. The BACnet interface shall support BACnet Broadcast Management (BBMD). Operation and monitoring points include, but are not limited to, on/off, operation mode, fan speed, prohibit remote controller, filter sign reset, alarm state, error code, and error address.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Radiant heating hydronic piping.

1.2 RELATED REQUIREMENTS
A. Section 08 31 00 - Access Doors and Panels.
B. Section 23 07 16 - HVAC Equipment Insulation.
C. Section 23 07 19 - HVAC Piping Insulation.
D. Section 23 09 13 - Instrumentation and Control Devices for HVAC.
E. Section 23 09 93 - Sequence of Operations for HVAC Controls.
F. Section 23 21 13 - Hydronic Piping.
G. Section 23 21 14 - Hydronic Specialties.

1.3 REFERENCE STANDARDS

1.4 ADMINISTRATIVE REQUIREMENTS
A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.
1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Manufacturer's Installation Instructions: Indicate installation instructions and recommendations.

C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions of equipment and controls, installation instructions, maintenance and repair data, and parts listings.

D. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

E. Maintenance Data:
   1. Include repair methods and parts list of components.
   2. See Section 01 60 00 - Product Requirements, for additional provisions.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

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

C. Copies of Documents at Project Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.7 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.1 RADIANT-HEATING HYDRONIC PIPING

A. Applications:
   1. Provide the following types of hydronic, radiant heating piping for the applications described:
      a. Piping in Interior Reinforced Concrete Floors: EPDM.
      b. Piping in Level Fill Concrete Floors (Not Reinforced): EPDM.

B. Crosslinked Polyethylene (PEX) Pipe and Fittings:
   1. Pipe Material: PEX plastic according to ASTM F876.
   2. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.000044 grains per cu ft/day at 104 degrees F according to DIN 4726.
   3. Fittings: ASTM F1807, metal insert and copper crimp rings.
   4. Pressure/Temperature Rating: Minimum 100 psig and 180 degrees F.

C. Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX/AL/PEX) Pipe and Fittings:
   1. Pipe Material: PEX plastic bonded to the inside and outside of a welded aluminum tube according to ASTM F1281.
   2. Oxygen Barrier: Limit oxygen diffusion through the pipe to maximum 0.0000436996 grains per cu ft/day at 104 degrees F according to DIN 4726.
3. Fittings: ASTM F1974, metal insert fittings with split ring and compression nut (compression joint) or metal insert fittings with copper crimp rings (crimp joint).

4. Flame Spread and Smoke Developed Indexes: 25 and 50 or less, respectively, when tested in accordance with ASTM E84.

5. Pressure/Temperature Rating: Minimum 100 psig and 210 degrees F.

D. Distribution Manifolds (Manufacturer’s Standard):
1. Manifold: Minimum 1 inch, brass, copper, stainless steel, or __________.
2. Main Shutoff Valves:
   a. Factory installed on supply and return connections.
   b. Two-piece brass, bronze, or _______ body.
   c. Ball: Chrome-plated bronze.
   d. Seals: PTFE.
   e. CWP Rating: 150 psig.
   f. Maximum Operating Temperature: 225 degrees F.

3. Manual Air Vents:
   a. Body to consist of bronze, brass, or ______.
   b. Internal Parts: Nonferrous.
   c. Operator: Key furnished with valve or screwdriver bit.
   d. Inlet Connection: 1/2 inch.
   e. Discharge Connection: 1/8 inch.
   f. CWP Rating: 150 psig.
   g. Maximum Operating Temperature: 225 degrees F.

4. Balancing Valves:
   a. Body: Provide plastic, bronze, or ______, plug, globe, or ______ cartridge type.
   b. Plug: EPDM.
   d. Seat: PTFE.
   e. Visual Flow Indicator: Flowmeter with visible indication in a clear plastic cap at top of valve.
   f. Differential Pressure Gage Connections: Integral seals for portable meter to measure loss across calibrated orifice.
   g. Handle Style: Knob, with memory stop to retain set position if used for shutoff.
   h. CWP Rating: Minimum 125 psig.
   i. Maximum Operating Temperature: 250 degrees F.

5. Zone Control Valves:
   a. Body: Provide brass, bronze, or ______, plug, globe, or ______ cartridge type.
   b. Plug: EPDM.
   d. Seat: PTFE.
   e. Actuator: Replaceable electric motor.
   f. CWP Rating: Minimum 125 psig.
   g. Maximum Operating Temperature: 250 degrees F.

6. Thermometers:
   a. Mounted on supply and return connections.
   b. Case: Dry type, metal or plastic, 2 inch diameter.
   c. Element: Bi-metallic coil.
   d. Movement: Mechanical, connecting element and pointer.
   e. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.
   f. Pointer: Black metal.
   g. Window: Plastic.
   h. Connector: Rigid, back type.
   i. Thermal System: Bi-metallic coil.
   j. Accuracy: Plus or minus 1 percent of range, 1 scale division, or __________ to maximum of 1.5 percent of range.
7. Mounting Brackets: Provide copper, plastic, rubber-clad steel, or ____________, where in contact with manifold.

PART 3 EXECUTION

3.1 EXAMINATION

A. Hydronic Radiant Heating Piping:
   1. Examine surfaces and substrates to receive radiant heating piping for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
      a. Ensure that surfaces and pipes in contact with radiant heating piping are free of burrs and sharp protrusions.
      b. Ensure that surfaces and substrates are level and plumb.
   2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean all surfaces prior to installation.

3.3 INSTALLATION

A. Install in accordance with manufacturer's recommendations.

B. Hydronic Radiant Heating Piping:
   1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
   2. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
   3. Install piping as indicated unless deviations to layout are approved on shop drawings or coordination drawings.
   4. Install radiant heating piping continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels.
   5. Connect radiant piping to manifold in a reverse-return arrangement.
   6. Do not bend pipes in radius smaller than manufacturer's minimum bend radius dimension.
   7. Install manifolds accessible locations, or install access panels to provide maintenance access as required in Section 08 31 00.
   8. Comply with requirements in Sections 23 21 13 and 23 21 14 for pipes and connections to hydronic systems and for glycol-solution fill requirements.
   9. Fire and Smoke Barrier Penetrations:
      a. Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations.
      b. Seal pipe penetrations with firestop materials according to Section 07 84 00.
   10. Piping in Interior Reinforced Concrete Floors:
      a. Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.
      b. Space cable ties a maximum of 18 inches and at center of turns or bends.
      c. Maintain 2 inch minimum cover.
      d. Install a sleeve of 3/8 inch thick, foam type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints.
         1) Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
   11. Piping in Level Fill Concrete Floors (Not Reinforced):
a. Secure piping in concrete floors by attaching pipes to subfloor using tracks, clamps, or staples.
b. Space tracks, clamps, or staples a maximum of 18 inches o.c. and at center turn of bends.
c. Maintain 3/4 inch minimum cover.
d. Install a sleeve of 3/8 inch thick, foam type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints.
   1) Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
e. Maintain minimum 40 psig pressure in piping during the concrete pour and continue for 24 hours during curing.

12. Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of piping and as approved by Architect.
13. After system balancing has been completed, mark balancing valves to permanently indicate final position.
14. Perform the following adjustments before operating the system:
   a. Open valves to fully open position.
   b. Check operation of automatic valves.
   c. Set temperature controls so all zones call for full flow.
   d. Purge air from piping.

3.4 FIELD QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Provide manufacturer's field representative to test, inspect, instruct, and observe.
C. Hydronic Radiant Heating Piping
   1. Prepare radiant heating piping for testing as follows:
      a. Open all isolation valves and close bypass valves.
      b. Open and verify operation of zone control valves.
      c. Flush with clean water and clean strainers.
   2. Perform the following tests and inspections with the assistance of a factory authorized service representative:
      a. Leak Test:
         1) After installation, charge system and test for leaks.
         2) Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 100 psig.
         3) Repair leaks and retest until no leaks exist.
      b. Test and adjust controls and safeties.
      c. Replace damaged and malfunctioning controls and equipment.
   3. Prepare test and inspection reports.
   4. Protect hydronic piping system from damage during construction.

3.5 CLOSEOUT ACTIVITIES
A. See Section 01 78 00 - Closeout Submittals.
B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

3.6 PROTECTION
A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. General requirements applicable to all components and systems included in Electric Work Prime Contract
   B. Products Installed but Not Furnished Under This Section
   C. Make all electrical connections to equipment shown on Drawings and furnished by other Prime Contractors. Obtain approved wiring diagrams and location drawings for roughing in and final connections from Prime Contractor furnishing equipment. Provide disconnect switches, push button stations, and similar components, required but not furnished with equipment as shown on Drawings.

1.2 RELATED REQUIREMENTS
   A. Section 01 30 00 - Administrative Requirements:
   B. Section 01 70 00 - Execution and Closeout Requirements: Additional requirements for alterations work.
   C. Section 08 31 00 - Access Doors and Panels

1.3 REFERENCES
   A. AIA American Institute of Architects
   B. AISC American Institute of Steel Construction
   C. ANSI American National Standards Institute
   D. ASTM American Society of Testing Materials
   E. IEEE Institute of Electric and Electronic Engineers
   F. IES Illuminating Engineering Society
   G. NBFU National Board of Fire Underwriters
   H. NEC National Electric Code
   I. NEMA National Electrical Manufacturers' Association
   J. NETA International Electrical Testing Association
   K. NFPA National Fire Protection Association
   L. UL Underwriters' Laboratories, Inc.

1.4 SYSTEM DESCRIPTIONS
   A. Design Requirements - Provide complete systems, properly tested, balanced, and ready for operation including necessary details, items and accessories although not expressly shown or specified, including (but not limited to):
      1. All wiring and conduit for work specified in Project Manual and shown on Drawings.
2. All electrical devices and equipment for work specified in Project Manual and shown on Drawings.

B. Systems included, but not limited to:
   1. Electrical Distribution
   2. Electrical Connections
   3. Electric Layouts: Arrange all panels, disconnect switches, enclosed breakers, equipment, raceways, and similar components neatly, orderly and symmetrically. Provide 3/4-inch plywood backboards for all surface mounted panels, disconnect switches, enclosed breakers, and similar equipment. Arrangements shown on Drawings are diagrammatic only; provide and adjust raceways, wiring, and other components as required.
   4. Power Interruptions and Scheduled Outages: Coordinate scheduling of all power interruptions and outages with Owner. EC shall confirm with Owner prior to interruption of power, which building systems are considered critical and must remain operational during the interruption. If a scheduled power outage is to extend beyond one standard workday, EC shall provide temporary power to operate critical building systems (including, but not limited to fire alarm system, security system, building access control system, and building energy management control system).

1.5 QUALITY ASSURANCE
   A. Codes and Standards: Comply with all applicable Federal, State and Local Building and Electrical Codes, Laws, Ordinances, and Regulations, and comply with all applicable NFPA, National Electrical Code and Utility Company requirements and regulations. Provide Underwriter's Laboratory Seal on all materials.
   B. Permits and Inspections: Obtain all approvals, tests, and inspections required by Architect, Engineer, Local Electrical Inspector, agent or agency specified in Project Manual, or National, State, or Local Codes and Ordinances.
   C. Schedule electrical inspection by an agency acceptable to the local authority having jurisdiction and submit final inspection certificate to Architect.
   D. Furnish all materials and labor necessary for tests and pay all costs associated with tests and inspections.
   E. Conduct all tests under load for load balancing and where required by Codes, Regulations, Ordinances, or Technical Specification.
   F. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Take all reasonable precautions to store materials and products to protect finishes and not permit dust and dirt to penetrate equipment.
   B. Replace all equipment damaged beyond reasonable repair as required by Architect.
   C. Refinish any equipment with marks, stains, scratches, dents, etc., as required by Architect.

1.7 COORDINATION OF WORK
   A. New Construction
      1. Openings, Chases, Recesses, Sleeves, Lintels and Bucks (required for admission of Electric Work Prime Contract systems and components): Coordinate requirements with General Work Prime Contractor for inclusion in General Work Prime Contract. Furnish all necessary information (e.g. locations and sizes) to General Work Prime Contractor in
ample time for installation of systems and components included in Electric Work Prime Contract.

2. Anchor Bolts: Deliver to General Work Prime Contractor all anchor bolts required for Electric Work Prime Contract construction that are to be installed in construction included in General Work Prime Contract.

3. Locate settings, check locations as installation in General Work Prime Contract progresses, and provide templates or holding fixtures as required to maintain proper accuracy.

B. Existing Construction: Unless otherwise specified, employ General Work Prime Contractor for all cutting, patching, repairing and replacing of general work required for installation of systems and components included in Electric Work Prime Contract. Secure approval before cutting.

1. Anchor Bolts: Deliver to General Work Prime Contractor all anchor bolts required for Electric Work Prime Contract construction that are to be installed in construction included in General Work Prime Contract. Provide templates or holding fixtures as required to maintain proper accuracy.

2. Rough Openings in Roofs: Refer to SECTION 01 70 00 - Execution and Closeout Requirements.

3. Access Doors: Provide and install all access doors shown on Drawings or required for access to pull boxes, junction boxes, relays and all other electrical devices requiring periodic inspection, adjustment or maintenance, where located above or within inaccessible walls or ceilings, and including cutting and patching of adjacent walls and ceilings to match existing materials and finishes.

4. Refer to SECTION 08 31 00 - Access Doors and panels for material and installation requirements for access doors provided and installed as part of Electric Work Prime Contract.

1.8 ALTERATION PROCEDURES

A. In locations where existing light fixtures with PCB containing ballasts are to be disconnected and removed all removals and disposal shall be in strict accordance with Section 01 35 17 - Alteration Project Procedures, and SECTION 01 74 19 - Waste Management plan; Landfill diversion proposals; Waste Disposal Reports shall be done as part of Electrical Work Prime Contract.

B. In locations where existing non-TCLP compliant fluorescent lamps are to be removed, all removals and disposal shall be in strict accordance with SECTION 01 35 17 - Alteration Project Procedures, and SECTION 01 74 19 - Waste Management plan; Landfill diversion proposals; Waste Disposal Reports shall be done as part of Electrical Work Prime Contract.

C. In locations where existing devices are indicated to be disconnected and removed and existing circuit is not scheduled to be reused:

1. Remove circuit conductors back to source.

2. Modify panel directory for that circuit.

3. Remove all existing exposed and accessible conduit

4. Provide blank cover plate over existing recessed junction boxes or back boxes. Paint cover plates in finished areas to match existing room finish.

5. Patch and paint existing walls where disturbed by the electrical demolition. Refer to SECTION 01 35 17 - Alteration Project Procedures for additional requirements for patching and painting.

D. In locations where existing devices are to remain in place, ensure circuits feeding such devices remain operational. Modify existing circuits as required to allow new construction to occur and to maintain all necessary circuitry to existing devices.

E. In locations where entire existing system is being removed or modified:

1. Refer to individual system specification sections for Documentation and Testing Requirements prior to any alteration work on any system.
2. Take all necessary measures to ensure that down time will not compromise safety
3. Notify Owner, Architect and all other Prime Contractors not less than 2 weeks prior to interruptions in service.
4. Coordinate work schedule to minimize duration of system outage during hours when building is occupied.
5. Refer to SECTION 01 30 00 - Administrative Requirements for additional information and requirements.

1.9 SUBMITTALS
A. Comply with requirements of SECTION 01 30 00 - Submittal Procedures and as modified below. Refer to submittal listing in each section for specific items required.

B. Shop Drawings

C. Electric Layouts: Submit detailed drawings showing exact sizes and locations for approval before beginning work.

D. Samples

E. Factory-Finished Surfaces: On all submittals, indicate standard factory color. Where more than one color is available, selection made by Architect from manufacturer's full range of colors.

F. Contract Closeout Submittals: Comply with requirements of SECTION 01 78 00, including submission of operating and maintenance instructions as item in "Electric Work Instructions" manual described in that section.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 CUTTING AND PATCHING
A. Furnish and install all sleeves, inserts, panels, raceways, boxes, etc., ahead of general construction work and maintain Contractor personnel at Site during installation of general construction work to be responsible for and to maintain these items in position.

B. Unless otherwise noted elsewhere in Contract Documents, bear expense of all cutting, patching, repairing or replacing of work of other trades made necessary by any fault, error or tardiness on part of Electrical Work Prime Contract or damage done by Electric Work Prime Contract. Employ and pay Prime Contractor whose work is involved.

C. Do not cut waterproofed floors or walls for admission of any equipment or materials and do not pierce any structural members without written permission.

3.2 DEMONSTRATION OF COMPLETE ELECTRICAL SYSTEMS
A. Thoroughly demonstrate and instruct Owner's designated representative in care and operation of all electrical systems and equipment furnished and installed in Electric Work Prime Contract.

B. System Operator: Maintain competent operator at building for at least 2 days in 2 consecutive weeks after Owner takes occupancy of major parts of building to operate systems and equipment in presence of Owner's representative.
C. Factory Representative: In addition to demonstration and instruction specified above, provide technically qualified factory representatives from manufacturers of major equipment, to train Owner’s representatives in care and operation of applicable products as specified in applicable technical sections of Division 26.

D. Coordinate and schedule time and place of all training through the Architect at the Owner’s convenience.

E. Submit letters attesting to satisfactory completion of all instructions, including date of completion of instruction, names of persons in attendance and signature of Owner’s authorized representative.

F. Architect's representative must be present when Owner’s representatives participate in instruction.

G. The following equipment and systems are included:
   1. Emergency generator
   2. Stage lighting and control system
   3. Fire alarm system
   4. Clock and program system
   5. Sound systems
   6. Computer network systems
   7. Telephone system
   8. Security system
   9. Lightning Protection System

3.3 CLEANING AND REPAIR
   A. Clean and repair existing materials and equipment that remain or that are to be reused.
   B. Provide full inspection of exposed finishes.
   C. Remove burrs, dirt, and construction debris.
   D. Repair damaged surfaces including chips, scratches, and abrasions. Damp Rag clean all electrical equipment, panels, boxes, and accessories.

END OF SECTION
SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES
A. Single conductor building wire.
B. Metal-clad cable.
C. Wire and cable for 600 volts and less.
D. Wiring connectors.
E. Electrical tape.
F. Wire pulling lubricant.
G. Cable ties.

1.2 RELATED REQUIREMENTS
A. Section 07 84 00 - Firestopping.
B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS
F. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
G. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); 2012.
I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
M. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
N. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.

O. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

1.4 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.1 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

C. Concealed Dry Interior Locations: Use only building wire in raceway, building wire with Type THHN/THWN insulation in raceway, or metal clad cable.

D. Exposed Dry Interior Locations: Use only building wire in raceway or building wire with Type THHN/THWN insulation in raceway.

E. Above Accessible Ceilings: Use only building wire in raceway, building wire with Type THHN/THWN insulation in raceway, or metal clad cable.

F. Wet or Damp Interior Locations: Use only building wire with Type THHN/THWN insulation in raceway.

G. Exterior Locations: Use only building wire with Type THHN/THWN insulation in raceway.

H. Underground Installations: Use only building wire with Type THHN/THWN insulation in raceway.

I. Use solid or stranded conductor for feeders and branch circuits 10 AWG and smaller.

J. Use stranded conductors for control circuits.

K. Use conductor not smaller than 12 AWG for power and lighting circuits.

L. Use conductor not smaller than 16 AWG for control circuits.

M. Use 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet.

N. Use 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 feet.

O. Conductor sizes are based on copper. Aluminum conductors shall not be used.

2.2 CONDUCTOR AND CABLE MANUFACTURERS


D. Substitutions: See Section 01 60 00 - Product Requirements.
2.3 CONDUCTOR AND CABLE GENERAL REQUIREMENTS
   A. Provide products that comply with requirements of NFPA 70.
   B. Provide products listed, classified, and labeled as suitable for the purpose intended.
   C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
   D. Comply with NEMA WC 70.
   E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
   F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
   G. Conductor Material:
      1. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
      2. Tinned Copper Conductors: Comply with ASTM B33.
   H. Conductor Color Coding:
      1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
      2. Color Coding Method: Integrally colored insulation.
      3. Color Code:

2.4 SINGLE CONDUCTOR BUILDING WIRE
   A. Description: Single conductor insulated wire.
   B. Conductor Stranding:
      1. Feeders and Branch Circuits:
         b. Size 8 AWG and Larger: Stranded.
   C. Insulation Voltage Rating: 600 V.
   D. Insulation:
      1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
   E. Conductor: Copper.
   F. Insulation Voltage Rating: 600 volts.
   G. Insulation: NFPA 70, Type THHN/THWN.

2.5 METAL-CLAD CABLE
   A. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.
   B. Conductor Stranding:
      2. Size 8 AWG and Larger: Stranded.
   C. Insulation Voltage Rating: 600 V.
   D. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.
   E. Grounding: Full-size integral equipment grounding conductor.
F. Armor: Steel, interlocked tape.
G. Description: NFPA 70, Type MC.
H. Conductor: Copper.
I. Insulation Voltage Rating: 600 volts.
J. Insulation Temperature Rating: 75 degrees C.
K. Insulation Material: Thermoplastic.
L. Armor Material: Steel.
M. Armor Design: Interlocked metal tape.

2.6 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

2.7 WIRING ACCESSORIES

A. Electrical Tape:
   1. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.

B. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.

C. Cable Ties: Material and tensile strength rating suitable for application.

D. Split Bolt Connectors:

E. Solderless Pressure Connectors:

F. Spring Wire Connectors:

G. Compression Connectors:

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that interior of building has been protected from weather.
B. Verify that work likely to damage wire and cable has been completed.
C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
D. Verify that raceway installation is complete and supported.
E. Verify that field measurements are as shown on the drawings.
F. Verify that conditions are satisfactory for installation prior to starting work.
3.2 PREPARATION
   A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.3 INSTALLATION
   A. Install products in accordance with manufacturer's instructions.
   B. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1.
   C. Install metal-clad cable (Type MC) in accordance with NECA 120.
   D. Installation in Raceway:
      1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
      2. Pull all conductors and cables together into raceway at same time.
      3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
      4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
   E. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
   F. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
   G. Terminate cables using suitable fittings.
      1. Metal-Clad Cable (Type MC):
         a. Use listed fittings.
         b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
   H. Install conductors with a minimum of 12 inches of slack at each outlet.
   I. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
   J. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
   K. Make wiring connections using specified wiring connectors.
      1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
      2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
      3. Do not remove conductor strands to facilitate insertion into connector.
      4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
   L. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
   M. Insulate ends of spare conductors using vinyl insulating electrical tape.
N. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

O. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

P. Install wire and cable securely, in a neat and workmanlike manner, as specified in NECA 1.

Q. Route wire and cable as required to meet project conditions.
   1. Wire and cable routing indicated is approximate unless dimensioned.
   2. Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.
   3. Include wire and cable of lengths required to install connected devices within 10 ft of location shown.

R. Use wiring methods indicated.

S. Pull all conductors into raceway at same time.

T. Use suitable wire pulling lubricant for building wire 4 AWG and larger.

U. Protect exposed cable from damage.

V. Support cables above accessible ceiling, using spring metal clips or metal or plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.

W. Use suitable cable fittings and connectors.

X. Neatly train and lace wiring inside boxes, equipment, and panelboards.

Y. Clean conductor surfaces before installing lugs and connectors.

Z. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

AA. Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.

AB. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.

AC. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

AD. Identify and color code wire and cable under provisions of Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Grounding and bonding requirements.
B. Conductors for grounding and bonding.
C. Connectors for grounding and bonding.
D. Grounding and bonding components.
E. Provide all components necessary to complete the grounding system(s) consisting of:
   1. Metal underground water pipe.
   2. Metal frame of the building.
   3. Rod electrodes.

1.2 RELATED REQUIREMENTS
A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS
A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
C. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.4 PERFORMANCE REQUIREMENTS
A. Grounding System Resistance: 5 ohms.

1.5 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
B. Product Data: Provide for grounding electrodes and connections.
C. Test Reports: Indicate overall resistance to ground and resistance of each electrode.
D. Project Record Documents: Record actual locations of components and grounding electrodes.
E. Certificate of Compliance: Indicate approval of installation by authority having jurisdiction.

1.6 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
PART 2  PRODUCTS

2.1  GROUNDING AND BONDING REQUIREMENTS

A. Do not use products for applications other than as permitted by NFPA 70 and product listing.

B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.2  GROUNDING AND BONDING COMPONENTS

A. General Requirements:
   1. Provide products listed, classified, and labeled as suitable for the purpose intended.
   2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:
   1. Use insulated copper conductors unless otherwise indicated.
      a. Exceptions:
         1) Use bare copper conductors where installed underground in direct contact with earth.
         2) Use bare copper conductors where directly encased in concrete (not in raceway).

C. Connectors for Grounding and Bonding:
   1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
   2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
   3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.

2.3  ELECTRODES

A. Rod Electrodes: Copper.
   2. Length: 10 feet.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

2.4  CONNECTORS AND ACCESSORIES

A. Mechanical Connectors: Bronze.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Exothermic Connections:
   1. Product: _________ manufactured by Cadweld, Copperweld, Erico.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

C. Wire: Stranded copper.
D. Grounding Electrode Conductor: Size to meet NFPA 70 requirements.

PART 3 EXECUTION

3.1 EXAMINATION
A. Verify that work likely to damage grounding and bonding system components has been completed.
B. Verify that field measurements are as shown on the drawings.
C. Verify that conditions are satisfactory for installation prior to starting work.
D. Verify existing conditions prior to beginning work.
E. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 INSTALLATION
A. Install products in accordance with manufacturer's instructions.
B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.
C. Make grounding and bonding connections using specified connectors.
   1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
   2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
   3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
   4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
   5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
D. Identify grounding and bonding system components in accordance with Section 26 05 53.
E. Install ground electrodes at locations indicated. Install additional rod electrodes as required to achieve specified resistance to ground.
F. Provide grounding electrode conductor.
G. Provide bonding to meet requirements described in Quality Assurance.
H. Bond together metal siding not attached to grounded structure; bond to ground.
I. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Flexible metal conduit (FMC).
   B. Liquidtight flexible metal conduit (LFMC).
   C. Electrical metallic tubing (EMT).
   D. Rigid polyvinyl chloride (PVC) conduit.
   E. Conduit fittings.
   F. Conduit, fittings and conduit bodies.

1.2 RELATED REQUIREMENTS
   A. Section 07 84 00 - Firestopping.
   B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
   D. Section 26 05 53 - Identification for Electrical Systems.
   E. Section 26 05 37 - Boxes.

1.3 REFERENCE STANDARDS
   A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2005.
   B. ANSI C80.3 - American National Standard for Steel Electrical Metallic Tubing (EMT); 2005.
   C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
   D. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.
   E. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2003.
   F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.
   G. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; 2005.
   H. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2013.
   I. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2015.
   J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
   K. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
   L. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.
   M. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
N. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

O. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

1.4 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
B. Product Data: Provide for metallic conduit, flexible metal conduit, liquidtight flexible metal conduit, metallic tubing, nonmetallic conduit, nonmetallic tubing, fittings, and conduit bodies.

1.5 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.
C. Materials and equipment shall be listed and labeled by a nationally recognized testing laboratory such as UL. Work shall be preformed in accordance with NFPA 70 and be inspected by a local Authority Having Jurisdiction (AHJ). Contractor shall provide certificate of inspection prior to final payment request.

PART 2 PRODUCTS

2.1 CONDUIT REQUIREMENTS
A. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
B. Provide products listed, classified, and labeled as suitable for the purpose intended.
C. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.2 METAL CONDUIT
A. Manufacturers:
B. Rigid Steel Conduit: ANSI C80.1.
C. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.3 FLEXIBLE METAL CONDUIT (FMC)
A. Manufacturers:
   1. AFC Cable Systems, Inc; ______: www.afcweb.com.
B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.
C. Fittings:
1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.

D. Description: Interlocked steel construction.

E. Fittings: NEMA FB 1.

2.4 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Manufacturers:
   1. AFC Cable Systems, Inc; _____: www.afcweb.com.

B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

C. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.

D. Description: Interlocked steel construction with PVC jacket.

E. Fittings: NEMA FB 1.

2.5 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:

B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

C. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.
   3. Connectors and Couplings: Use compression (gland) or set-screw type.
      a. Do not use indenter type connectors and couplings.

D. Description: ANSI C80.3; galvanized tubing.

E. Fittings and Conduit Bodies: NEMA FB 1; steel set screw type.

2.6 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Manufacturers:

B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

C. Fittings:
   1. Manufacturer: Same as manufacturer of conduit to be connected.
   2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.
3. Cantex
4. Carlon
5. Picoma

D. Description: NEMA TC 2; Schedule 40 PVC.
E. Fittings and Conduit Bodies: NEMA TC 3.

PART 3 EXECUTION

3.1 EXAMINATION
A. Verify that field measurements are as shown on drawings.
B. Verify that mounting surfaces are ready to receive conduits.
C. Verify that conditions are satisfactory for installation prior to starting work.
D. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

3.2 INSTALLATION
A. Install products in accordance with manufacturer's instructions.
B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.
C. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
D. Conduit Support:
   1. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
   2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
E. Connections and Terminations:
   1. Use suitable adapters where required to transition from one type of conduit to another.
   2. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
   3. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
   4. Secure joints and connections to provide maximum mechanical strength and electrical continuity.
F. Penetrations:
   1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
   2. Make penetrations perpendicular to surfaces unless otherwise indicated.
   3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
   4. Conceal bends for conduit risers emerging above ground.
   5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
   6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
   7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and
maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.

8. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

G. Provide grounding and bonding in accordance with Section 26 05 26.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
C. Wall and ceiling outlet boxes.
D. Pull and junction boxes.

1.2 RELATED REQUIREMENTS
A. Section 07 84 00 - Firestopping.
B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
C. Section 26 27 26 - Wiring Devices:
   1. Wall plates.
D. Section 26 27 16 - Electrical Cabinets and Enclosures.
E. Section 26 27 26 - Wiring Devices: Wall plates in finished areas.

1.3 REFERENCE STANDARDS
A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.
D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.
E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
J. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

1.4 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
PART 2 PRODUCTS

2.1 BOXES

A. General Requirements:
   1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
   2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
   3. Provide products listed, classified, and labeled as suitable for the purpose intended.
   4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
   5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
   1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
   2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
   3. Use suitable concrete type boxes where flush-mounted in concrete.
   4. Use suitable masonry type boxes where flush-mounted in masonry walls.
   5. Use raised covers suitable for the type of wall construction and device configuration where required.
   6. Use shallow boxes where required by the type of wall construction.
   7. Do not use "through-wall" boxes designed for access from both sides of wall.
   8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
   9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
   10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
   1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
   2. NEMA 250 Environment Type, Unless Otherwise Indicated:
   3. Junction and Pull Boxes Larger Than 100 cubic inches:
      a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

2.2 MANUFACTURERS

A. Appleton Electric; Model ______: www.appletonelec.com.
B. Raeco/Hubbell
C. Steel City/Thomas&Betts

2.3 OUTLET BOXES

A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch male fixture studs where required.

B. Cast Boxes: NEMA FB 1, Type FD, cast ferroloy. Provide gasketed cover by box manufacturer. Provide threaded hubs.

C. Wall Plates for Finished Areas: As specified in Section 26 27 26.

2.4 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.

B. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
   1. Material: Galvanized cast iron.

PART 3 EXECUTION

3.1 INSTALLATION

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

B. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Box Supports:
   1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
   2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.

E. Install boxes plumb and level.

F. Flush-Mounted Boxes:
   1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
   2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
   3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.

G. Install boxes as required to preserve insulation integrity.

H. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

I. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

J. Close unused box openings.
K. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

L. Provide grounding and bonding in accordance with Section 26 05 26.

M. Install boxes securely, in a neat and workmanlike manner, as specified in NECA 1.

N. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and as required by NFPA 70.

O. Coordinate installation of outlet boxes for equipment connected under Section 26 27 17.

P. Set wall mounted boxes at elevations to accommodate mounting heights indicated.

Q. Electrical boxes are shown on Drawings in approximate locations unless dimensioned.  
   1. Adjust box locations up to 10 feet if required to accommodate intended purpose.

R. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.

S. Maintain headroom and present neat mechanical appearance.

T. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

U. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

V. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

W. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

X. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.

Y. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

Z. Use flush mounting outlet box in finished areas.

AA. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only.  
   Coordinate masonry cutting to achieve neat opening.

AB. Provide separate boxes for emergency power and normal power systems.

AC. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.

AD. Locate outlet boxes so that wall plates do not span different building finishes.

AE. Locate outlet boxes so that wall plates do not cross masonry joints.

AF. Do not install flush mounting box back-to-back in walls; provide minimum 6 inches separation.

AG. Secure flush mounting box to interior wall and partition studs.  Accurately position to allow for surface finish thickness.

AH. Use stamped steel bridges to fasten flush mounting outlet box between studs.

AI. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

AJ. Use adjustable steel channel fasteners for hung ceiling outlet box.

AK. Do not fasten boxes to ceiling support wires.

AL. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.

AM. Use gang box where more than one device is mounted together. Do not use sectional box.
AN. Use gang box with plaster ring for single device outlets.
AO. Use cast outlet box in exterior locations exposed to the weather and wet locations.

3.2 ADJUSTING

A. Adjust flush-mounting outlets to make front flush with finished wall material.
B. Install knockout closures in unused box openings.

3.3 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

END OF SECTION
SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES
A. Identification nameplates and labels.
B. Wire and cable markers.
C. Underground warning tape.
D. Warning signs and labels.
E. Field-painted identification of conduit.

1.2 RELATED REQUIREMENTS
A. Section 09 91 23 - Interior Painting.

1.3 REFERENCE STANDARDS
D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
B. Product Data: Provide catalog data for nameplates, labels, and markers.

1.5 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.1 IDENTIFICATION APPLICATIONS
A. Buried Electrical Lines: Underground warning tapes.
B. Communication Cabinets: Nameplates.
C. Control Device Station: Labels.
D. Electrical Distribution and Control Equipment Enclosures: Nameplates.
E. Junction Box Load Connections: Wire markers.
F. Outlet Box Load Connections: Wire markers.
H. Pull Box Load Connections: Wire markers.

2.2 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:
   1. Materials:
   2. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:
   1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
   2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Manufacturers:

D. Nameplates: Engraved three-layer laminated plastic, black letters on white background.

E. Plastic: Conform to ASTM D 709.

F. Letter Size:
   1. Use 1/4 inch letters for identifying grouped equipment and loads.

G. Labels: Embossed adhesive tape, with 3/16 inch white letters on black background. Use only for identification of individual wall switches and receptacles, control device stations, and ________.

2.3 WIRE AND CABLE MARKERS

A. Manufacturers:

B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

D. Legend: Power source and circuit number or other designation indicated.

E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.

F. Minimum Text Height: 1/8 inch.

G. Color: Black text on white background unless otherwise indicated.

H. Description: Vinyl cloth type self-adhesive wire markers.

I. Color: Black on white.

J. Legend:
   1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.
2.4 UNDERGROUND WARNING TAPE

A. Manufacturers:

B. Materials: Use non-detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

C. Non-detectable Type Tape: 6 inches wide, with minimum thickness of 4 mil.

D. Legend: Type of service, continuously repeated over full length of tape.

E. Color:

2.5 WARNING SIGNS AND LABELS

A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

B. Warning Signs:
   1. Materials:
   2. Minimum Size: 7 by 10 inches unless otherwise indicated.

C. Warning Labels:
   1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
   3. Minimum Size: 2 by 4 inches unless otherwise indicated.

D. Description: 3 inch wide polyethylene tape, detectable type colored yellow with suitable warning legend describing buried electrical lines.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

B. Degrease and clean surfaces to receive nameplates and labels.

3.2 INSTALLATION

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

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
   3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
   4. Elevated Equipment: Legible from the floor or working platform.
   5. Interior Components: Legible from the point of access.
   6. Conductors and Cables: Legible from the point of access.

C. Install identification products centered, level, and parallel with lines of item being identified.
D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.

END OF SECTION
PART 1  GENERAL

1.1 SECTION INCLUDES
A. Occupancy sensors.

1.2 RELATED REQUIREMENTS
A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
C. Section 26 05 37 - Boxes.
D. Section 26 27 26 - Wiring Devices: Devices for manual control of lighting, including wall switches, wall dimmers, and fan speed controllers.
E. Section 26 51 00 - Interior Lighting.

1.3 REFERENCE STANDARDS
A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate the placement of wall switch occupancy sensors with actual installed door swings.
   3. Coordinate the placement of occupancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
   4. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
   1. Occupancy Sensors: Include detailed motion detection coverage range diagrams.
C. Shop Drawings:
   1. Occupancy Sensors: Provide lighting plan indicating location, model number, and orientation of each occupancy sensor and associated system component.
D. Field Quality Control Reports.
1.6 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.

1.7 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide five year manufacturer warranty for all occupancy sensors.

PART 2  PRODUCTS

2.1 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS
   A. Provide products listed, classified, and labeled as suitable for the purpose intended.
   B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.

2.2 OCCUPANCY SENSORS
   A. Manufacturers:
      1. Hubbell Building Automation, Inc; __________:  www.hubbellautomation.com
      4. Substitutions:  See Section 01 60 00 - Product Requirements.
      5. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.
   B. All Occupancy Sensors:
      1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
      2. Sensor Technology:
         a. Passive Infrared (PIR) Occupancy Sensors: Designed to detect occupancy by sensing movement of thermal energy between zones.
         b. Passive Infrared/Ultrasonic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and ultrasonic technologies.
         c. Passive Infrared/Acoustic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and audible sound sensing technologies.
      3. Provide LED to visually indicate motion detection __________.
      4. Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.
      5. Dual Technology Occupancy Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
      6. Passive Infrared Lens Field of View: Field customizable by addition of factory masking material, adjustment of integral blinders, or similar means to block motion detection in selected areas.
      7. Turn-Off Delay: Field adjustable, with time delay settings up to 30 minutes.
      8. Compatibility (Non-Dimming Sensors): Suitable for controlling incandescent lighting, low-voltage lighting with electronic and magnetic transformers, fluorescent lighting with
electronic and magnetic ballasts, and fractional motor loads, with no minimum load requirements.

9. Load Rating for Line Voltage Occupancy Sensors: As required to control the load indicated on the drawings.

10. Isolated Relay for Low Voltage Occupancy Sensors: SPDT dry contacts, ratings as required for interface with system indicated.

C. Wall Switch Occupancy Sensors:

1. All Wall Switch Occupancy Sensors:
   a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
   b. Unless otherwise indicated or required to control the load indicated on the drawings, provide line voltage units with self-contained relay.
   c. Occupancy sensor to be field selectable as either manual-on/automatic-off or automatic on/off.
   d. Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
   e. Finish: Match finishes specified for wiring devices in Section 26 27 26, unless otherwise indicated.

   a. Products:
      1) Similar to Wattstopper WS-200.

D. Ceiling Mounted Occupancy Sensors:

1. All Ceiling Mounted Occupancy Sensors:
   a. Description: Low profile occupancy sensors designed for ceiling installation.
   b. Unless otherwise indicated or required to control the load indicated on the drawings, provide low voltage units, for use with separate compatible accessory power packs.
   c. Occupancy sensor to be field selectable as either manual-on/automatic-off or automatic on/off.
   d. Finish: White unless otherwise indicated.

2. Passive Infrared/Ultrasonic Dual Technology Ceiling Mounted Occupancy Sensors:
   a. Standard Range Sensors: Capable of detecting motion within an area of 1000 at a mounting height of 9 feet, with a field of view of 360 degrees.
      1) Products:
         (a) Similar to Wattstopper DT-300.
         (b) Substitutions: See Section 01 60 00 - Product Requirements.

E. Power Packs for Low Voltage Occupancy Sensors:

1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage occupancy sensors for switching of line voltage loads.

2. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on the drawings.

3. Input Supply Voltage: Dual rated for 120/277 V ac.

4. Load Rating:
   a. Fluorescent Load: Not less than 20 A.
PART 3  EXECUTION

3.1  EXAMINATION
   A. Verify that field measurements are as shown on the drawings.
   B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
   C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.
   D. Verify that final surface finishes are complete, including painting.
   E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.
   F. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.
   G. Verify that conditions are satisfactory for installation prior to starting work.

3.2  PREPARATION
   A. Provide extension rings to bring outlet boxes flush with finished surface.
   B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3  INSTALLATION
   A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
   B. Perform work in a neat and workmanlike manner in accordance with NECA 1, including mounting heights specified in that standard unless otherwise indicated
   C. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of lighting control devices provided under this section.
   D. Install lighting control devices in accordance with manufacturer's instructions.
   E. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
   F. Install lighting control devices plumb and level, and held securely in place.
   G. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 26 27 26.
   H. Provide required supports in accordance with Section 26 05 29.
   I. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
   J. Occupancy Sensor Locations:
1. Location Adjustments: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for complete coverage of respective room or area based on manufacturer’s recommendations for installed devices.

2. Locate ultrasonic and dual technology passive infrared/ultrasonic occupancy sensors a minimum of 4 feet from air supply ducts or other sources of heavy air flow and as per manufacturer’s recommendations, in order to minimize false triggers.

K. Unless otherwise indicated, install power packs for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near the sensor location.

L. Where indicated, install separate compatible wall switches for manual control interface with lighting control devices or associated power packs.

M. Unless otherwise indicated, install switches on load side of power packs so that switch does not turn off power pack.

3.4 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect each lighting control device for damage and defects.

C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.

D. Correct wiring deficiencies and replace damaged or defective lighting control devices.

3.5 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Architect.

C. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.

3.6 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION
PART 2 PRODUCTS

1.1 ELECTRICAL SERVICE REQUIREMENTS

A. Provide new electrical service consisting of all required conduits, conductors, equipment, metering provisions, supports, accessories, etc. as necessary for connection between Utility Company point of supply and service entrance equipment.

B. Products Furnished by Contractor: Comply with Utility Company requirements.

END OF SECTION
SECTION 26 24 16
PANELBOARDS

PART 1  GENERAL

1.1  SECTION INCLUDES
   A.  Power distribution panelboards.
   B.  Lighting and appliance panelboards.
   C.  Overcurrent protective devices for panelboards.

1.2  RELATED REQUIREMENTS
   A.  Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   B.  Section 26 05 29 - Hangers and Supports for Electrical Systems.
   C.  Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3  REFERENCE STANDARDS
   A.  FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; Federal Specification; Revision E, 2013.
   B.  NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
   C.  NECA 407 - Standard for Installing and Maintaining Panelboards; 2009.
   D.  NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
   E.  NEMA PB 1 - Panelboards; 2011.
   F.  NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less; 2013.
   H.  NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
   I.  UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
   K.  UL 67 - Panelboards; Current Edition, Including All Revisions.

1.4  SUBMITTALS
   A.  See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

C. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.

D. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Panelboard Keys: Two of each different key.

1.5 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.1 MANUFACTURERS


B. Schneider Electric; Square D Products; www.schneider-electric.us.

C. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 PANELBOARDS - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet.
   2. Ambient Temperature:
      a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

C. Short Circuit Current Rating:

D. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

E. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

F. Bussing: Sized in accordance with UL 67 temperature rise requirements.
   1. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.

G. Conductor Terminations: Suitable for use with the conductors to be installed.

H. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   2. Boxes: Galvanized steel unless otherwise indicated.
a. Provide wiring gutters sized to accommodate the conductors to be installed.

3. Fronts:
   a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
   b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.

4. Lockable Doors: All locks keyed alike unless otherwise indicated.

I. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

2.3 POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
   1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
   2. Main and Neutral Lug Type: Mechanical.

C. Bussing:
   1. Phase and Neutral Bus Material: Copper.
   2. Ground Bus Material: Copper.

D. Circuit Breakers:
   1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.

E. Enclosures:
   1. Provide surface-mounted enclosures unless otherwise indicated.

F. Description: NEMA PB 1, circuit breaker type.

G. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard.

H. Minimum integrated short circuit rating: As indicated.
   1. 240 Volt Panelboards: 10,000 amperes rms symmetrical.
   2. 480 Volt Panelboards: 14,000 amperes rms symmetrical.

I. Molded Case Circuit Breakers: With integral thermal and instantaneous magnetic trip in each pole; UL listed. For air conditioning equipment branch circuits provide circuit breakers UL listed as Type HACR.

J. Enclosure: NEMA PB 1, Type 1, _____ inches deep, _____ inches wide, cabinet box.

K. Cabinet Front: Surface type, fastened with hinge and latch, hinged door with flush lock, metal directory frame, finished in manufacturer's standard gray enamel.

2.4 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
   1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
   2. Main and Neutral Lug Type: Mechanical.

C. Bussing:
2. Phase and Neutral Bus Material: Copper.

D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

E. Enclosures:
   1. Provide surface-mounted or flush-mounted enclosures as indicated.
   2. Provide clear plastic circuit directory holder mounted on inside of door.

F. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.

G. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard; provide insulated ground bus where scheduled.

H. Minimum Integrated Short Circuit Rating: As indicated.
   1. 240 Volt Panelboards: 10,000 amperes rms symmetrical.
   2. 480 Volt Panelboards: 14,000 amperes rms symmetrical.

I. Molded Case Circuit Breakers: Thermal magnetic trip circuit breakers, bolt-on type, with common trip handle for all poles; UL listed.
   1. Type SWD for lighting circuits.
   2. Type HACR for air conditioning equipment circuits.
   3. Do not use tandem circuit breakers.

J. Enclosure: NEMA PB1, Type 1.

K. Cabinet Box: 6 inches deep, 20 inches wide for 240 volt and less panelboards, 20 inches wide for 480 volt panelboards.

L. Cabinet Front: Flush cabinet front with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:
   1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
   2. Interrupting Capacity:
      a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
      b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
   3. Conductor Terminations:
      a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
   4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
   5. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Install panelboards securely, in a neat and workmanlike manner in accordance with NECA 1 (general workmanship), NECA 407 (panelboards), and NEMA PB 1.1.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required supports in accordance with Section 26 05 29.

E. Install panelboards plumb.

F. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.

G. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.

H. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.

I. Provide grounding and bonding in accordance with Section 26 05 26.

J. Install all field-installed branch devices, components, and accessories.

K. Install panelboards in accordance with NEMA PB 1.1 and NECA 1.

L. Install panelboards plumb. Install recessed panelboards flush with wall finishes.

M. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.

N. Provide filler plates to cover unused spaces in panelboards.

O. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.

P. Provide identification nameplate for each panelboard in accordance with Section 26 05 53.

Q. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Identify each as SPARE.
   1. Minimum spare conduits: 5 empty 1 inch.

R. Ground and bond panelboard enclosure according to Section 26 05 26.

3.2 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Perform field inspection and testing in accordance with Section 01 40 00.

C. Inspect and test in accordance with NETA ATS, except Section 4.

D. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than ____ amperes. Tests listed as optional are not required.

E. Correct deficiencies and replace damaged or defective panelboards or associated components.

F. Perform inspections and tests listed in NETA STD ATS, Section 7.5 for switches, Section 7.6 for circuit breakers.
3.3 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of panelboard fronts.

C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Electrical connections to equipment.

1.2 RELATED REQUIREMENTS
   A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
   B. Section 26 05 34 - Conduit.
   C. Section 26 05 37 - Boxes.
   D. Section 26 27 26 - Wiring Devices.
   E. Section 26 28 18 - Enclosed Switches.

1.3 REFERENCE STANDARDS
   A. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (R 2010).
   B. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2012.
   C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS
   A. Coordination:
      1. Obtain and review shop drawings, product data, manufacturer’s wiring diagrams, and manufacturer’s instructions for equipment furnished under other sections.
      2. Determine connection locations and requirements.
   B. Sequencing:
      1. Install rough-in of electrical connections before installation of equipment is required.
      2. Make electrical connections before required start-up of equipment.

1.5 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.
   B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.1 MATERIALS
   A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
      1. Colors: Conform to NEMA WD 1.
2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

B. Disconnect Switches: As specified in Section 26 28 18 and in individual equipment sections.
C. Wiring Devices: As specified in Section 26 27 26.
D. Flexible Conduit: As specified in Section 26 05 34.
E. Wire and Cable: As specified in Section 26 05 19.
F. Boxes: As specified in Section 26 05 37.

2.2 EQUIPMENT CONNECTIONS
A. Refer to equipment Schedules on drawing for specific requirements for each piece of equipment.

PART 3 EXECUTION

3.1 EXAMINATION
A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 ELECTRICAL CONNECTIONS
A. Make electrical connections in accordance with equipment manufacturer’s instructions.
B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
D. Provide receptacle outlet to accommodate connection with attachment plug.
E. Provide cord and cap where field-supplied attachment plug is required.
F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
H. Install terminal block jumpers to complete equipment wiring requirements.
I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Wall switches.
B. Receptacles.
C. Wall plates.

1.2 RELATED REQUIREMENTS
A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
B. Section 26 05 37 - Boxes.
C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
D. Section 26 09 23 - Lighting Control Devices: Devices for automatic control of lighting, including occupancy sensors, in-wall time switches, and in-wall interval timers.
E. Section 26 27 17 - Equipment Wiring: Cords and plugs for equipment.

1.3 REFERENCE STANDARDS
B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); Federal Specification; Revision F, 1999.
C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
D. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
E. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (R 2010).
F. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2012.
G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
I. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
3. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
4. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Sequencing:

1.5 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
C. Operation and Maintenance Data:

1.6 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.1 MANUFACTURERS
C. Pass & Seymour, a brand of Legrand North America, Inc; ______: www.legrand.us
D. Source Limitations: Where possible, provide products for each type of wiring device produced by a single manufacturer and obtained from a single supplier.

2.2 WIRING DEVICE APPLICATIONS
A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
D. Provide GFCI protection for receptacles installed within 6 feet of sinks.
E. Provide GFCI protection for receptacles installed in kitchens.
F. Provide GFCI protection for receptacles serving electric drinking fountains.

2.3 ALL WIRING DEVICES
A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
B. Finishes:
   1. All Wiring Devices: Ivory with stainless steel wall plate unless otherwise indicated.
2. Wiring Devices Installed in Finished Spaces: Ivory with ______ stainless steel wall plate unless otherwise indicated.
3. Wiring Devices Installed in Unfinished Spaces: Ivory with galvanized steel wall plate unless otherwise indicated.
4. Wiring Devices Installed in Wet or Damp Locations: Ivory with specified weatherproof cover unless otherwise indicated.

2.4 WALL SWITCHES

A. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
   1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.

B. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
   1. Products:
      a. Similar to P&S 20AC Series.

2.5 RECEPTACLES

A. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
   1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
   2. NEMA configurations specified are according to NEMA WD 6.

B. Convenience Receptacles:
   1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
      a. Products:
         1) Similar to P&S 5362 Series.

C. GFCI Receptacles:
   1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
      a. Provide test and reset buttons of same color as device.
      a. Products:
         1) Similar to P&S2095.
   3. Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.
      a. Products:
         1) Similar to P&S 2095DSWRBK.

D. Locking Receptacles: Industrial specification grade, configuration as indicated on the drawings.

2.6 WALL PLATES

A. Wall Plates: Comply with UL 514D.
1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
2. Size: Standard; __________.
3. Screws: Metal with slotted heads finished to match wall plate finish.

B. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.
C. Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.
D. Weatherproof Covers for Wet or Damp Locations: Gasketed, __________, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected. Color by Architect. Similar to P&S WIUFC10S.

PART 3 EXECUTION

3.1 EXAMINATION
A. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
B. Verify that wall openings are neatly cut and will be completely covered by wall plates.
C. Verify that final surface finishes are complete, including painting.
D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION
A. Provide extension rings to bring outlet boxes flush with finished surface.
B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION
A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
B. Perform work in a neat and workmanlike manner in accordance with NECA 1, including mounting heights specified in that standard unless otherwise indicated.
C. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of wiring devices provided under this section.
   1. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
   2. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
   3. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
   4. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.
D. Install wiring devices in accordance with manufacturer's instructions.
E. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

F. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.

G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

H. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.

I. Install wiring devices plumb and level with mounting yoke held rigidly in place.

J. Install wall switches with OFF position down.

K. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.

L. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

M. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

N. Install identification label for all receptacles in accordance with Section 26 05 26 indicating serving branch circuit.

3.4 FIELD QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Inspect each wiring device for damage and defects.
C. Operate each wall switch with circuit energized to verify proper operation.
D. Test each receptacle to verify operation and proper polarity.
E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
F. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.5 ADJUSTING
A. Adjust devices and wall plates to be flush and level.

3.6 CLEANING
A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION
SECTION 26 28 18
ENCLOSED SWITCHES

PART 2 PRODUCTS

END OF SECTION
PART 2 PRODUCTS

1.1 DESCRIPTION

A. Variable Frequency Controllers: Enclosed controllers suitable for operating the indicated loads, in conformance with requirements of NEMA ICS 7. Select unspecified features and options in accordance with NEMA ICS 3.1.

B. Enclosures: NEMA 250, Type 1, suitable for equipment application in places regularly open to the public.

1.2 OPERATING REQUIREMENTS

1.3 COMPONENTS

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Packaged engine generator system and associated components and accessories:
   1. Engine and engine accessory equipment.
   2. Alternator (generator).
   3. Generator set control system.
   4. Generator set enclosure.
   5. Generator sub base fuel tank

1.2 RELATED REQUIREMENTS
A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
B. Section 26 36 00 - Transfer Switches.

1.3 REFERENCE STANDARDS
B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
C. NECA/EGSA 404 - Standard for Installing Generator Sets; 2014.
D. NEMA MG 1 - Motors and Generators; 2014.
E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
H. UL 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids; Current Edition, Including All Revisions.
I. UL 2200 - Stationary Engine Generator Assemblies; Current Edition, Including All Revisions.

1.4 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features. Include alternator starting capabilities, engine fuel consumption rates, and cooling, combustion air, and exhaust requirements.
C. Manufacturer's factory emissions certification.
D. Maintenance contracts.
E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. Extra Fuses: One of each type and size.
   2. Extra Filter Elements: One of each type, including fuel, oil and air.
1.5 QUALITY ASSURANCE
   A. Comply with the following:
      1. NFPA 70 (National Electrical Code).

1.6 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide minimum two year manufacturer warranty covering repair or replacement due to
      defective materials or workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS
   A. Packaged Engine Generator Set:

2.2 PACKAGED ENGINE GENERATOR SYSTEM
   A. Provide new engine generator system consisting of all required equipment, sensors, conduit,
      boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a
      complete operating system that provides the functional intent indicated.
   B. Provide products listed, classified, and labeled as suitable for the purpose intended.
   C. System Description:
      2. Configuration: Single packaged engine generator set operated independently (not in
         parallel).
   D. Packaged Engine Generator Set:
      1. Type: Diesel (compression ignition).
      3. Voltage: 208Y/120 V, 3 phase, 60 Hz.
      4. Main Line Circuit Breaker 400A and 40A:
         a. Type: Thermal magnetic.
   E. Generator Set General Requirements:
      1. Prototype tested in accordance with NFPA 110 for Level 1 systems.
      2. Factory-assembled, with components mounted on suitable base.
      3. List and label engine generator assembly as complying with UL 2200.
      4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor
         for three phase voltages and 1.0 power factor for single phase voltages.
      5. Provide suitable guards to protect personnel from accidental contact with rotating parts,
         hot piping, and other potential sources of injury.
   F. Service Conditions: Provide engine generator system and associated components suitable for
      operation under the service conditions at the installed location.
      1. Altitude: 1000 feet.
   G. Starting and Load Acceptance Requirements:
1. Cranking Method: Cycle cranking complying with NFPA 110 (15 second crank period, followed by 15 second rest period, with cranking limiter time-out after 3 cycles), unless otherwise required.

2. Cranking Limiter Time-Out: If generator set fails to start after specified cranking period, indicate overcrank alarm condition and lock-out generator set from further cranking until manually reset.

3. Start Time: Capable of starting and achieving conditions necessary for load acceptance within 10 seconds (NFPA 110, Type 10).

4. Maximum Load Step: Supports 100 percent of rated load in one step.

H. Exhaust Emissions Requirements:
1. Comply with federal (EPA), state, and local regulations applicable at the time of commissioning; include factory emissions certification with submittals.

2.3 ENGINE AND ENGINE ACCESSORY EQUIPMENT

A. Provide engine with adequate horsepower to achieve specified power output at rated speed, accounting for alternator efficiency and parasitic loads.

B. Engine Fuel System - Diesel (Compression Ignition):
1. Fuel Source: Diesel, ASTM D975 No. 2-D or approved cold weather diesel blends.
5. Sub-Base Fuel Tank:
   a. Provide sub-base mounted, double-wall fuel tank with secondary containment; listed and labeled as complying with UL 142.
   b. Tank Capacity: 300 gallons
   c. Features:
      1) Direct reading fuel level gage.
      2) Normal atmospheric vent.
      3) Emergency pressure relief vent.
      4) Fuel fill opening with lockable cap.
      5) Dedicated electrical conduit stub-up area.

C. Engine Starting System:
1. System Type: Electric, with DC solenoid-activated starting motor(s).
2. Battery(s):
   a. Battery Type: Lead-acid.
   b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.
   c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.
4. Battery Heater: Provide thermostatically controlled battery heater to improve starting under cold ambient conditions.

D. Engine Speed Control System (Governor):
2. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.

E. Engine Lubrication System:
   1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.

F. Engine Cooling System:
   1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.
   2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.

G. Engine Air Intake and Exhaust System:
   1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
   2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.

2.4 ALTERNATOR (GENERATOR)

A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 1; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3 phase alternators.

B. Exciter:
   1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
   2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.
   3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.

C. Temperature Rise: 125 C.

D. Insulation System: NEMA MG 1, Class H; suitable for alternator temperature rise.

E. Enclosure: NEMA MG 1, drip-proof.

F. Total Harmonic Distortion: Not greater than five percent.

G. Minimum 211 SKW and 663SKVA

3.1 GENERATOR SET CONTROL SYSTEM

A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.

B. Control Panel:
   1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
   2. Generator Set Control Functions:
      a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).
      c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.
d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.

e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.

f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).

g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.

3. Generator Set Status Indications:

a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.

b. Current (Amps): For each phase.

c. Frequency (Hz).

d. Real power (W/kW).

e. Reactive power (VAR/kVAR).

f. Apparent power (VA/kVA).

g. Power factor.

h. Duty Level: Actual load as percentage of rated power.

i. Engine speed (RPM).

j. Battery voltage (Volts DC).

k. Engine oil pressure.

l. Engine coolant temperature.

m. Engine run time.

n. Generator powering load (position signal from transfer switch).

4. Generator Set Protection and Warning/Shutdown Indications:

a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following protections/indications:

1) Overcrank (shutdown).

2) Low coolant temperature (warning).

3) High coolant temperature (warning).

4) High coolant temperature (shutdown).

5) Low oil pressure (shutdown).

6) Overspeed (shutdown).

7) Low fuel level (warning).

8) Low coolant level (warning/shutdown).

9) Generator control not in automatic mode (warning).

10) High battery voltage (warning).

11) Low cranking voltage (warning).

12) Low battery voltage (warning).

13) Battery charger failure (warning).

b. In addition to NFPA 110 requirements, provide the following protections/indications:

1) High AC voltage (shutdown).

2) Low AC voltage (shutdown).

3) High frequency (shutdown).

4) Low frequency (shutdown).

5) Overcurrent (shutdown).

c. Provide lamp test function that illuminates all indicator lamps.

3.2 GENERATOR SET ENCLOSURE

A. Enclosure Type: Sound attenuating, weather protective.

B. Enclosure Material: Steel or aluminum.

C. Hardware Material: Stainless steel.

D. Color: Manufacturer's standard.

E. Access Doors: Lockable, with all locks keyed alike.
F. Openings: Designed to prevent bird/rodent entry.

G. External Drains: Extend oil and coolant drain lines to exterior of enclosure for maintenance service.

PART 3 EXECUTION

4.1 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1.

B. Install products in accordance with manufacturer's instructions.

C. Install generator sets and associated accessories in accordance with NECA/EGSA 404.

D. Arrange equipment to provide minimum clearances and required maintenance access.

E. Unless otherwise indicated, mount generator set on properly sized 6 inch high concrete pad constructed in accordance with Section 03 30 00. Provide suitable vibration isolators, where not factory installed.

F. Use manufacturer's recommended oil and coolant, suitable for the worst case ambient temperatures.

4.2 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Notify Owner and Architect at least two weeks prior to scheduled inspections and tests.

C. Provide all equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.

D. Preliminary inspection and testing to include, at a minimum:
1. Inspect each system component for damage and defects.
2. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
3. Check for proper oil and coolant levels.

E. Prepare and start system in accordance with manufacturer's instructions.

F. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

4.3 MAINTENANCE

A. Provide to Owner at no extra cost, a separate maintenance contract for the service and maintenance of engine generator system for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a detailed schedule.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Transfer switches for low-voltage (600 V and less) applications and associated accessories:
   1. Service entrance rated automatic transfer switches.

1.2 RELATED REQUIREMENTS
A. Section 26 32 13 - Engine Generators: For interface with transfer switches.
   1. Includes code requirements applicable to work of this section.

1.3 REFERENCE STANDARDS
A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
F. UL 1008 - Transfer Switch Equipment; Current Edition, Including All Revisions.

1.4 SUBMITTALS
A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features.
B. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

1.5 QUALITY ASSURANCE
A. Comply with the following:
   1. NFPA 70 (National Electrical Code).
   2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for system Level specified in Section 26 32 13.
B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.6 WARRANTY
A. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.
PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Transfer Switches:
   1. Same as manufacturer of engine generator(s) used for this project.

2.2 TRANSFER SWITCHES

A. Provide complete power transfer system consisting of all required equipment, conduit, boxes, wiring, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Construction Type: Only "contactor type" (open contact) transfer switches are acceptable. Do not use "breaker type" (enclosed contact) transfer switches.

D. Comply with NEMA ICS 10 Part 1, and list and label as complying with UL 1008 for the classification of the intended application (e.g. emergency, optional standby).

E. Switching Methods:
   1. Open Transition:
      a. Provide break-before-make transfer without a neutral position that is not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.

F. Enclosures: NEMA 1
   1. Finish: Manufacturer's standard unless otherwise indicated.

G. Short Circuit Current Rating: 10,000 AIC

H. Automatic Transfer Switches:
   1. Description: Transfer switches with automatically initiated transfer between sources; electrically operated and mechanically held.
   2. Control Functions:
      a. Automatic mode.
      b. Test Mode: Simulates failure of primary/normal source.
      c. Voltage and Frequency Sensing:
         1) Undervoltage sensing for each phase of primary/normal source; adjustable dropout/pickup settings.
         2) Undervoltage sensing for alternate/emergency source; adjustable dropout/pickup settings.
         3) Underfrequency sensing for alternate/emergency source; adjustable dropout/pickup settings.
      d. Outputs:
         1) Contacts for engine start/shutdown (except where direct generator communication interface is provided).
         2) Auxiliary contacts; one set(s) for each switch position.
      e. Adjustable Time Delays:
         1) Engine generator start time delay; delays engine start signal to override momentary primary/normal source failures.
         2) Transfer to alternate/emergency source time delay.
         3) Retransfer to primary/normal source time delay.
4) Engine generator cooldown time delay; delays engine shutdown following retransfer to primary/normal source to permit generator to run unloaded for cooldown period.
   
   f. Engine Exerciser: Provides programmable scheduled exercising of engine generator selectable with or without transfer to load; provides memory retention during power outage.
   
3. Status Indications:
   a. Connected to alternate/emergency source.
   b. Connected to primary/normal source.
   c. Alternate/emergency source available.

4. Automatic Sequence of Operations:
   a. Upon failure of primary/normal source for a programmable time period (engine generator start time delay), initiate starting of engine generator where applicable.
   b. When alternate/emergency source is available, transfer load to alternate/emergency source after programmable time delay.
   c. When primary/normal source has been restored, retransfer to primary/normal source after a programmable time delay. Bypass time delay if alternate/emergency source fails and primary/normal source is available.
   d. Where applicable, initiate shutdown of engine generator after programmable engine cooldown time delay.

I. UL 869A Service Entrance Rated Transfer Switches:
   1. Furnished with integral disconnecting and overcurrent protective device on the primary/normal source.

PART 3 EXECUTION

3.1 INSTALLATION
   
   A. Perform work in accordance with NECA 1 (general workmanship).
   
   B. Install products in accordance with manufacturer's instructions.
   
   C. Install transfer switches plumb and level.

3.2 FIELD QUALITY CONTROL
   
   A. See Section 01 40 00 - Quality Requirements, for additional requirements.
   
   B. Prepare and start system in accordance with manufacturer's instructions.

3.3 CLOSEOUT ACTIVITIES
   
   A. Training: Train Owner's personnel on operation, adjustment, and maintenance of transfer switches.
      1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

END OF SECTION
PART 2 PRODUCTS

1.1 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.

B. Protected Modes:

C. UL 1449 Voltage Protection Ratings (VPRs):

D. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.

E. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Interior luminaires.
B. Emergency lighting units.
C. Exit signs.
D. Ballasts and drivers.
E. Emergency Battery Units.
F. Wall Packs on building exterior.
G. Lamps.
H. Luminaire accessories.

1.2 RELATED REQUIREMENTS
A. Section 26 05 37 - Boxes.
B. Section 26 09 23 - Lighting Control Devices: Automatic controls for lighting including occupancy sensors, outdoor motion sensors, time switches, outdoor photo controls, and daylighting controls.
C. Section 26 27 26 - Wiring Devices: Manual wall switches and wall dimmers.

1.3 REFERENCE STANDARDS
B. ANSI C82.4 - American National Standard for Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type); 2002.
D. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Cor 1, 2012).
F. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
I. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts; 2011.
J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
   2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
   3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
   4. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Shop Drawings:
   1. Provide photometric calculations where luminaires are proposed for substitution upon request.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
   1. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IESNA LM-63 standard format upon request.
   2. Ballasts: Include wiring diagrams and list of compatible lamp configurations.
   3. Lamps: Include rated life, color temperature, color rendering index (CRI), and initial and mean lumen output.

D. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

E. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

1.7 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Provide two year manufacturer warranty for all linear fluorescent ballasts.
C. Provide five year pro-rata warranty for batteries for emergency lighting units.
D. Provide ten year pro-rata warranty for batteries for self-powered exit signs.

PART 2  PRODUCTS

2.1  MANUFACTURERS - LUMINAIRES

B. Cooper Lighting, a division of Cooper Industries; __________:  www.cooperindustries.com.
D. Other manufactures as listed on Fixture Schedule..
E. Substitutions:  See Section 01 60 00 - Product Requirements, except where individual lumaire types are designated with substitutions not permitted.

2.2  LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

2.3  LUMINAIRES

A. Provide products that comply with requirements of NFPA 70.
B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
C. Provide products listed, classified, and labeled as suitable for the purpose intended.
D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

2.4  EMERGENCY LIGHTING UNITS

A. Description:  Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
B. Operation:  Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
C. Battery:
   1. Sealed maintenance-free lead calcium unless otherwise indicated.
   2. Size battery to supply all connected lamps, including emergency remote heads where indicated.
D. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.

E. Provide low-voltage disconnect to prevent battery damage from deep discharge.

F. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.

2.5 EXIT SIGNS

A. Description: Internally illuminated exit signs with LEDs unless otherwise indicated; complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
1. Number of Faces: Single or double as indicated or as required for the installed location.
2. Directional Arrows: As indicated or as required for the installed location.

B. Self-Powered Exit Signs:
1. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
2. Battery: Sealed maintenance-free nickel cadmium unless otherwise indicated.
3. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
4. Provide low-voltage disconnect to prevent battery damage from deep discharge.

2.6 BALLASTS AND DRIVERS

A. Manufacturers:
4. Universal
5. Substitutions: See Section 01 60 00 - Product Requirements.
6. Manufacturer Limitations: Where possible, for each type of luminaire provide ballasts produced by a single manufacturer.

B. Ballasts - General Requirements:
1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.

C. Fluorescent Ballasts:
1. All Fluorescent Ballasts: Unless otherwise indicated, provide high frequency electronic ballasts complying with ANSI C82.11 and listed and labeled as complying with UL 935.
   b. Input Voltage: Suitable for operation at voltage of connected source, with variation tolerance of plus or minus 10 percent.
   c. Total Harmonic Distortion: Not greater than 10 percent.
   d. Power Factor: Not less than 0.95.
   e. Ballast Factor: Normal ballast factor between 0.85 and 1.15, unless otherwise indicated.
   f. Thermal Protection: Listed and labeled as UL Class P, with automatic reset for integral thermal protectors.
g. **Sound Rating:** Class A, suitable for average ambient noise level of 20 to 24 decibels.

h. **Lamp Compatibility:** Specifically designed for use with the specified lamp, with no visible flicker.

i. **Lamp Operating Frequency:** Greater than 20 kHz, except as specified below.
   1) Do not operate lamp(s) within the frequencies from 30 kHz through 40 kHz in order to avoid interference with infrared devices.

j. **Lamp Current Crest Factor:** Not greater than 1.7.

k. **Lamp Wiring Method:**
   1) Programmed Start Ballasts: Provide parallel or series/parallel wired where available; otherwise series wired is acceptable.

l. **Provide automatic restart capability to restart replaced lamp(s) without requiring resetting of power.**

m. **Provide end of lamp life automatic shut down circuitry for T5 and smaller diameter lamp ballasts.**

n. **Surge Tolerance:** Capable of withstanding characteristic surges according to IEEE C62.41.2, location category A.

o. **Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits:** Comply with FCC requirements of 47 CFR 15, for Class A, non-consumer application.

p. **Ballast Marking:** Include wiring diagrams with lamp connections.

2. **Non-Dimming Fluorescent Ballasts:**
   a. **Lamp Starting Method:**
      1) **T8 Lamp Ballasts:** Programmed start unless otherwise indicated.
      2) **Compact Fluorescent Lamp Ballasts:** Programmed start unless otherwise indicated.

D. **High Intensity Discharge (HID) Ballasts:** Complying with ANSI C82.4 and listed and labeled as complying with UL 1029.
   1. **Electromagnetic Metal Halide Ballasts:**
      a. **Input Voltage:** Suitable for operation at voltage of connected source, with variation tolerance of plus or minus 5 percent.
      b. **Power Factor:** Not less than 0.90 unless otherwise indicated.
      c. **Lamp Starting Temperature:** Capable of starting standard lamp(s) at a minimum of -22 degrees F.

2.7 **LAMPS**

A. **Manufacturers:**
   4. Substitutions: See Section 01 60 00 - Product Requirements.
   5. Manufacturer Limitations: Where possible, provide lamps produced by a single manufacturer.

B. **Lamps - General Requirements:**
   1. Unless explicitly excluded, provide new, compatible, operable lamps in each luminaire.
   2. Verify compatibility of specified lamps with luminaires to be installed. Where lamps are not specified, provide lamps per luminaire manufacturer's recommendations.
   3. **Minimum Efficiency:** Provide lamps complying with all current applicable federal and state lamp efficiency standards.
   4. **Color Temperature Consistency:** Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the Architect to be inconsistent in perceived color temperature.
C. Compact Fluorescent Lamps: Wattage and bulb type as indicated, with base type as required for luminaire.
   1. Low Mercury Content: Provide lamps that pass the EPA Toxicity Characteristic Leaching Procedure (TCLP) test for characteristic hazardous waste.
   2. Correlated Color Temperature (CCT): 3,500 K unless otherwise indicated.
   3. Color Rendering Index (CRI): Not less than 80.
   4. Average Rated Life: Not less than 10,000 hours for an operating cycle of three hours per start.

D. Linear Fluorescent Lamps: Wattage and bulb type as indicated, with base type as required for luminaire.
   1. Low Mercury Content: Provide lamps that pass the EPA Toxicity Characteristic Leaching Procedure (TCLP) test for characteristic hazardous waste.
   2. T8 Linear Fluorescent Lamps:
      a. Correlated Color Temperature (CCT): 3,500 K unless otherwise indicated.
      b. Color Rendering Index (CRI): Not less than 80.
      c. Average Rated Life: Not less than 20,000 hours for an operating cycle of three hours per start.

E. High Intensity Discharge (HID) Lamps: Wattage as indicated, with bulb type, burning position, and base type as required for luminaire.
   1. Metal Halide Lamps:
      a. Non-Reflector Type Metal Halide Lamps: Phosphor coated lamp finish unless otherwise indicated.

2.8 ACCESSORIES

A. Chain hang pendant luminaires in utilitarian spaces.

PART 3 EXECUTION

3.1 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.2 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of luminaires provided under this section.

B. Install products according to manufacturer’s instructions.

C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship), NECA 500 (commercial lighting), and NECA 502 (industrial lighting).

D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

E. Suspended Ceiling Mounted Luminaires:
   1. Do not use ceiling tiles to bear weight of luminaires.
   2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
   3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members or to building structure.
4. Secure pendant-mounted luminaires to building structure.
5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
6. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gage, connected from opposing corners of each recessed luminaire to building structure.
7. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.

F. Recessed Luminaires:
1. Install trims tight to mounting surface with no visible light leakage.
2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.

G. Suspended Luminaires:
1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
3. Provide minimum of two supports for each luminaire __________, with no more than 8 feet between supports.

H. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

I. Install accessories furnished with each luminaire.
J. Bond products and metal accessories to branch circuit equipment grounding conductor.
K. Emergency Lighting Units:

L. Exit Signs:
M. Install lamps in each luminaire.

3.3 FIELD QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Inspect each product for damage and defects.
C. Operate each luminaire after installation and connection to verify proper operation.
D. Test self-powered exit signs and emergency lighting units to verify proper operation upon loss of normal power supply.
E. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.4 ADJUSTING
A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.
B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Architect or authority having jurisdiction.
C. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Architect or authority having jurisdiction.
3.5 CLEANING
   A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting),
      and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and
      restore finishes to match original factory finish.

3.6 CLOSEOUT ACTIVITIES
   A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
   B. Just prior to Substantial Completion, replace all lamps that have failed .

3.7 PROTECTION
   A. Protect installed luminaires from subsequent construction operations.

3.8 ATTACHMENTS
   A. Luminaire schedule located on contract drawings.
PART 2 PRODUCTS

1.1 LUMINAIRES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.

F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

END OF SECTION
PART 1  GENERAL

1.1 SUMMARY

A. The purpose of this grounding system is to create a low impedance path to earth ground for electrical surges and transient voltages. Lightning, fault currents, circuit switching (motors turning on and off), and electrostatic discharge (ESD) are common causes of these surges and transient voltages. An effective grounding system minimizes the detrimental effects of these electrical surges, which include degraded network performance and reliability and increased safety risks.

1. The grounding system must be intentional, visually verifiable, adequately sized to handle expected currents safely, and directs these potentially damaging currents away from sensitive network equipment. As such, grounding must be purposeful in its design and installation. The following four issues require special consideration:

   a. Although AC powered equipment typically has a power cord that contains a ground wire, the integrity of this path cannot be easily verified. Thus, many equipment manufacturers require grounding above and beyond that which is specified by local electrical codes, such as the National Electrical Code, etcetera. Always follow the grounding recommendations of the manufacturer when installing equipment.

   b. While the building steel and metallic water piping must be bonded to the grounding system for safety reasons, neither may be substituted for the telecommunications bonding backbone (TBB).

   c. Electrical continuity throughout each rack or cabinet is required to minimize safety risks. Hardware typically supplied with bolt-together racks is not designed for grounding purposes. Additionally, most racks are painted and paint is an insulator. Unless rack members are deliberately bonded, continuity between members is incidental, and in many cases, unlikely.

   d. Any metallic component that is part of the data center, including equipment, racks, ladder racks, enclosures, cable trays, etc. must be bonded to the grounding system.

B. Section Includes:

1. Electrostatic Discharge (ESD) Hardware
2. Telecommunications Main Grounding Busbars
3. Telecommunications Grounding Busbars
4. Telecommunications Equipment Bonding Conductors
5. Beam Grounding Clamps
6. Bonding Hardware
7. Wire
8. Mechanical connectors

C. Related Sections:

1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

1.2 REFERENCES

A. Building Industry Consulting Service International, Inc.

B. Telecommunication Industry Association
   1. TIA 607-B - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
C. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code.

1.3 SYSTEM DESCRIPTION
A. Includes products and execution requirements relating to furnishing and installing Grounding/Earthing and Bonding for Communications Systems.
B. All cables and related terminations, support and grounding / earthing hardware shall be furnished, installed, wired, tested, labeled, and documented by the telecommunications contractor as detailed in this document.
C. Communications grounding systems use the following elements as grounding electrodes:
   1. Building grounding electrode
D. Do not use the following elements as grounding electrodes:
   1. Building plumbing system
   2. Gas piping system
   3. Fire Sprinkling System

1.4 SUBMITTALS
A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
B. Product Data: Submit data on grounding electrodes and connections.
C. Test Reports: Indicate overall resistance to earth ground.
D. Manufacturer's Installation Instructions: Submit for active electrodes.
E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS
A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
B. Project Record Documents: Record actual locations of components and grounding electrodes.

1.6 QUALITY ASSURANCE
A. Provide grounding, surge protection and lightning protection of telecommunications system in accordance with latest version of Grounding, Bonding and Electrical Protection chapter of the BICSI TDM Manual, TIA 607-B, current NEC codes, and NFPA 70.
   1. Maintain one copy of each document on site.
B. Assure that the "as installed" system is correctly and completely documented including engineering drawings, manuals, and operational procedures in such a manner as to support maintenance and future expansion of the system.
C. Cable assemblies shall be UL Listed and CSA Certified. Cables shall be a distinctive green or green/yellow in color, and all jackets shall be UL, VW-1 flame rated.
D. Two-hole lugs shall be used wherever possible to resist loosening when twisted (bumped) or exposed to vibration. All lugs shall be irreversible compression and meet NEBS Level 3 as tested by Telcordia. Lugs with inspection windows shall be used in all non-corrosive environments so that connections may be inspected for full conductor insertion.
E. Die index numbers shall be embossed on all compression connections to allow crimp inspection.
F. Lugs, HTAPs, grounding strips, and busbars shall be UL Listed and made of premium quality tin-plated electrolytic copper that provides low electrical resistance while inhibiting corrosion. Antioxidant shall be used when making bonding connections in the field.

1.7 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five years documented experience.
B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.8 PRE-INSTALLATION MEETINGS
A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING
A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.10 COORDINATION
A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
B. Complete grounding and bonding of building reinforcing steel prior concrete placement.

PART 2 PRODUCTS

2.1 ALL PRODUCTS SHALL BE INSTALLED PER MANUFACTURER'S INSTALLATION INSTRUCTIONS.

2.2 GROUNDING WIRE
A. The Telecommunications Grounding Busbar (TGB) in each telecommunications space shall be grounded / earthed to the Telecommunications Main Grounding Busbar (TMGB) located at the service entrance. The gauge of the connecting copper ground / earth cable, known as the Telecommunications Bonding Backbone (TBB) shall follow BICSI TDM Manual and TIA-607-B guidelines, as is shown in the table below.

<table>
<thead>
<tr>
<th>TBB Length in Linear meters (feet)</th>
<th>TBB Size (AWG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 4 (13)</td>
<td>6</td>
</tr>
<tr>
<td>4 - 6 (14 - 20)</td>
<td>4</td>
</tr>
<tr>
<td>6 - 8 (21 - 26)</td>
<td>3</td>
</tr>
<tr>
<td>8 - 10 (27 - 33)</td>
<td>2</td>
</tr>
<tr>
<td>10 - 13 (34 - 41)</td>
<td>1</td>
</tr>
<tr>
<td>13 - 16 (42 - 52)</td>
<td>1/0</td>
</tr>
<tr>
<td>16 - 20 (53 - 66)</td>
<td>2/0</td>
</tr>
</tbody>
</table>
B. The TMGB will be bonded to building steel and grounded to the electrical service ground according to BICSI TDM Manual and TIA 607-B guidelines. In telecommunications spaces with only one rack, the rack jumper cable shall be connected directly to the TGB. The gauge of connecting copper ground cables shall be sized as shown in the table below.

<table>
<thead>
<tr>
<th>Equipment / Purpose</th>
<th>Copper Cable Size (AWG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonding conductor to each PDU or panel board serving the room</td>
<td>Size per NEC 250.122 and manufacturer requirements</td>
</tr>
<tr>
<td>Conduits, water pipes, and ducts</td>
<td>6</td>
</tr>
<tr>
<td>Bonding conductor to HVAC equipment</td>
<td>6</td>
</tr>
<tr>
<td>Cable trays / ladder racks</td>
<td>6</td>
</tr>
<tr>
<td>Building columns</td>
<td>4</td>
</tr>
<tr>
<td>Aisle grounds (over head or under floor) of the common bonding network</td>
<td>1/0</td>
</tr>
</tbody>
</table>

C. Material: Copper
D. Grounding Conductor: Copper conductor insulated.
E. Bonding Conductor: Copper conductor insulated.

2.3 TWO HOLE LONG BARREL WITH WINDOW LUG COMPRESSION LUGS
A. Description: Copper conductors for connection of grounding wire to busbars, racks, cabinets, all data equipment, cable runway, building steel, etc.
B. Manufacturers:
   1. Panduit Code Conductor Model LCCxx-xxxxxx-x

2.4 EQUIPMENT GROUNDING JUMPER KIT
A. Description: #6 AWG to connect rack mounted equipment such as servers, switches, UPS, etc. to the vertical rack grounding bar. Antioxidant joint compound and abrasive pad are included to clean the contact areas of the jumper and the vertical rack grounding bar.
   1. Factory terminated at both ends.
   2. Provide (6) at each rack or cabinet installed.
B. Manufacturers:
   1. Panduit Model RGEJ1024PFY

2.5 RACK / CABINET EQUIPMENT GROUNDING JUMPER CABLES
A. Description: #6 AWG that connects rack to the vertical rack grounding bar. Antioxidant joint compound and abrasive pad are included to clean the contact areas of the rack and the vertical rack grounding bar. The Jumper must be at least 60 inches long.
B. Manufacturers:
   1. Panduit Model RGEJ660U

2.6 VERTICAL RACK GROUND BAR KIT
A. Description: Copper conductor that attaches vertically to the rack equipment mounting rails to provide connection of rack mounted equipment with jumper to the telecommunications grounding busbar.
B. Manufacturers:
1. Threaded Rails Panduit Model RGS134-1Y
2. Cage Nut Rails Panduit Model RGS134B-1

2.7 ELECTROSTATIC DISCHARGE (ESD) PORT KIT AND WRIST STRAP
A. Description: Wrist strap to provide rapid and continuous drain of electrostatic charge between a person and the surface that the wrist strap is bonded to.
   1. Provide (1) at each rack or cabinet to prevent damaging static discharge into equipment.
B. Manufacturers:
1. ESD Wrist Strap Panduit Model RGESDWS
2. ESD Port Kit for #12-24 or M6 Panduit Model RGESD2-1
3. ESD Port Kit for Cage Nut Rails Panduit Model RGESD2B-1

2.8 CABLE TRAY / LADDER RUNWAY GROUNDING BRACKETS
A. Description: Grounding brackets for cable trays and ladder runway within telecommunications spaces. Serves as routing and support for overhead grounding conductors along cable trays and ladder runways.
B. Manufacturers:
1. Panduit Model GACB-2
   a. Bonding jumper kits required Model GACBJ618U

2.9 LADDER RUNWAY BONDING JUMPER KIT
A. Description: Provide grounding pathway between ladder runway splices.
B. Manufacturers:
1. 18" Panduit Model GACBJ618U
2. 12" Panduit Model GACBJ612U
3. 8" Panduit Model GACBJ68U

2.10 GROUNDING CLAMP FOR CONDUITS
A. Description: Provide a grounding point on metal pipes within the data room.
B. Manufacturers:
2. Panduit (1" - 1 1/4" Pipe) Model GC-18A-X
3. Panduit (1 1/2"- 2" Pipe) Model GC-22A-4

2.11 UNIVERSAL BEAM GROUNDING CLAMP
A. Description: Provides mounting pad suitable for a two-hole compression lug.
B. Provide for any grounding connections made to beams
C. Manufacturers:
1. Panduit Model GUBC500-6

2.12 SPLIT BOLT COPPER GROUNDING CLAMP
A. Description: Grounding connection for wire tray / baskets.
B. Manufacturers:
1. Standard Panduit Model SBC3-C
2. Tin-Plated for galvanized Panduit Model SBCT3-C
2.13 BONDING HARDWARE KITS

A. Description: Creates bonding point between the rack or cabinet and painted patch panels, mounted equipment, servers, busbars, and jumpers.

B. Manufacturers:
   1. Panduit
      a. Stud kit for threaded #12-24 rail fasteners Model TRBSK
      b. Stud kit for threaded M6 rail fasteners Model TRBSM6K
      c. Stud kit for cage nut rail fasteners Model CGNBSK
      d. Bonding nut for threaded #12-24, cage nut, and 1/4" thru-hole rail fasteners Model BGN-C
      e. Bonding nut for threaded M6 rail fasteners Model BGNM6-C

2.14 PAINT PIERCING GROUNDING WASHER KIT

A. Description: Bonds frame members on bolt-together racks

B. Manufacturers:
   1. Panduit Model RGW-100-1Y

2.15 SUBSTITUTIONS

A. Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 PREPARATION

A. Remove paint, rust, mill oils, surface contaminants at connection points using an abrasive pad and provide antioxidant compound.

B. Antioxidant shall be used when making bonding connections in the field.

3.2 INSTALLATION

A. Install in accordance with BICSI TDM Manual, TIA-607-B, and NFPA 70

B. Install all components of the grounding system in a manner so that they are intentional, visually verifiable, adequately sized to handle expected currents safely, and to direct potentially damaging currents away from sensitive network equipment.

C. Install grounding for each rack / cabinet using 6 AWG THHN, rated for 90 degrees C, insulated, copper stranded conductor to copper communication grounding bus bar located in main telecommunications entrance facility.

D. No "daisy chaining" of racks / cabinets, each rack / cabinet shall have it's own independent connection to the telecommunications grounding bar within the data room either through a main common bonding network or homerun.

E. Bond main telecommunications grounding system to building grounding electrode system at main electrical service entrance location with 3/0 AWG copper stranded conductor.

F. Install routing for grounding conductor as short and direct as practical.

G. Install routing of bonding conductors with minimum number of bends and splices. Use sweeping bends.
H. Position grounding busbars near associated equipment and insulate from supports.

I. Ground data cabinets, racks, cable trays, air conditioning unit, building structure, metal piping and metal conduit located in all data rooms to the

J. Install ground from each piece of equipment to MDF Room and IDF Room to grounding bar via an insulated cable no smaller than 6 AWG stranded copper wire. Install proper grounding lug on cable where connecting to grounding bar.

K. Label grounding conductors and grounding bus bars in accordance with BICSI guidelines and Section 27 05 53.

L. Permanently attach equipment and grounding conductors prior to energizing equipment.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Visually inspect from each bus bar to main grounding electrode service location.

C. Test in accordance with BICSI TDM Manual, TIA-607-B and NFPA 70.

D. When improper grounding is found during testing, check entire project, perform corrections, and perform retesting.

E. Installations not conforming to BICSI TDM Manual, TIA-607-B and NFPA 70 shall be subject to manufacturer grounding audit to identify correction requirements. Grounding audit and corrections required shall be at the expense of the contractor performing the improper installation.

END OF SECTION
PART 1 GENERAL

1.1 SUMMARY
A. Section includes:
   1. J-Hooks
   2. Cable Ties
   3. Fire Stopping
   4. Conduit Sleeves
   5. Bushings

1.2 SUBMITTALS
A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
B. Shop Drawings: Indicate product type, dimensions, support points, and finishes.
C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.3 QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.1 FIRE RATED CONDUIT SLEEVES
A. Wiremold FlameStopper Series 4 inch Trade Size Model FS4R-RED
B. Wiremold FlameStopper Series 2 inch Trade Size Model FS2R-RED
C. Product Description: The firestop device for use in through-penetration firestop systems shall have been examined and tested by Underwriters Laboratories Inc. to UL 1479 (ASTM E 814) and bear the U.S. and Canadian UL Classification Mark. The device shall be classified for use in one-, two-, three-, and four-hour rated gypsum, concrete and block walls and provide a maximum L rating of 3.3 cfm. The device shall be classified for use in one-, two-, and three-hour rated concrete floors having a minimum 4-1/2 inches (114 mm) thick reinforced lightweight or normal weight (100 to 150 pcf) (1600 to 2400 kg/cu. m). The devices shall also been tested by Underwriters Laboratories Inc. to UL 2043 and determined to be suitable for use in air handling spaces.
1. The firestop device box shall be constructed of 17 gauge G90 steel.
   a. The firestop device intumescent block shall be constructed of a graphite base material with expansion starting at 375 degrees F and an unrestrained expansion between 6 to 12 times. The intumescent block shall be held securely by the box in order to prevent tampering and damage during installation.
b. The firestop device shall have doors which can be adjusted to prevent materials from penetrating the device if the device is empty or completely full. The doors shall be constructed of 16 gauge G90 steel with No. 10-32 screws use to adjust opening size.

c. Additional Installation notes: Fire rated conduit sleeves must be ordered and installed with all components necessary for the specific application per the manufacturer’s installation instructions. No incomplete installations shall be permitted or accepted.

d. Substitutions: Section 01 60 00 - Product Requirements.

2.2 J-HOOKS

A. Panduit J-Pro Cable Support System
   1. Wall Mount Model JP2W-L20
   2. Wall Mount with Bracket Model JP2WP2-L20
   3. Ceiling Mount Model JP2CM-L20
   4. Drop Wire and Threaded Rod Clip Model JP2DW-L20
   5. Screw-On Beam Clamps Model JP2SBC87R-L20

B. Product Description: Saddle style cable supports / hangers. UL 2043 Listed and suitable for use in air handling spaces.

2.3 CABLE TIES

A. Panduit Hook and Loop Cable Ties
   1. Tak-Tape Model TTS-35R3-0

B. Product Description: Re-usable and releasable cable ties with operating temperature range of between -22 Degrees F. and 194 Degrees F.
   1. Note: No plastic Zip Ties are permitted.
   2. Note: Minimum 2" overlap required to achieve loop tensile rating.

PART 3 EXECUTION

4.1 INSTALLATION

A. Install firestopping in accordance with Section 07 84 00 to sustain ratings when passing cable tray through fire-rated elements.

B. Ground and bond metal ladder rack in accordance with Section 27 05 26 and ANSI/TIA/EIA-607 Standards.
   1. Provide continuity between tray components.
   2. Use anti-oxidant compound to prepare aluminum contact surfaces before assembly.
   3. Make connections to tray using mechanical, compression or exothermic connectors.

END OF SECTION
SECTION 27 05 53
IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 2 PRODUCTS

1.1 NAMEPLATES
   A. Description: Laminated three-layer plastic with engraved black letters on white contrasting background color. Furnish materials in accordance with TIA/EIA-606-A Standard. Letter Size is to be 1/8 inch high letters for identifying wall plates, 1/4 inch high letters for identifying grouped equipment.
   B. Manufacturers:
      1. Panduit Faceplates ModelUILS7BW
   C. Letter Size:
      1. 1/8 inch high letters for identifying individual wall plates.
      2. 1/4 inch high letters for identifying grouped equipment.

1.2 LABELS
   A. Description: Labels: Embossed adhesive tape, with 3/16 inch black letters on white background.
   B. Manufacturer: Panduit
      1. Cat6 Cables Model S050X150YAJ
      2. Patch Panels ModelUILS7BW
      3. Ground Busbars Model C200X100YPT
      4. Grounding and Bonding Conductors Model LTYK
      5. Data Outlets Model C195X040Y1J

1.3 CONDUIT AND RACEWAY MARKERS
   A. Manufacturer: Panduit
      1. Fiber Cable & Innerduct Label Model PCV-FORY

1.4 SUBSTITUTIONS: SECTION 01 60 00 - PRODUCT REQUIREMENTS IN ACCORDANCE WITH TIA/EIA-606-A STANDARDS.
PART 1 GENERAL

1.1 SECTION INCLUDES

A. Communications system design requirements.
B. Communications identification.
C. Cabling inside building(s).
D. Jack modules
E. Faceplates
F. Outlets
G. Surface mount boxes
H. Patch cables
I. Patch panels & strain relief bars
J. Speaker Cabling

1.2 RELATED REQUIREMENTS

A. Section 07 84 00 - Firestopping.
B. Section 27 05 26 - Grounding and Bonding for Communications Systems.
C. Section 26 05 37 - Boxes.
D. Section 27 05 28 - Pathways for Communications Systems.
E. Section 27 05 53 - Identification for Communications Systems.
F. Section 27 15 55 - Communications Cable Testing.

1.3 REFERENCE STANDARDS

B. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
   2. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air Handling Spaces.
C. Telecommunications Industry Association / Electrical Industries Alliance:
   1. TIA-568-C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards; Rev C, 2009 (with Addenda; 2014).
   2. TIA-569-C - Commercial Building Standard for Telecommunications Pathways and Spaces; Rev C, 2012 (with Addenda; 2013).
5. UL 94 - Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

D. Any violations of applicable standards or codes committed by the Contractor shall be remedied at the Contractor’s expense.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer’s standard catalog pages and data sheets for each product.
   1. Performance test reports showing compliance with minimum specifications.
   3. Storage and handling requirements and recommendations.
   4. Part numbers.
   5. Notes to clarify any part number choices on product sheet.
   6. Installation methods.

C. Provide manufactures cut sheets, specifications, and installation instructions for the products herein specified.
   1. Category 6 cable
   2. Patch Panels
   3. Communications Faceplates
   4. Wall Phone Faceplates
   5. Termination Jacks
   6. Patch Cords

D. Certification:

E. Evidence of qualifications for installer.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Project Record Documents: Record actual locations and sizes of pathways, outlets, and Jacks.

1.6 QUALITY ASSURANCE

A. Equipment and materials shall be of the quality and manufactures indicated. The equipment specified is based on the acceptable manufacturers listed. Where “approved equal” is stated, equipment shall be equivalent in every way to that of the equipment specified, and subject to the approval of the Engineer.

B. System Warranty
   1. A Certification / System Warranty shall provide a complete system warranty to guarantee end-to-end high performance cabling systems that meet application requirements. The guarantee shall include all copper connectivity components. The system shall be warranted for a period of a minimum of 25 years.
   2. Manufacturer system warranty based on the following:
      a. Panduit Corp.

C. Product Guarantee
   1. All Manufacturers’ non-consumable products must have a 25-year guarantee. When installed per TIA or ISO/IEC standards, the installed Network Cabling System will operate the application(s) for which the system was designed to support.
   2. Manufacturer product guarantee based on the following:
      a. Panduit Corp.
D. Installer Qualifications:
1. Company specializing in installing products specified in this section with minimum three years documented experience, and with service facilities within 120 miles of project. The contractor must be approved by the manufacturer for cabling solutions – a qualified BICSI trained installer who also is certified to install the solution able to be warrantied by the Manufacturer. A current copy of the Manufacturers’ Certified Installer document MUST be submitted.
2. The contractor is responsible for workmanship and installation practices in accordance with the Manufacturer’s Certified Program. Manufacturer shall extend a 25-year Static, Dynamic and Applications Warranty to the end user once the contractor fulfills all requirements under the Manufacturer’s Certified Program. Contractor Project Manager on site must be manufacturer certified in the copper information transport systems to be installed. At least 30 percent of the installation and termination crew must be certified by Manufacturer with a Technicians Level of Training.
3. Note: All Networks shall be installed per applicable standards and manufacturer’s requirements.
4. Manufacturer accepted installer qualifications based on the following:
   a. Panduit Corp.
      1) Panduit Certified Installer (PCI)
      2) Panduit Certified Technician (PCT)

1.7 DELIVERY, STORAGE, AND HANDLING
A. Store products in manufacturer's unopened packaging until ready for installation.
B. Keep stored products clean and dry.

1.8 WARRANTY
A. Provide Warranty per Section 1.6.
B. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
C. Correct defective Work within a 6 month period after Date of Substantial Completion.

PART 2 PRODUCTS
2.1 CATEGORY 6 UNSHIELDED HORIZONTAL CABLE (PLENUM RATED)
A. Manufacturers:
   1. Panduit CAT-6 Cable Model - PUP6004BU-UY
   2. Belden CAT-6 Cable Model - 3613 D15U1000
   3. Superior Essex CAT-6 Cable Model - 66-246-2P
   4. General Cable CAT-6 Cable Model - 7131900
B. Color:
   1. General Use Data Blue
   2. Wireless Access Points Blue
   3. Security Cameras Blue
C. Product Description: Enhanced Category 6 TIA/EIA 568-B.2-1, 100-ohm, unshielded twisted pair plenum rated cable with 4 pairs, 23 AWG solid bare annealed copper conductors, 100% FEP Insulation. Cable shall be manufactured in the United States of America. Cable shall be UL LISTED. Cable shall be third party verified to meet ANSI/TIA/EIA 568-B.2-1, Category 6 requirements.
D. Additional Installation notes: Any cable installed by the contractor exceeding 90 meters (295 feet) long must be replaced and routed to reduce length to 90 meters or less. Complete all cable re-routing at no additional cost to Owner. Identify in writing to Architect / Engineer prior to installation of any cables that cannot be reduced to 90 meters or less in length.

2.2 CATEGORY 6 DATA JACKS

A. CAT6 - Panduit Mini-Com TX6 PLUS Jack
   Model CJ688TG**
B. CAT6 - Panduit Mini-Com TX6 PLUS Shuttered Jack
   Model CJH688TG**
C. CAT6 - Panduit Mini-Com TX6 PLUS Corrosive Resistant Jack
   Model CJE688TG**
D. Color:
   1. General Use Data
      Blue (**= BU)
   2. Wireless Access Points
      Green (**= GR)
   3. Security Cameras
      Violet (**= VL)
E. Wiring Scheme: T568B
F. Product Description: RJ45, 8-position, 8-wire universal module. Contacts plated with 50 micro inches of gold. Compatible with Mini-Com Modular Patch Panels, Faceplates, and Surface Mount Boxes. Termination shall be accomplished by use of a forward motion termination cap and shall not require the use of a punch down tool. The modules shall be able to be re-terminated a minimum of 10 times. Do not untwist cable pairs more than 0.125 in. (3.18mm) when terminating.
G. Note: Shuttered CAT6 Jacks to be used for all above ceiling applications unless otherwise noted.
H. Note: Corrosive Resistant Jacks to be used in harsh/humid environments

2.3 CATEGORY 6 PATCH CABLES

A. Panduit Patch Cables (for Data Room End - 1 Per Data drop)
   Model UTPSP[x]**Y
B. Panduit Patch Cables (for Device End - 1 Per Data drop)
   Model UTPSP[x]**Y
C. Panduit 36" Patch Cables (for Lightning Protection Device - 1 Per Data drop requiring lightning protection)
   Model UTPSP3ORY
D. Lengths:
   1. Data room end Locations with Data Cabinets 3 foot ([x] = 3)
   2. Data room end Locations with Data Racks 6 foot ([x] = 6)
   3. Wireless access point device location 6 foot ([x] = 6)
   4. Security Camera device location 6 foot ([x] = 6)
   5. General Data outlet location 10 foot ([x] = 10)
E. Color:
   1. General Use Data
      Blue (**= BU)
   2. Wireless Access Points
      Blue (**= BU)
   3. Security Cameras
      Blue (**= BU)
F. Product Description: Category 6, 24 AWG UTP patch cords with TX6 PLUS Modular Plugs on each end. Exceed ANSI/TIA-568-C.2 Category 6 and ISO 11801 Class E Standards.
G. Additional Installation notes:
   1. Contractor to establish proper wire management for patch cables from patch panels to switches. “Spider Webbing” with patch cables will not be accepted.
   2. Patch cables shall not be shorter than 36".
2.4 DATA FACEPLATES
   A. Panduit Mini-Com Classic Series
      1. Two Module Model UICFP2IW
      2. Four Module Model UICFP4IW
   B. Provide Blank Modules for all unused module spaces. Model CMBIW-X

2.5 DATA OUTLET BOXES
   A. Panduit Mini-Com Shuttered Surface Mount Box Model CBXS2IW-A
      1. For use at Wireless Access Point and Security Camera locations.
   B. Mounting:
      1. Panduit magnets to mount Surface Mount Boxes to structural steel or other permanent metal surface where possible. Model CBM-X
      2. Hook and Loop Cable ties may be used to mount Surface Mount Boxes where magnets cannot be used.
      3. Wall anchors may be used where the Surface Mount Box is located in an exposed area (such as gymnasium) AND there is no possible asbestos material.
   C. Product Description: Shuttered surface mount box accepts up to two Panduit Mini-Com Modules.

2.6 DATA PATCH PANELS
   A. Panduit Mini-Com 48 Port HD Blank Patch Panel Model CPA48HDBL
      1. Product Description: TIA/EIA 568, rack-mounted assembly of terminals and accessory patch cords, with adequate capacity for active and spare circuits. 1RU. For all unused positions provide Mini-Com blank module CMBBL-X.
   B. Strain Relief Bar with Clips (Provide with each Patch Panel)
      1. Panduit strain relief bar with integrated adjustable clips. Model SRBWCY
   C. Note: Patch panel to be mounted at a minimum of 4 points.

2.7 SPEAKER CABLING
   A. Plenum Cable for Speaker Circuits: 18 AWG copper conductor, shielded, 2 conductor, and covered with a nonmetallic jacket; suitable for use for Class 2 circuits in air handling ducts, hollow spaces used as ducts, and plenums.
      1. Belden Part Number 6300FE

2.8 SUBSTITUTIONS
   A. This is a performance-based solution. Substitutions must follow the same rigid standards for quality and termination style as those described above.
   B. Any Contractor wishing to offer structured cabling products other than those specified herein shall submit a request for product substitution in writing no less than one week in advance of bid. Written requests for substitution shall be accompanied by all drawings, specification sheets and engineering documents, as well as third party laboratory performance test results proving equivalency in performance and manufacturing style.
   C. This written documentation shall be accompanied by samples of the substitution product offered for evaluation. Equal product acceptance must be received in writing.
D. Contractor shall be responsible and assume all costs for removal and replacement of any substituted product installed without prior written approval. Such costs shall include, but not be limited to labor, materials as well as any penalties, fees or costs incurred for late completion.

2.9 SYSTEM DESIGN

A. Provide a complete permanent end to end system of cabling and pathways for data communications, including but not limited to cables, conduits and wireways, pull wires, support structures, support devices, racks and cabinets, outlets, patch panels, and patch cables.
   1. Comply with TIA-568 (SET) (cabling) and TIA-569-C (pathways), latest editions (commercial standards).
   2. Provide fixed cables and pathways that comply with NFPA 70 and TIA-607-B and are UL listed or third party independent testing laboratory certified.
   3. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.

2.10 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

C. Comply with Communication Service Provider requirements.
D. Grounding and Bonding: Perform in accordance with TIA-607-B and NFPA 70.
E. Contractor must remove all abandoned cable per Article 800 of the National Electrical Code and per TIA and BICSI standards, recycling these materials where possible. Removal of orphaned cable is mandatory. Contractors must consider this when placing bids.

3.2 INSTALLATION OF EQUIPMENT AND CABLEING

A. The contractor is responsible for workmanship and installation practices in accordance with the Manufacturer’s Certified Program. Manufacturer shall extend a minimum 20-year Static, Dynamic and Applications Warranty to the end user once the contractor fulfills all requirements under the Manufacturer’s Certified Program. At least 30 percent of the installation and termination crew must be certified by Manufacturer with a Technicians Level of Training.
B. Note: All Networks shall be installed per applicable standards and manufacturer’s requirements.
C. Copper Cabling:
   1. Use only type CMP plenum-rated cable.
   2. Horizontal distribution cables shall be bundled in groups of no more than manufacturers recommendations. Cable bundle quantities in excess of manufacturers recommendations may cause deformation of the bottom cables within the bundle and degrade cable performance.
   3. Maintain cable geometry; do not untwist more than .125 inch from point of termination.
4. Do not exceed 25 pounds pull tension.
5. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
6. Do not pre pull cable out of box / reel prior to installing.
7. Do not over-cinch or crush cables.
8. Do not exceed manufacturer's recommended cable pull tension.
9. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.
10. Protect from paint and other damaging contaminants. (any painted / contaminated cables shall be replaced at contractor's expense).
11. Leave sufficient slack in the ceiling to reach any telecommunications outlet/connector within room.
12. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
13. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits
14. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the contractor shall install appropriate carriers to support the cabling.
15. Install category 6,6A cable in a separate open cable hanger segment. Do not install with coaxial, optical fiber cable or any other cable type. If cables have more than 12" of sag, install more hangers.
16. Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points.
17. Cable shall have no physical defects such as cuts, tears or bulges in the outer jacket. Cables with defects shall be replaced.
18. The Contractor shall be responsible for replacing all cables that do not pass required bandwidth and throughput tests.

D. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly: Do not loop in circle, only "figure 8" looping is allowed.

E.
1. Cabinet / Rack end: 6 - 10 feet
2. Outlet end: 12 - 18 inches

F. Identification:
1. Use wire and cable markers to identify cables at each end.

3.3 FIELD QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Comply with inspection and testing requirements of specified installation standards.
C. Visual Inspection:
   1. Inspect cable jackets for certification markings.
   2. Inspect cable terminations for color coded labels of proper type.
   3. Inspect outlet plates and patch panels for complete labels.
D. Testing per specifications.
E. Labeling per specifications.
F. Comply with all manufacturers installation, warranty, and handling requirements.

END OF SECTION
PART 1  GENERAL

1.1  SECTION INCLUDES

A. Cabinets
B. Wire Management
C. Distribution frames, cross-connection equipment, and enclosures

1.2  RELATED REQUIREMENTS

A. Section 27 05 26 - Grounding and Bonding for Communications Systems
B. Section 27 05 28 - Pathways for Communications Systems
C. Section 27 05 53 - Identification for Communications Systems

1.3  REFERENCE STANDARDS

A. EIA-310 - Cabinets, Racks, Panels, and Associated Equipment; Electronic Industries Association; Revision D, 1992.
B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
E. TIA-569 - Commercial Building Standard for Telecommunications Pathways and Spaces; 2012.

1.4  SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Storage and handling requirements and recommendations.
   2. Installation methods.

1.5  QUALITY ASSURANCE

A. Manufacturer Qualifications: At least 5 years experience manufacturing products of the type specified.
B. Installer Qualifications: A company having at least 5 years experience in the installation and testing of the type of system specified, and:

C. Installer Qualifications: A company having at least 3 years experience in the installation and testing of the type of system specified, and:
1. Supervisors and installers factory certified by manufacturers of products to be installed.
2. Employing BICSI Registered Cabling Installation Technicians (RCIT) for all work.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Store products in manufacturer’s unopened packaging until ready for installation.
B. Keep stored products clean and dry.

1.7 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Correct defective Work within a 2 year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. Data Cabinets:
   1. 48" H x 30" D x 27.3" W Wall Mount Data Cabinet;
      a. Chatsworth CUBE-iT Cabinet Part# TS1024670
         1) Color- Black
            (a) Adjustable threaded equipment rails
            (b) Vertical large ring cable managers installed on left and right side
            (c) perforated front metal door with keyed lock
         2) Chatsworth Fan Kit Part# 12804-701
            (a) 100 CFM, 115 VAC
         3) Panduit Metered Rack PDU (Horizontal) Model CMRPSH20CM
         4) Panduit Horizontal Cable Manager (Provide 3) Model NM1
   2. Locks: All locks in this project shall be keyed alike
   3. Refer to Section 27 05 26 for additional grounding and bonding components to provide with each cabinet.

B. Substitutions: Section 01 60 00 - Product Requirements

2.2 SYSTEM DESIGN
A. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
   1. Comply with TIA/EIA-568 and TIA/EIA-569, latest editions.
   3. Provide fixed cables and pathways that comply with NFPA 70 and ANSI/J-STD-607 and are UL listed or third party independent testing laboratory certified.
   4. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
   5. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.
2.3 ENCLOSURES

A. Backboards: Interior grade plywood without voids, 3/4 inch thick; UL-labeled fire-retardant.
   1. Size: 48 inches wide by 96 inches high.
   2. Do not paint over UL label.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL


3.2 INSTALLATION OF EQUIPMENT

A. Wall-Mounted Racks and Enclosures:
   1. Install to plywood backboards only, unless otherwise indicated.

3.3 FIELD QUALITY CONTROL

A. Comply with inspection and testing requirements of specified installation standards.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

A. Provide all labor, materials, tools, equipment, and field-test instruments required for the complete testing, identification and administration of the work called for in the Contract Documents.

B. To conform to the overall project schedule, the cabling contractor shall survey the work areas and coordinate cabling testing with other applicable trades.

C. Minimum requirements for the test certification, identification and administration of backbone and horizontal optical fiber cabling.
   1. Category 6 Copper Cabling

1.2 RELATED REQUIREMENTS

A. Section 27 10 05 - Communications Copper Cabling

1.3 REFERENCE STANDARDS


1.4 SUBMITTALS

A. Manufacturers catalog sheets and specifications for fiber optic and copper field-test instruments.

B. Sample test reports.

C. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.5 QUALITY ASSURANCE

A. Installer / Tester Qualifications:
   1. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. Appropriate training programs include but are not limited to installation certification programs provided by BiCSi or the ACP (Association of Cabling Professionals).
      a. Manufacturer of the copper cable and copper connectors.
      b. Manufacturer of the test equipment used for the field certification.

B. Testing Equipment Qualifications:
   1. Field test instruments shall comply with the accuracy requirements for level III field testers as defined in ANSI/TIA-1152. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table
3 of ANSI/TIA-1152 (Table 3 in this TIA document also specifies the accuracy requirements for the Channel configuration).

2. Field-test instruments shall have the latest software and firmware installed.

3. Field-test instruments (tester) shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.

4. The RJ45 test plug shall fall within the values specified in ANSI/TIA-568-C Annex C for NEXT, FEXT and Return Loss.

5. The copper tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The contractor shall provide proof that the interface has been calibrated within the period recommended by the vendor. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.

6. Field-test instruments (tester) shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.

7. Field-test instruments shall have the latest software and firmware installed.

PART 2  EXECUTION

2.1 COPPER

A. Every cabling link in the installation shall be tested in accordance with the field test specifications defined in ANSI/TIA-568-C.2 "Commercial Balanced Twisted-Pair Telecommunications Cabling and Components Standard". This document will be referred to as the "Category 6 Standard."

B. Every cabling link in the installation shall be tested for the following:
   1. Wire map
   2. Length
   3. Insertion loss
   4. NEXT loss
   5. PS NEXT loss
   6. ACR-F loss
   7. PS ACR-F loss
   8. Return loss
   9. Propagation delay
   10. Delay skew

C. The cable type must be set to match the cable manufacturer and type installed, do not set to the default Cat 6 UTP. If the manufacturer of the cable installed is not listed in the field test equipment, only then, the default Cat 6 UTP may be used.

D. The location of the "Main" shall be at the MDF or IDF and the location of the "Remote" shall be at the outlet. If the location of the "Main" and "Remote" are reversed, it must be noted in the test report documentation for any and all instances.

E. The installed twisted-pair horizontal links shall be tested from the IDF in the telecommunications room to the telecommunication wall outlet in the work area for compliance with the "Permanent Link" performance specification as defined in the Category 6 Standard.

F. One hundred percent of the installed cabling links must pass the requirements of the Category 6 Standard and as further detailed in this Section. Any failing link must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected
link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation in accordance with this Section.

G. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk " * " when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer must provide documentation as an aid to interpret results marked with asterisks. To which extent " * " results shall determine approval or disapproval of the element under test shall be defined in the relevant detail specification, or agreed on as a part of a contractual specification.

H. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests (detailed in Section 4.2.2 of ANSI/TIA-1152). Any Fail or Fail* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass*.

2.2 DOCUMENTATION

A. The test results / measurements saved within the field test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of the test records. A guarantee shall be made that the measurement results are transferred to the PC unaltered, i.e., "as saved in the field test instrument" at the end of each test and that these results cannot be modified at a later time. The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.

B. The test results documentation shall be available for inspection by the Owner or the Owner’s representative during the installation period and shall be passed to the Owner's representative within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling. The installer shall retain a copy to aid preparation of as built information.

C. The database for the completed job shall be stored and delivered on CD-ROM or DVD prior to Owner acceptance. This CD-ROM or DVD shall include the software tools required to view, inspect, and print any selection of test reports.

D. Circuit IDs reported by the test instrument should match the specified label ID.

E. Detailed test result documentation shall be provided in an electronic data base and shall include the following information for each link:
   1. Identification of the customer site as specified by the owner.
   2. Identification of the link in accordance with the naming convention defined in the overall system documentation.
   3. The name of the test limit selected to execute the stored test results.
   4. The name of the personnel performing the test.
   5. The overall Pass/Fail evaluation of the link-under-test.
      a. Including the NEXT Headroom (overall worst case) number for copper.
      b. Including OLTS and OTDR measurements for fiber.
   6. Identification of the tester interface.
   7. Date and time the test results were saved in the memory of the tester.
   8. The manufacturer, model and serial number of the field-test instrument.
   9. The version of the test software and the version of the test limit database held within the test instrument.
   10. Test results information must contain information on each of the required test parameters that are listed in this Section and as further detailed below.

F. Copper
   1. Detailed test results data to be provided in the electronic database for must contain the following information:
a. For each of the frequency-dependent test parameters, the value measured at every frequency during the test is stored. The PC-resident database program must be able to process the stored results to display and print a color graph of the measured parameters. The PC-resident software must also provide a summary numeric format in which some critical information is provided numerically as defined by the summary results (minimum numeric test results documentation) as outlined above for each of the test parameters.

1) **Length**: Identify the wire-pair with the shortest electrical length, the value of the length rounded to the nearest 0.1 m (1) and the test limit value.
2) **Propagation delay**: Identify the pair with the shortest propagation delay, the value measured in nanoseconds (ns) and the test limit value.
3) **Delay Skew**: Identify the pair with the largest value for delay skew, the value calculated in nanoseconds (ns) and the test limit value.
4) **Insertion Loss (Attenuation)**: Minimum test results documentation as explained in this Section for the worst pair.
5) **Return Loss**: Minimum test results documentation as explained in this Section for the worst pair as measured from each end of the link.
6) **NEXT, ACR-F**: Minimum test results documentation as explained in this Section for the worst pair combination as measured from each end of the link.
7) **PS NEXT and PS ACR-F**: Minimum test results documentation as explained in this Section for the worst pair as measured from each end of the link.

b. Cable type and the value of NVP used for length calculations.

2.3 **FIELD QUALITY CONTROL**

A. A representative of the owner shall reserve the right to be invited to witness field testing. The representative shall be notified of the start date of the testing phase five business days before testing commences.

B. A representative of the owner shall reserve the right to select a random sample of 5% of the installed links. The representative (or his / her authorized delegate) shall test these randomly selected links and the results are to be stored in accordance with the prescriptions in this Section. The results obtained shall be compared to the data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the end-user representative shall repeat 100% testing and the cost shall be borne by the installation contractor.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Cabling and pathways inside building(s).
   B. Couplers, Modules, Outlets
   C. Hardware

1.2 SCOPE OF WORK
   A. This document describes the products and execution requirements relating to furnishing and installing audio and video cabling, connectors and components covered under this document.
   B. All cables and related terminations, support and grounding hardware shall be furnished, installed, wired, tested, labeled, and documented by the Electrical/AV contractor as detailed in this document.
   C. Product specifications, general design considerations, and installation guidelines are provided in this document. Quantities of audio/video outlets, typical installation details, cable routing and outlet types will be provided as an attachment to this document. If the bid documents are in conflict, formal clarification shall be obtained from in the form of Request For Information (RFI)
   D. This section includes minimum requirements for the following work:
      1. DAV (Digital Audio/Video) Station Outlet and cabling to the projector back box location
      2. PROJ (Projector) back box for connection to cabling from DAV.
      3. Ceiling mounted projector & mount.
      5. Digital Signage Display & Mount.

1.3 RELATED REQUIREMENTS

1.4 PRICE AND PAYMENT PROCEDURES
   A. See Section 01 21 00 - Allowances, for cash allowances affecting this section.
   B. See Section 01 23 00 - Alternatives, for product alternatives affecting this section.

1.5 REFERENCE STANDARDS
   A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.6 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Manufacturers installation instructions.
   2. Storage and handling requirements and recommendations.
   3. Part numbers.
   4. Notes to clarify any part number choices on product sheet.
   5. Installation methods.

C. Installer Qualifications.

D. Field Test Reports.

1.7 CLOSEOUT SUBMITTALS
A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
B. Project Record Documents: Record actual locations and sizes of pathways and outlets.

1.8 QUALITY ASSURANCE
A. Installer Qualifications: A company having at least 3 years experience in the installation and testing of the type of system specified, and:
   1. Employing experienced technicians for all work; show at least 3 years experience in the installation of the type of system specified, with evidence from at least 2 projects that have been in use for at least 18 months; submit project name, address, and written certification by user.

1.9 DELIVERY, STORAGE, AND HANDLING
A. Store products in manufacturer's unopened packaging until ready for installation.
B. Keep stored products clean and dry.

1.10 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Correct defective Work within a 2 year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS
A. Cabling:
   1. Verify all cable lengths required for installation in field
   2. VGA, Composite, 3.5mm Audio Rapid Run
      a. 15' Multi-Format Runner CMG Rated Rapid Run Part # 60002
      b. 35' Multi-Format Runner CMG Rated Rapid Run Part # 60004
      c. 50' Multi-Format Runner CMG Rated Rapid Run Part # 60005
      d. 75' Multi-Format Runner CMG Rated Rapid Run Part # 60006
      e. 100' Multi-Format Runner CMG Rated Rapid Run Part # 60007
      f. 125' Multi-Format Runner CMG Rated Rapid Run Part # 60008
      g. VGA, 3.5mm, Composite Video Lead 1.5' Rapid Run Part # 60018
      h. Single Gang Integrated VGA & 3.5mm & Composite Video & Stereo Audio Wall Plate Rapid Run Part # 60032

B. Substitutions
1. Section 01 60 00 - Product Requirements.

2.2 SYSTEM DESIGN

A. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
   1. Provide fixed cables and pathways that comply with NFPA 70 and ANSI/J-STD-607 and are UL listed or third party independent testing laboratory certified.
   2. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.

B. Intermediate Distribution Frames (IDF): Support structures for terminating horizontal cables that extend to telecommunications outlets.
   1. Locate intermediate distribution frames as indicated on the drawings.

2.3 PATHWAYS

A. Conduit: As specified in Section 26 05 34; provide pull cords in all conduit.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

A. Comply with all manufacturer's installation instructions for all components being installed.
   1. Any installation that does not comply with manufacturer's installation instructions must be approved by engineer prior to installation.

3.2 PATHWAYS

A. Install with the following minimum clearances:
   1. 48 inches from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.
   2. 12 inches from power conduits and cables and panelboards.
   3. 5 inches from fluorescent and high frequency lighting fixtures.
   4. 6 inches from flues, hot water pipes, and steam pipes.

B. Conduit:
   1. Do not install more than 2 (two) 90 degree bends in a single horizontal cable run.
   2. Leave pull cords in place where cables are not initially installed.
   3. Conceal conduit under floor slabs and within finished walls, ceilings, and floors except where specifically indicated to be exposed.
      a. Conduit may remain exposed to view in mechanical rooms, electrical rooms, and telecommunications rooms.
      b. Treat conduit in crawl spaces and under floor slabs as if exposed to view.
      c. Where exposed to view, install parallel with or at right angles to ceilings, walls, and structural members.
      d. Under floor slabs, locate conduit at 12 inches, minimum, below vapor retarder; seal penetrations of vapor retarder around conduit.

C. Outlet Boxes:

D. Grounding and Bonding: Perform in accordance with ANSI/J-STD-607 and NFPA 70.

E. Firestopping: Seal openings around pathway penetrations through fire-rated walls, partitions, floors, and ceilings in accordance with Section 07 84 00.
3.3 INSTALLATION OF EQUIPMENT AND CABLING

A. Cabling:
   1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
   2. Do not over-cinch or crush cables.
   3. Do not exceed manufacturer's recommended cable pull tension.
   4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.

B. Field-Installed Labels: Comply with TIA/EIA-606 using encoded identifiers.
   1. Cables: Install color coded labels on both ends.
   2. Outlets: Label each jack on its face plate as to its type and function, with a unique numerical identifier.

3.4 FIELD QUALITY CONTROL

A. Comply with inspection and testing requirements of specified installation standards.

B. Visual Inspection:
   1. Inspect cable jackets for certification markings.
   2. Inspect cable terminations for color coded labels of proper type.
   3. Inspect outlet plates and patch panels for complete labels.

END OF SECTION
SECTION 27 51 17
PUBLIC ADDRESS SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES
A. Amplifier and control equipment.
B. Input equipment.

1.2 RELATED REQUIREMENTS
A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

1.3 REFERENCE STANDARDS
A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 SYSTEM DESCRIPTION
A. Public address system for voice and music.
B. Input components:
   1. Fire Dept radio equipment
C. Features:
   1. Interface to telephone system.
   2. One-way paging by zone.

1.5 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate electrical characteristics and connection requirements. Indicate layout of equipment mounted in racks and cabinets, component interconnecting wiring, and wiring diagrams of field wiring to speakers and remote input devices.
C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
E. Operation Data: Include instructions for adjusting, operating, and extending the system.
F. Maintenance Data: Include repair procedures and spare parts documentation.

1.6 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70 and Federal Communications Commission.
B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience with service facilities within 100 miles of Project.
PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Bogen Communications, Inc; GS150D: www.bogen.com.

1. Include Rack Panel Mounting Kit Model - GSDRPK
2. Include Remote Volume Control Model - GSRVC
3. The amplifier shall be a model GC150D, rated at 150 watts
4. The amplifier shall provide a frequency response from 65 Hz to 20 kHz +0/-2 dB at rated power. Distortion shall be 0.3% typically
5. The amplifier shall include an Audio Enhancement circuit, variable loudness contour control, and dual function equalizer. The equalizer shall be switch selectable for feedback control or acoustic shaping and shall include 10 center-detent slide controls providing ±12 dB of boost or cut from 62.5 Hz to 16 kHz in acoustic mode and from 125Hz to 8kHz in feedback control mode.

6.
7. Outputs shall be provided for 4- and 8-ohm speakers and for 25V, 25VCT and 70V distributed systems. Additional outputs shall be provided to feed a booster amp and recorder. A dedicated output shall permit feeding a 600-ohm telephone line using an accessory transformer (Model WMT1A). A Pre-Amp Out/Power-Amp In circuit shall be provided to insert signal processing equipment.

2.2 COMPONENTS

A. Speakers: 8 inch coaxial speaker with integral crossover circuit.

2. Frequency Range: 45 to 18,000 Hz.
3. Sound Pressure Level: 95 dB at 3 feet with 1 watt input.
4. Magnet: Ceramic; 10 ounces low frequency unit; 3 ounces high frequency unit.
5. Dispersion: Minus 3 dB at 90 degrees, minus 5 dB at 110 degrees.
6. Substitutions: See Section 01 60 00 - Product Requirements.

B. Horns: Wide dispersion indoor/outdoor horn with driver.

1. Power Rating: 60 watts.
2. Low Frequency Cutoff: 250 Hz.
3. Sound Distribution: 20 x 50 degrees.
4. Sound Pressure Level: 120 dB at 4 feet with full range input.

C. Telephone Interface: 600 ohm - auxiliary input.

2.3 WIRE AND CABLE

A. Input Cable: 22 AWG copper conductor, 300 volt insulation, rated 60 degrees C, paired conductors twisted together, shielded, and covered with a PVC jacket.

B. Speaker Wire and Cable: 22 AWG copper conductor, 300 volt insulation, rated 60 degrees C, paired conductors twisted together shielded and covered with a PVC jacket.

C. Plenum Cable for Speaker Circuits: 22 AWG copper conductor, 300 volt insulation, rated 200 degrees C, paired conductors twisted together shielded and covered with a nonmetallic jacket; suitable for use for Class 2 circuits in air handling ducts, hollow spaces used as ducts, and plenums.
PART 3 EXECUTION

3.1 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Splice cable only in accessible junction boxes or at terminal block units.
C. Make cable shields continuous at splices and connect speaker circuit shield to equipment ground only at amplifier.
D. Install input circuits in separate cables and raceways from output circuits.
E. Provide protection for exposed cables where subject to damage.
F. Use armored cable for outside speaker circuits.
G. Support cables above accessible ceilings to keep them from resting on ceiling tiles. Use spring metal clips or plastic cable ties to support cables from structure for ceiling suspension system. Include bridle rings or drive rings.
H. Use suitable cable fittings and connectors.
I. Connect reproducers to amplifier with matching transformers.
J. Ground and bond equipment and circuits in accordance with Section 26 05 26.

3.2 FIELD QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Measure and record sound power levels at designated locations.

3.3 CLOSEOUT ACTIVITIES
A. Training: Train Owner's personnel on operation and maintenance of system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of two hours of training.

3.4 MAINTENANCE
A. Provide service and maintenance of public address and music system for one year from Date of Substantial Completion.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Television distribution equipment.
   B. Cable and accessories.

1.2 RELATED REQUIREMENTS
   A. Section 26 05 34 - Conduit.

1.3 REFERENCE STANDARDS
   A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 SYSTEM DESCRIPTION
   A. Service entrance from local cable utility.
   B. Premises wiring for broadband distribution of television signal, including individual outlets.
   C. Signal at each outlet: 3 dBmV across 75 ohms, minimum, plus 5 dB, minus 0 dB.

1.5 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide showing electrical characteristics and connection requirements for each component.
   C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
   D. Project Record Documents: Record actual locations of outlets, devices, and cable routing.
   E. Operation Data: Instructions for setting and tuning channels.
   F. Maintenance Data: Basic trouble-shooting procedures.

1.6 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70 and cable television utility company.
   B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience with service facilities within 100 miles of Project.
   C. Supplier Qualifications: Authorized distributor of specified manufacturer with minimum three years documented experience.
   D. Installer Qualifications: Authorized installer of specified manufacturer with service facilities within 100 miles of the project.
E. Products: Listed, classified and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.1 RECEIVING COMPONENTS

A. Manufacturers:

2.2 AMPLIFIERS AND CONVERTERS

A. Manufacturers:

2.3 ACCESSORIES

A. Tap:
   1. Surface mounted, all channel, back-matched tap.
   2. Through Loss: 0.7 dB, maximum.
   4. Isolation: 12 dB.
   5. Connector: F type coaxial connector.

B. Splitter:
   1. Inline, all channel, back-matched splitter.
   2. Through Loss: 3.5 dB for two-way; 6.7 dB for four-way.

C. Main Distribution Cable:
   1. Description: RG 11/F.

D. Branch Distribution Cable:
   1. Description: RG 6/F.

E. Television Lead Cable:
   1. Provide set-matched cord with 75-300 ohm transformer. Use RG 59/F coax cable, minimum length 6 feet.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Connect cable television service in accordance with cable utility instructions.

C. Provide proper grounding of television system components and wiring. Bond outdoor components to lightning protection system.

3.2 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Measure signal level at each outlet.
3.3 ADJUSTING
   A. Adjust each antenna using field strength meter to orient it for maximum signal reception.
   B. Adjust amplifier gain and make other system adjustments to achieve specified output levels at each outlet.

3.4 CLOSEOUT ACTIVITIES
   A. Demonstration: Demonstrate operation of system to Owner's personnel.
      1. Use operation and maintenance data as reference during demonstration.
      2. Briefly describe function, operation, and maintenance of each component.
      3. Include demonstration of television operation specified signal level at two outlets selected by Owner.

3.5 MAINTENANCE
   A. Provide service and maintenance of television system for one year from Date of Substantial Completion.
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Access control units and software.
   B. Access control point peripherals, including readers.
   C. Accessories.
   D. Access control field devices.
   E. Access control panel(s), System Controller(s)
   F. Access control Server and software.
   G. Signal and control wiring
   H. All hardware and accessories for a complete and functioning system.

1.2 RELATED REQUIREMENTS
   A. Section 08 71 00 - Door Hardware.
   B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
   D. Section 27 10 05 - Communications Copper Cabling: Data cables for access control system IP network connections.
   E. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables (600 V and Less).
   F. Section 26 05 33 - Conduits and Backboxes for Electrical Systems.
   G. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

1.3 REFERENCE STANDARDS
   A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
   B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
   C. NFPA-730 Guide for Premises Security
   D. NFPA-731 Standards for the Installation of Electronic Premises Security
   E. National Electric Code
   F. UL 294 Access Control Systems
   G. National Electrical Manufacturers Association (NEMA)
   H. Applicable Federal, State and Local laws and regulations
   I. Americans with Disabilities Act (ADA)
1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Include plan views indicating locations of system components and proposed size, type, and routing of conduits and/or cables. Include elevations and details of proposed equipment arrangements. Include system interconnection schematic diagrams. Include requirements for interface with other systems.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for each system component. Include ratings, configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.

D. Test Reports: Indicate satisfactory completion of required tests and inspections.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

F. Manufacturer's detailed field testing procedures.

G. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.

H. Operation Data: Operating instructions.

I. Maintenance Data: Maintenance and repair procedures.

J. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Deliver blank credentials to Owner as directed.

K. Shop Drawings: Indicate system wiring diagram showing each device and wiring connection; indicate layout, sequence of operation.
1. Indicate all system device locations on architectural floor plans.
2. Include a complete SYSTEM one-line, block diagram.
3. Include full schematic wiring information on these drawings for all devices. Wiring information shall include cable type, conductor routings, quantities, and connection details at device.

1.5 QUALITY ASSURANCE

A. Comply with the following:
1. NFPA 70
2. The requirements of the local authorities having jurisdiction.
3. Applicable TIA/EIA standards.

B. Conform to requirements of NFPA 70.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with access control systems of similar size, type, and complexity and providing contract maintenance service as a regular part of their business; authorized manufacturer’s representative.

E. Products: Furnish products listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and indicated.
F. Provide wiring materials located in plenums with peak optical density not greater than 0.5,
   average optical density not greater than 0.15, and flame spread not greater than 5 feet (1.5 m)
   when tested in accordance with NFPA 262.

G. Perform Work in accordance with NEC, TIA/EIA 568 Standards.

H. Maintain one copy of each document on site.

1.6 SYSTEM DESCRIPTION/REQUIREMENTS

A. Access Control System (ACS): Control access to buildings using authorized credentials and
   associated electronic devices monitored and programmed by networked software control system.

B. Control access into and out of the building areas: Reference contract drawings for Electronic
   Access Control door locations.
   1. Card Reader (CR)
   2. Request to Exit Sensor (REX)
      a. To shunt Door Monitoring (Door Contacts) from exit side of doors
   3. Electric Locking Hardware (DS)

C. Access Control Functions:
   1. The System shall be to electronically regulate access through specific doors and gates to
      secured areas of the Owner’s facility.
   2. The System shall utilize valid Access credentials (cards, fobs, etc.) and card readers,
      located at designated entry doors [and designated corridor partitioning doors]. A valid
      credential is one that has been programmed to perform the indicated function on a
      specified partition during a valid time for that user.
   3. The system shall be able to make access granted or denied decisions, define access
      privileges, and to set schedules and holiday groups. Any authorized changes made to
      personnel data will be automatically updated for all system functions and reporting.
   4. All inputs and outputs shall be capable of being transmitted globally across all system
      networks.

D. Monitor open closed status of selected doors. Reference contract drawings for door locations.
   Doors equipped with door contacts (DC):
   1. Door open status beyond programmed time out period will send alarm status to
      designated workstation and provide record of alarm in a report form with system
      programming per owner requirements.
   2. Door contacts will be addressable on a door location basis (multiple doors at entry exit
      point may report as one alarm point) and home run wired to the Input Control Module(s).
   3. Monitoring shall provide for full time 24-7 monitoring and reporting functionalities of open
      closed status of equipped doors.
   4. Door status will be graphically represented through the ACS software on any client
      software equipped PC. Automatic notification of door open status alarm will be capable to
      appear as both audible and visual notification on selected PC via system programming.
      Program Door Monitoring functionality for both occupied (normal day operation) and
      unoccupied (night shift/weekends, etc.) per owner requirements.

E. The ACS Hardware and Software shall support:
   1. The ACS software shall be enterprise level and upgradeable and expandable to
      accommodate unlimited card access readers without requiring System Server or Software
      replacement.
   2. The ACS software will have standard Min. capacity for 32 card readers and can be
      expanded to accommodate up to 64 card access readers.
      a. The software shall be expandable to support an unlimited number of input points,
         output points and relay outputs.
3. The ACS database server shall support a minimum of 25,000 cardholders, visitors, and assets and be expandable limited only locally on the available memory on the Intelligent System Controller(s) Control Panels.
4. The database server shall also support an unlimited number of system events and System Operator transactions in the history file.
5. The ACS software shall be capable to support a minimum of 5 client workstations and be expandable for an additional 5.
6. Refer to Control Panels for System control hardware requirements.

F. The ACS shall utilize a single seamlessly integrated relational database for all functions utilizing a fully multi-tasking multi-threading Microsoft Windows 7 or Windows XP Operating System. The ACS shall be written so that all modules Access Control, Alarm Monitoring, ID / Credential Management, and Digital Video Management System (DVMS) are developed and built from a unified single 32-bit source code set.

G. Upgrades or expansion of the ACS, as specified herein, to a larger size system in scale shall not require installation of a different and or new ACS application or require the administrator/operator to learn a different and or new interface from the previous version.

H. Upgrades or expansion of the ACS software, as specified herein, to a larger size system in scale shall not require installation of a different and or new control panels or associated communication wiring (BUS).

I. The ACS shall be able to seamlessly interface with and monitor:
   1. Intelligent System Controllers
   2. Reader Interface Modules (Door Controllers)
   3. I/O panels modules
   4. Access Control Intercom systems

J. The ACS shall fully integrate the [Access Control] [Employee Data Base] System in use. This Contract shall include the downloading of all current personnel credentials database information into the ACS software for a complete functioning system as specified herein.

K. Credential Management
   1. The ACS shall incorporate a Credential Management and Enrollment module that is integral to the ACS source code with the ability to create and maintain the Cardholder database. Features shall include the ability to:
      a. Add, Modify and Delete records based upon permissions
      b. Capture photo images
      c. Print Credentials
      d. Boolean Search on any single or multiple fields
      e. Customization of screen layout and field names
      f. Advanced customization of fields, field names and screen tabs (pages)
      g. Determine single or multiple active badges
      h. Assign Access Levels and Access Groups
      i. Bulk Assignment/Modification/Deletion of Access Levels
      j. Bulk Deletion of Cardholder Records

PART 2 PRODUCTS

2.1 MANUFACTURERS-CONTROL SYSTEM

A. Access Control System:
B. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

C. Source Limitations: Where possible, furnish system components and accessories produced by a single manufacturer and obtained from a single supplier.
   1. Andover Controls, ACX Continuum

2.2 ACCESS CONTROL SYSTEM SERVER

A. Provide new access control system consisting of all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. System Battery Backup: Provide batteries/uninterruptible power supplies (UPS) as required for 120 minutes full operation.

C. Computers Required:
   1. See article "ACCESS CONTROL UNITS AND SOFTWARE" below for product descriptions.
   2. Server(s):
      a. Quantity: One.
      b. Peripherals required for each server:
         1) Mouse and keyboard.
         2) Monitor(s): One.
   3. Workstation Computer(s):
      a. Quantity: One.
      b. Peripherals required for each workstation computer:
         1) Mouse and keyboard.
         2) Monitor(s): One.

D. Networked Access Control System: Software configured to Control access to building and selected areas using Authorized Credentials-cards

E. Access Control System Servers
   1. Min. Server hardware
      a. Core 2 Duo E6850, 3.0 GHz or better
      b. 8GB 2x4GB Dual Ranked DIMMs
      c. 48x CDRW/DVD IDE Combo Drive, Half-Height
      d. PERC 5i SAS internal Raid adapter, PCI-Express
      e. RAID 5: (3) 160GB 7.2K RPM Serial ATA 3Gbps 3.5-in Cabled Hard Drive
      f. 64 bit operating system
   2. Min. Workstation hardware:
      a. Core i5
      b. 8GB, 1333MHz, DDR3 NECC SDRAM Memory, 2X4096
      c. nVidia Quadro K620 2GB video card
      d. 48X/32X/48X CD-RW/DVD Combo Drive
      e. 500 GB SATA 3.0Gb/s with NCQ and 8MB DataBurst Cache
      f. 64-bit operating system
   3. Server Software shall have the requirements listed in Part 1 herein.

2.3 ACCESS CONTROL UNITS AND SOFTWARE

A. Provide access control units and associated software compatible with readers to be connected.
2.4 ACCESS CONTROL POINT PERIPHERALS

A. Provide devices compatible with control units.
B. Provide devices suitable for operation under the service conditions at the installed location.
C. Provide readers compatible with credentials to be used.
D. Proximity Readers:
   1. Utilizes 125 kHz RF communication with compatible credentials.
E. Door Position Switches:
   1. Magnetic Contacts: Encapsulated reed switch(es) and separate magnet; designed to monitor opened/closed position of doors.
F. Request to Exit Devices:
G. Door Locking Devices (Electric Strikes and Magnetic Locks): Comply with Section 08 71 00.

2.5 ACCESSORIES

A. Provide components as indicated or as required for connection of access control system to devices and other systems indicated.
B. Unless otherwise indicated, credentials to be provided by Contractor.
   1. Provide credentials compatible with readers and control units/software to be used.
C. Provide cables as indicated or as required for connections between system components.
D. Provide accessory racks/cabinets as indicated or as required for equipment mounting.

2.6 ACCESS CONTROL SYSTEM FIELD COMPONENTS

A. Security Access Control Panel:
   1. Main Controller Andover Controls
      a. Andover Controls Continuum Continuum ACX Series
   2. Substitutions: See Section 01 60 00 - Product Requirements.
B. Proximity Reader:
   1. HID ThinLine II proximity card reader, Model Number 5395, HID Prox Pro Model 5355,
      Mullion mount HID Mini Prox Model 5365
C. Card Reader Door Controllers: Anover Controls Continuum
   1. Product: Continuum AT Series , UI-8
   2. Substitutions: See Section 01 60 00 - Product Requirements.
D. Access Credentials Proximity Cards:
   1. Product: HID Corp. Model 1386 ISOProx II
E. Door Contacts
   1. Product: Sentrol Model 1078 Recess Mount
   2. Sentrol Model 1086 Recess Mount for steel doors
   3. Sentrol Model 1038T Surface Mount
F. Request To Exit Sensor (REX)
G. Wire and Cable
   1. Manufacturers: Belden; 3M; ADC
      a. Door Contact Cable
         1) 2 conductor insulated cooper 18-AWG, 75 deg, C rated plenum jacket, unshielded, UL Type CMP.
b. Card Reader Signal / Power Cable
   1) 6 Conductor cooper, 18 AWG, 75 deg. C rated plenum jacket, overall shield with drain wire, UL Type CMP.

c. Request to Exit Sensors (REX)
   1) 4C, 18 AWG, Shielded, 75 deg. C rated plenum jacket, UL Type CMP.

d. Electric Door Strike Power Cable
   1) 2 conductor insulated copper, 16 AWG, 75 deg. C rated plenum jacket, unshielded, UL Type CMP.

e. Electric Locking Hardware as part of door set:
   1) Provide wire per door hardware Mfg. Size all wire for volt drop.

f. Provide all associated wire and cable for the Intercom Solution listed herein and per manufacturer recommendations.

g. Substitutions: Section 01 60 00 - Product Requirements.

H. Cable Located Exposed in Plenums: Power limited cable classified for fire and smoke characteristics, copper conductor, 300 volts insulation rated 105 degrees C, suitable for use in air handling ducts, hollow spaces used as ducts, and plenums.

2.7

PART 3 EXECUTION

3.1 INSTALLATION

A. Install access control system in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Provide grounding and bonding in accordance with Section 26 05 26.

D. Identify system wiring and components in accordance with Section 26 05 53.

E. Make conduit and wiring connections to door hardware devices furnished and installed under Section 08 71 00.

F. Provide wiring in conduit per NEC and Local codes.

G. Provide wiring and connections to door hardware devices.

H. Provide engraved plastic nameplates in accordance with Section 28 05 53.

I. Ground and bond security access equipment and circuits in accordance with Section 26 05 26.

J. Electronic locking devices shall have a separate power supply. Provide and install power supplies as required to support the locks. The unit shall incorporate integral battery charging capabilities and a fused line voltage input for individual locks. All power supplies shall be equipped with optional battery pack for up to 24 hours of backup. As required, the unit shall be equipped with a module to accommodate fire alarm NC contacts when a fire alarm activates.

K. Provide all interface wiring, relays, connections and programming required to interface electric locking/unlocking of door hardware with powered door openers/actuator buttons.

1. Entry from exterior through door during scheduled lock times: Exterior ADA actuator button/powered opener will be disabled until authorized credentials (card, fob) are presented to Access system reader. Access control system to activate door opener actuator buttons so that when in a locked position, an entry door powered opener will NOT engage against a door with the latch in the locked position. User must first present an authorized credential to the card reader to unlock the door. Authorized credential will
unlock door and either initiate opening of door or activate the pushbutton for powered opening activation.

a. When entry point has second set of interior Vestibule doors with powered opener, and no actuator button inside the Vestibule, the interior opened door must have programmed time delay to stay open for a sufficient time to allow the persons to pass through.

2. Exit at powered door in scheduled lock times: Upon pushing interior located actuator button(s), the access control system will unlock associated doors and allow the person to pass through door(s) and exit the building. Doors to close and lock after (adjustable) set time period.

L. At locations with removable mullions and electric strikes, provide quick disconnect plugs in order to facilitate the removal of the mullion without cutting the wires to the electric strike.

M. All conduit sleeves and holes shall be ground smooth to remove all sharp edges and burrs that could potentially damage cabling. All cabling shall be supported and protected at all holes, penetration points, boxes, conduit, etc. with protective grommets or material that will protect the cabling from any abrasive contact with surfaces that might cause damage.

N. Comply with manufacturer's instructions and recommendations for installation of product in the applications indicated. Anchor products securely in place, accurately located and aligned with other work.

O. It is the installer's / contractor's responsibility to test every aspect of the ACS system and document the location and performance of every cable, termination point, riser, control panel, Card Reader, Door contact, rex, Input point, and all associated software functions.

P. All cable management (troughs) are mounted tight, level and square with all fasteners installed and be free of debris on the inside and outside.

Q. All cabling outside enclosures are installed free from sharp edges and dressed neatly.

R. Cables installed using approved method when not in cable management trays.

S. Cable management not to use adhesive tie wraps, due to loss of secure mounting.

T. Cables enter and leave junction boxes using proper bushings, fittings, grommets.

U. All wiring to be neatly dressed. All Bend radii are sufficient, and equate to cable type requirements.

V. Cable runs are continuous and not spliced. Field splice connections will be documented and only as necessary to end of line device to minimize points of failure/DB loss. Field splice connections will be in secured enclosure.

W. All terminations at field devices are visually inspected to ensure properly soldered-no dolphins, wire nuts or b-connects.

X. All field devices mounted using approved installation fasteners and hardware to ensure serviceability (field devices can be removed and remounted)

Y. All field devices mounted tight, level, square and sealed as needed for weatherproof applications.

Z. All terminations at field devices are inspected to ensure there are no bare wire conductors and all is insulated and shrink wrapped. All spare un-terminated conductors are properly safe-ended with shrink wrap.

AA. Supervision EOL resistors are located at the field device to be supervised.

AB. Cable installation shall not impact any existing cabling infrastructure.
3.2 SYSTEM PROGRAMMING

A. The Contractor and the ACS Vendor are jointly responsible for Initial Programming and report formatting of the ACS as specified herein and as directed by the owner/owner representative. The owner will convey their programmable operational requirements for all system functions in lay terms, and Initial System programming will be completed to satisfy the owner’s requirements.

B. The Contractor and the ACS Vendor will be required to meet with the owner’s representatives a Min. 3 times to discuss, recommend and document the owner’s needs for programming and sequences of operation.

C. Programming Functions to be provided shall include but not be limited to:
   1. Schedules, groups and sequence of operation(s) for:
      a. Access Groups
      b. Access Levels
      c. Actions
      d. Action Groups
      e. Alarm Inputs
      f. Alarm Mask Groups
      g. Alarm Outputs
      h. Areas
      i. Badge Types
      j. Badge creation
      k. Card Formats
      l. Cardholders
      m. Card Readers
      n. Global I/O Function Lists
      o. Global I/O Links
      p. Holidays
      q. Maps
      r. Monitor Zones
      s. Receiver Accounts
      t. System Operators
      u. User Permission Groups
      v. Time Zones
      w. Visitor management
   2. Initial Graphic Map creation with icons and programming setup
   3. Set-up and pathing of all alarm notifications
   4. Report generation and formats for printing and notifications.
   5. Door Monitoring Status: Alarm Conditions; Graphic Annunciation

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Provide services of a manufacturer’s authorized representative to observe installation and assist in inspection and testing. Include manufacturer’s detailed testing procedures and field reports with submittals.

C. Prepare and start system in accordance with manufacturer’s instructions.

D. Program system parameters according to requirements of Owner.

E. Test for proper interface with other systems.
F. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

3.4 DEMONSTRATION AND MANUALS

A. Manuals: Final copies of the manuals shall be delivered after completing the installation test with signed (owner/owner representative) proof of receipt. Each manual’s contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the contractor responsible for the installation and maintenance of the system and the factory representatives for each item of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation test shall include all modifications made during installation, checkout, and acceptance testing. The manuals shall consist of the following:

B. Functional Design Manual: The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included.

C. Hardware Manual: The manual shall describe all equipment furnished including:
1. General description and specifications
2. Installation and check out procedures
3. Equipment layout and electrical schematics to the component level
4. System layout drawings and schematics
5. Alignment and calibration procedures
6. Manufacturers repair parts list indicating sources of supply

D. Software Manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:
1. Definition of terms and functions
2. System use and application software
3. Initialization, start up, and shut down
4. Reports generation
5. Details on forms customization and field parameters
6. Operators Manual: The operators manual shall fully explain all procedures and instructions for the operation of the system including:
7. Computers and peripherals
8. System start up and shut down procedures
9. Use of system, command, and applications software
10. Recovery and restart procedures
11. Graphic alarm presentation
12. Use of report generator and generation of reports
13. Data entry
14. Operator commands
15. Alarm messages and reprinting formats
16. System permissions functions and requirements

E. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

F. As-Built Drawings: During system installation, the Contractor shall maintain a separate hard copy set of drawings, elementary diagrams, and wiring diagrams of the ACS to be used for record drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the ACS. Copies of the final as-built drawings shall be provided to the end user in DXF format.
3.5 CLOSEOUT ACTIVITIES
   A. Provide ____ hours of instruction each for ____ persons.
      1. Conduct instruction at project site with manufacturer's representative.

3.6 MAINTENANCE
   A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
   B. Provide a separate maintenance contract for specified maintenance service.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES

A. Video surveillance system requirements.
B. CCTV Cameras and associated mounting Accessories and hardware
C. Cable and accessories.
D. Digital Video Management Software System and associated Storage Servers

1.2 RELATED REQUIREMENTS

A. Section 27 10 05 - Communications Copper Cabling: Data cables for IP video surveillance system network connections.
B. Section 27 05 26 - Grounding and Bonding for Communications Systems.
C. Section 27 05 53 - Identification For Communications Systems
D. Section 27 05 33 - Conduits and Backboxes for Communications Systems.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
D. NFPA-730 Guide for Premises Security
E. NFPA-731 Standards for the Installation of Electronic Premises Security Systems
F. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of cameras with structural members, ductwork, piping, equipment, luminaires, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
   2. Coordinate the work with other installers to provide power for cameras and equipment at required locations.
   3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Preinstallation Meetings:
   1. Conduct meeting with facility representative to review camera and equipment locations and camera field of view objectives.
   2. Conduct meeting with facility representative and other related equipment manufacturers to discuss video surveillance system interface requirements.
1.5 SYSTEM DESCRIPTION

A. Description: Video surveillance and monitoring at points as indicated on Drawings.

B. The Digital Video Management System (DVMS) will be a complete solution to record digital video from new IP video cameras positioned on the interior, exterior & site of the building. Provide all available software upgrades to the DVMS and provide licensing for all cameras shown on the contract documents. System shall be accessible via the local area network and be capable of storing digital video files on multiple hard drives. System programming and file retrieval will be password protected and available at work stations & mobile devices per the owner.

C. Configuration: 10\100\1000 Mbps Network.

D. Contractor responsible for verifying DVMS server fitment into wall mounted cabinet per specification.

1.6 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Include plan views indicating locations of system components and proposed size, type, and routing of conduits and/or cables. Include elevations and details of proposed equipment arrangements. Include system interconnection schematic diagrams. Include requirements for interface with other systems.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets for each system component. Include ratings, configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.

D. Certify that proposed system design and components meet or exceed specified requirements.

E. Evidence of qualifications for installer.

F. Evidence of qualifications for maintenance contractor (if different entity from installer).

G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.

H. Field quality control test reports.

I. Project Record Documents: Record actual locations of cameras and routing of cables.

J. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

K. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

L. Maintenance contracts.

1.7 QUALITY ASSURANCE

A. Comply with the following:

1. NFPA 70
2. Applicable TIA/EIA standards.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with video surveillance systems of similar size, type, and complexity and providing contract maintenance service as a regular part of their business; authorized manufacturer's representative.
   1. Contract maintenance office located within 120 miles of project site.

E. Products: Furnish products listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions and NECA 303.

B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.9 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Video Management System Software:
   1. Bosch Security Systems
   2. Honeywell Video Systems
   3. On-Net Surveillance Systems, Inc. (ONSSI)
   4. Milestone Protect Enterprise
   5. Genetec Inc-Omnicast

B. Camera Manufacturers:
   1. Cameras to be IP 3MP Megapixel vandal resistant dome cameras.
      a. Bosch Security Systems
      b. Honeywell Video Systems
      c. Pelco
      d. Axis Communications

C. Network Video Recorders-Servers:
   1. Server specs based on Video management software. Provide 30 day storage for 3MP camera at 24 hour recording.
2. HP  
3. Dell  
4. Bosch  
5. Honeywell  

2.2 DIGITAL VIDEO MANAGEMENT SYSTEM  
A. Provide new video surveillance system consisting of all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.  
B. System Description: IP system with connection to network (IP) cameras.  
   1. Video Storage Capacity: Suitable for storing video from all cameras for 30 days.  
   2. System Battery Backup: Provide batteries/uninterruptible power supplies (UPS) as required for 60 minutes full operation.  
   3. Surge Protection:  
      a. Provide surge protection for exterior cameras.  
      b. Provide equipment power surge protection where electrical distribution system surge protection is not provided.  
C. Provide products listed, classified, and labeled as suitable for the purpose intended.  
E. Capacities:  
   1. Cameras: 50 cameras per server & per software Management System.  
   2. Client Administrative Stations: 2 per owner's directive.  

2.3 NETWORK SWITCH ELECTRONICS  
A. Requirements:  
   1. Network Switch  
      a. Capacity: 48-Port  
      b. Full Power Over Ethernet: PoE+ (60w)  
      c. Uplink: 10Gbps Uplink module with Small Form Factor (SFP+) on top of stack network switch  
      d. Network Port Speed: 10/100/1000 Mbps (Gigabit Ethernet)  
      e. Stacking Backplane: 20 Gbps minimum  
      f. Power Supply: 740W minimum  
      g. IOS: LAN Base  
      h. Contractor to Provide all configuration of switch.  
B. Approved Products:  
   1. Cisco Systems Model: WS-C2960x-FPS-L  
C. Substitutions: See Section 01 60 00 - Product Requirements.  

2.4 NETWORK VIDEO RECORDER & STORAGE  
A. Requirements: Provide storage servers to record all IP cameras called for on the camera schedule based on frame rate, video compression settings and desired video retention period (30 Days). Provide all available software updates and apply them on the storage servers. Servers must meet the following minimum requirements:  
   1. Windows Server 2008 R2 64 Bit  
   2. Intel Core 2 Duo E6850 Processor, 3.0Ghz  
   3. 8 GB of RAM
4. (x2) Dual 10/100/1000 Mbps Network Interface Cards
5. 10K RPM Hard Drives with NTFS and rated for Video Recording
6. 8TB Storage Capacity per server
   a. Contractor to verify required amount of space for 24 hour recording at full resolution.
7. RAID 10 hard drive configuration
8. Contractor to Verify server submitted on will fit in wall mounted cabinet.

B. Approved Products:
   1. Hewlett Packard Model: DL-360

C. Substitutions: See Section 01 60 00 - Product Requirements.

2.5 IP CAMERAS AND MOUNTS

A. Indoor Ceiling & Wall Mounted Camera
   1. Product Requirements:
      a. Image Sensor: Progressive Scan RGB 1/2.8” CMOS
      b. Lens: 3-9mm, Horizontal FOV 100-35
      c. Minimum Alumination Color: 0.2 lux at F1.3, Black & White: .04 lux at F1.3
      d. Camera Angle Adjustment: Pan 360, Tilt 160, Rotate 340 degrees
      e. Video Compression: H.264
      f. Resolution: 1920x1080
      g. Frame Rate in H.264: 25/30 fps with 50/60 Hz power frequency
      h. Operating Conditions: 0-50 Celcius, Humidity 10-85% RH
      i. Security: Password Protected, HTTPS, IP Address Filtering
   2. Approved Product:
      a. Axis Cameras Model: P3364-V

B. Outdoor Wall & Pendant Mounted Camera
   1. Product Requirements:
      a. Image Sensor: Progressive Scan RGB 1/2.8” CMOS
      b. Lens: 3 - 9mm Varifocal with 100-35 degree view, F1.3
      c. Minimum Alumination (F1.2): Color: 0.2 lux, Black & White: .04 lux
      d. Camera Angle Adjustment: Pan 360, Tilt 160, Rotate 340 degrees
      e. Video Compression: H.264
      f. Resolution: 2592 x 1944 pixels (5 MP)
      g. Frame Rate in H.264: 2 MP - 30 fps
      h. Security: Password Protected, HTTPS, IP Address Filtering
      i. Operating Temperatures: -40° to 131 °F
   2. Approved Product:
      a. Axis Cameras 2MP Model: P3365-VE

C. Recessed Ceiling Mount
   1. Approved Product:
      a. Axis Housing (Clear) Model:5502-361
      b. Axis Housing (Smoked) Model:5502-371

D. Pendant Mount
   1. Approved Product:
      a. Axis Pendant Kit Model:5502-321
      b. Axis Wall Bracket Model:5017-611

E. CAT 6 LAN Surge Suppressor- PoE Compatible
   1. Manufacturers:
      a. Product: L-Com Model # HGLN-CAT6J
   2. Requirements:
a. UL listing: UL 497 & UL 497B  
b. Fused/Auto-resettable  
c. Clamping level: 65V  
d. Data Line Impedance: 100 Ohms  
e. Termination Type: RJ-45

PART 3 EXECUTION

3.1 EXAMINATION
A. Verify that ratings and configurations of system components are consistent with the indicated requirements.
B. Verify that mounting surfaces are ready to receive system components.
C. Verify that branch circuit wiring installation is completed, tested, and ready for connection to system.
D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION
A. Install video surveillance system in accordance with NECA 1 (general workmanship) and NECA 303.
B. Install products in accordance with manufacturer's instructions.
C. Provide required support and attachment in accordance with Section 26 05 29.
D. Wiring Method: Unless otherwise indicated, use cables (not in conduit).
   1. Use listed plenum rated cables in all spaces.
   2. Conceal all cables unless specifically indicated to be exposed.
   3. Cables in the following areas may be exposed, unless otherwise indicated:
      a. Equipment closets.
   4. Include service loop cable lengths to allow relocation of cameras within 15 ft of installed location.
E. Label all cameras per Owner requirements and to match as in software naming convention.
F. Configure System for maximum video resolutions and recording time within parameters established through programming and training meetings with owner.
G. For IP Cameras: Test all cabling per Section 27 10 00.
H. All cameras to be verified for start up and software programming.
I. The Contractor shall carefully follow instructions in documentation provided by the manufacturer to insure all steps have been taken to provide a reliable system.
J. All equipment shall be tested and configured in accordance with instructions provided by the manufacturer prior to installation.
K. 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.
L. Coordinate all final locations with owner. Get sign off from owner on final view of camera.
M. All Camera cabling drops will have a 15 foot service loop for adjusting camera location to achieve alternate view.
N. Comply with manufacturer’s instructions and recommendations for installation of product in the applications indicated. Anchor products securely in place, accurately located and aligned with other work.

3.3 INTERFACE WITH OTHER PRODUCTS
A. Interface installation of video surveillance with security access and intrusion detection systems.

3.4 FIELD QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Prepare and start system in accordance with manufacturer’s instructions.
C. Adjust cameras to provide desired field of view and produce suitable images under all service lighting conditions.
D. Program system parameters according to requirements of Owner.
E. Test for proper interface with other systems.
F. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
G. Provide the services of manufacturer’s technical representative to prepare and start systems and supervise final wiring connections and system adjustments.

3.5 ADJUSTING
A. Adjust Varifocal lens for view and to meet lighting conditions.

3.6 SYSTEM PROGRAMMING
A. The Contractor and the DVMS Vendor are jointly responsible for Initial Programming and report formatting of the DVMS as specified herein and as directed by the owner/owner representative. The owner will convey their programmable operational requirements for all system functions in lay terms, and Initial System programming will be completed to satisfy the owner’s requirements.
B. The Contractor and the DVMS Vendor will be required to meet with the owner’s representatives a Min. 3 times to discuss, recommend and document the owner’s needs for programming and sequences of operation.
C. Programming Functions to be provided shall include but not be limited to:
   1. Schedules, groups, etc. and sequence of operation(s) for all functions listed herein (Para 2.1) and including but not limited to:
      a. Digital Video Archive Servers set up
      b. Forms and System Page(s) set up, forms customization and field parameters.
      c. Camera set up: Digital focus, digital resolution; motion detection; tours; etc. depending upon Camera capabilities.
      d. Recording Functions: FPS; durations; resolutions; etc. depending on Camera and System Capabilities.
      e. Head end Hardware configurations
      f. Graphic building Map and associated icons
      g. Alarm Inputs
      h. Alarm Outputs
      i. Areas
      j. Global I/O Function Lists
      k. Global I/O Links
l. Holidays
m. Maps
n. Monitor Zones
o. System Operators
p. User Permission Groups
q. Time Zones
r. Tour Groups (as applicable)

2. Initial Graphic Map creation with icons and programming setup
3. Set-up and pathing of all alarm notifications
4. Report generation and formats for printing and notifications.

3.7 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.

B. Demonstrate system operation and provide 8 hours of instruction with manufacturer's training personnel.

C. Conduct walking tour of project and briefly describe function, operation, and maintenance of each component.

D. Manuals: Final copies of the manuals shall be delivered after completing the installation test with signed (owner/owner representative) proof of receipt. Each manual’s contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the contractor responsible for the installation and maintenance of the system and the factory representatives for each item of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation test shall include all modifications made during installation, checkout, and acceptance testing. The manuals shall consist of the following:

E. Functional Design Manual: The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included.

F. Hardware Manual: The manual shall describe all equipment furnished including:
   1. General description and specifications
   2. Installation and check out procedures
   3. Equipment layout and electrical schematics to the component level
   4. System layout drawings and schematics
   5. Alignment and calibration procedures
   6. Manufacturers repair parts list indicating sources of supply

G. Software Manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:
   1. Definition of terms and functions
   2. System use and application software
   3. Initialization, start up, and shut down
   4. Reports generation
   5. Camera views; Camera recording on motion; FPS, Time periods; playback retrieval; PTZ programming; integration with card reader/access point activation.
   6. Details on forms customization and field parameters

H. Operators Manual: The operators manual shall fully explain all procedures and instructions for the operation of the system including:
   1. Computers and peripherals
   2. System start up and shut down procedures
3. Use of system, command, and applications software
4. Recovery and restart procedures
5. Graphic alarm presentation
6. Use of report generator and generation of reports
7. Data entry
8. Operator commands
9. Alarm messages and reprinting formats
10. System permissions functions and requirements

I. As-Built Drawings: During system installation, the Contractor shall maintain a separate hard copy set of drawings, elementary diagrams, and wiring diagrams of the DVMS to be used for record drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the DVMS. Copies of the final as-built drawings shall be provided to the end user in DXF format.

END OF SECTION
PART 2 PRODUCTS

1.1 MANUFACTURERS
   A. Fire Alarm Control Units - Basis of Design: SELECT/ENTER MANUFACTURER NAME AND ENTER MODEL NUMBER.
   B. Fire Alarm Control Units - Other Acceptable Manufacturers: Provided their products meet or exceed the performance of the basis of design product, products of the following are acceptable:
      1. Provide all control units made by the same manufacturer.

1.2 FIRE ALARM SYSTEM
   A. Fire Alarm System: Provide a new automatic fire detection and alarm system:
      1. Provide all components necessary, regardless of whether shown in the contract documents or not.
      2. Protected Premises: Entire building shown on drawings.
      3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
         a. ADA Standards.
         b. The requirements of the local authority having jurisdiction, which is ________.
         c. Applicable local codes.
         d. The contract documents (drawings and specifications).
         e. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
      4. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.
      6. General Evacuation Zones: Each smoke zone is considered a general evacuation zone unless otherwise indicated, with alarm notification in all zones on the same floor, on the floor above, and the floor below.
      7. Program notification zones and voice messages as directed by Owner.
      8. Fire Command Center: Location indicated on drawings.

   B. Supervising Stations and Fire Department Connections:
      1. Public Fire Department Notification: By on-premises supervising station.
      2. On-Premises Supervising Station: Existing proprietary station operated by Owner, located at ________.
      3. Means of Transmission to On-Premises Supervising Station: Directly connected noncoded system.

   C. Circuits:
      1. Initiating Device Circuits (IDC): Class B, Style A.
      2. Signaling Line Circuits (SLC) Within Single Building: Class B, Style 0.5.
      4. Notification Appliance Circuits (NAC): Class B, Style W.
D. Spare Capacity:
1. Initiating Device Circuits: Minimum 25 percent spare capacity.
4. Master Control Unit: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.

E. Power Sources:
1. Primary: Dedicated branch circuits of the facility power distribution system.
2. Secondary: Storage batteries.
3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.

1.3 FIRE SAFETY SYSTEMS INTERFACES
A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:

1.4 COMPONENTS
A. General:
1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.

B. Fire Alarm Control Units, Initiating Devices, and Notification Appliances: Analog, addressable type; listed, classified, and labeled as suitable for the purpose intended.

C. Master Control Unit: As specified for Basis of Design above, or equivalent.

D. Initiating Devices:

E. Notification Appliances:

F. Circuit Conductors: Copper or optical fiber; provide 200 feet extra; color code and label.

G. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.

H. Locks and Keys: Deliver keys to Owner.

I. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
2. Provide one for each control unit where operations are to be performed.
3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
4. Provide extra copy with operation and maintenance data submittal.

END OF SECTION
SECTION 31 05 13
SOILS FOR EARTHWORK

PART 1 GENERAL

1.1 SECTION INCLUDES

1.2 RELATED REQUIREMENTS:
   A. Section 31 05 16 - Aggregates for Earthwork.
   B. Section 31 22 00 - Grading.
   C. Section 31 23 16 - Excavation.
   D. Section 31 23 16.13 - Trenching.
   E. Section 31 23 23 - Fill.
   F. Section 32 92 19 - Seeding.
   G. Section 32 93 00 - Plants.

1.3 REFERENCE STANDARDS
   A. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a
   4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
   B. ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using
   Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
   C. ASTM D 1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil
   Using Modified Effort (6,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
   D. ASTM D 2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil
   Classification System).

1.4 SUBMITTALS
   A. Section 01 30 00 - Administrative Requirements: Submittal Procedures
   B. Samples: Submit, in air-tight containers, 10 lbs sample of each type of fill to testing laboratory.
   C. Materials Source: Submit name of imported materials source.
   D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE
   A. Furnish each subsoil and topsoil material from a single source throughout the Work.
   B. Perform Work in accordance with NYSDOT standards.
PART 2 PRODUCTS

2.1 SUBSOIL MATERIALS
A. Excavated and re-used material or imported select borrow.
B. Graded.
C. Free of lumps larger than 3 inch, rocks larger than 2 inch, and debris.
D. Conforming to ASTM D 2487.

2.2 TOPSOIL MATERIALS
A. On-site Topsoil:
   1. Excavated onsite material shall not be used as topsoil. Topsoil shall be imported onto the site from an approved source.
B. Imported Topsoil
   1. Imported borrow.
   2. Friable loam.
   3. Reasonably free of roots, rocks larger than 1/2 inch, subsoil, debris, large weeds, and foreign matter.
      a. Screening: Double screened.
   4. Acidity range (pH) of 5.5 to 7.5
   5. Containing minimum of 4 percent and maximum of 25 percent inorganic matter.
   6. Conforming to ASTM D 2487.
   7. Limit decaying matter to 5 percent of total content by volume.

2.3 SOURCE QUALITY CONTROL
A. Section 01 40 00 - Quality Requirements: Testing and analysis of soil material.
D. When tests indicate materials do not meet specified requirements, change material and retest.
E. Furnish materials of each type from the same source throughout the Work.

PART 3 EXECUTION

3.1 EXCAVATION
A. Excavate subsoil and topsoil from areas designated. Strip topsoil to full depth of topsoil in designated areas.
B. Stockpile excavated material meeting requirements for subsoil and topsoil materials.
C. Remove excess excavated materials, subsoil, and topsoil not intended for reuse from site.
D. Remove excavated materials not meeting requirements for subsoil and topsoil materials from site.

3.2 STOCKPILING

A. Stockpile materials on site as designated by Architect.
B. Stockpile in sufficient quantities to meet Project schedule and requirements.
C. Separate differing materials with dividers or stockpile apart to prevent mixing.
D. Stockpile topsoil 8 feet high maximum.
E. Prevent intermixing of soil types or contamination.
F. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.
G. Stockpile unsuitable materials on impervious material and cover to prevent erosion and leaching until disposed of.

3.3 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.
B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION
SECTION 31 05 16
AGGREGATES FOR EARTHWORK

PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Coarse aggregate materials.
   B. Fine aggregate materials.
   C. Blended aggregate materials.

1.2 RELATED SECTIONS:
   A. Section 31 05 13 - Soils for Earthwork.
   B. Section 31 22 00 - Grading.
   C. Section 31 23 16 - Excavation.
   D. Section 31 23 16.13 - Trenching.
   E. Section 31 23 23 - Fill.
   F. Section 31 37 00 - Riprap.
   G. Section 33 11 16 - Water Utility Distribution Piping.

1.3 REFERENCES
   A. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54kg (10 lb) Rammer and a 457 mm (18 in) Drop.
   D. ASTM D 1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft³).
   E. ASTM D 2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

1.4 SUBMITTALS
   A. Section 01 30 00 - Administrative Requirements: Submittal Procedures.
   B. Samples: Submit, in air-tight containers, 10 lb sample of each type of fill to testing laboratory.
   C. Materials Source: Submit name of imported materials suppliers.
   D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
1.5 QUALITY ASSURANCE

A. Furnish each aggregate material from a single source throughout the Work.

B. Perform Work in accordance with NYSDOT standards.

PART 2 PRODUCTS

2.1 COURSE AGGREGATE MATERIALS

A. CRUSHED STONE
   Crushed stone shall be a mixture of 50% No. 1 & 2 crushed stone meeting all
   requirements in Section 703-02 of the NYSDOT Standard Specification or conform to
   AASHTO No. 57 coarse stone aggregate meeting all requirements in Section 703.3 of
   PennDOT Form 408 Specifications.

B. GRANULAR FILL
   Granular fill shall meet all requirements specified for Type 4 Subbase in Section 304-2.02
   of the NYSDOT Standard Specification or No. 2RC aggregate in Section 703.3 of
   PennDOT Form 408 Specification.

C. GRAVEL (STRUCTURAL) FILL
   Gravel fill shall meet all requirements for Type 3 Subbase in Section 304-2.02 of the
   NYSDOT Standard Specification or Item 2A in Section 703.3 of PennDOT Form 408
   Specification.

2.2 FINE AGGREGATE MATERIALS

A. CUSHION SAND
   Cushion sand shall consist of clean, hard, durable, uncoated particles, free from lumps of
   clay and all deleterious substances. It shall meet the following gradation requirements and
   shall be approved by the Engineer before use.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4 inch</td>
<td>100</td>
</tr>
<tr>
<td>No. 50</td>
<td>0-35</td>
</tr>
<tr>
<td>No. 100</td>
<td>0-10</td>
</tr>
</tbody>
</table>

B. PEA STONE
   Stone meeting all requirements in Section 605-2.02 of the NYSDOT Standard
   Specification; free of shale, clay, friable material and debris. Pea stone shall consist of
   clean, durable rock of uniform quality.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch</td>
<td>100</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>30-100</td>
</tr>
<tr>
<td>1/4 inch</td>
<td>0-30</td>
</tr>
<tr>
<td>No. 10</td>
<td>0-10</td>
</tr>
<tr>
<td>No. 20</td>
<td>0-5</td>
</tr>
</tbody>
</table>

2.3 BLENDED AGGREGATE MATERIAL

A. CRUSHER RUN
Crusher run shall meet all requirements for Type 2 subbase in Section 304-2.02 of the NYSDOT Standard Specification or crushed No. 2A coarse aggregate in Section 703.3 of PennDOT Form 408 Specification.

B. SELECT NATIVE FILL
   General: On-site material shall be considered select fill if it is free from organic materials and debris, meets the following gradation and soundness requirements, and is approved by the Architect.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 inch</td>
<td>100</td>
</tr>
<tr>
<td>No. 40</td>
<td>0-70</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-15</td>
</tr>
</tbody>
</table>

   Soundness: Less than 30 percent magnesium sulfate soundness loss.

C. UNCLASSIFIED FILL
   On-site material used as unclassified fill shall be free of stones larger than 8 inches in the largest dimension, shall be free of organic materials and debris, and shall be approved by the Architect.

2.4 SOURCE QUALITY CONTROL
A. Section 01 40 00 - Quality Requirements: Testing and inspection services.
D. When tests indicate materials do not meet specified requirements, change material and retest.

PART 3 EXECUTION

3.1 EXCAVATION
A. Excavate aggregate materials from on-site locations as indicated on drawings or designated by Architect as specified in Section 31 23 16 - Excavation.
B. Stockpile excavated material meeting requirements for coarse aggregate and fine aggregate materials.
C. Remove excess excavated, coarse aggregate, and fine aggregate materials not intended for reuse from site.
D. Remove excavated materials not meeting requirements for coarse aggregate and fine aggregate materials from site.

3.2 STOCKPILING
A. Stockpile materials on site at locations indicated or designated by Architect.
B. Stockpile in sufficient quantities to meet Project schedule and requirements.
C. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.
D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.
E. Stockpile unsuitable materials on impervious material and cover to prevent erosion and leaching until disposed of.

3.3 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION
PART 2 PRODUCTS

1.1 MATERIALS
   A. Fill Material: As specified in Section 31 23 23 - Fill and Backfill.
   B. Herbicides: Not allowed.

PART 3 EXECUTION

2.1 EXAMINATION
   A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
   B. Verify existing plant life designated to remain is tagged or identified.
   C. Identify salvage area for placing removed materials.
   D. Verify that utilities have been disconnected and capped.
   E. Survey existing conditions and correlate with requirements indicated to determine extent of demolition required.
   F. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
   G. Survey the condition of the building to determine whether removing any element might result in a structural deficiency or unplanned collapse of any portion of the structure or adjacent structures during demolition or relocation.
   H. Perform surveys as the Work progresses to detect hazards resulting from demolition activities.

2.2 INITIAL PREPARATION
   A. Call Local Utility Line Dig Safely New York Information service at 1-800-962-7962 not less than three working days before performing Work.
      1. Request underground utilities to be located and marked within and surrounding construction areas.

2.3 PROTECTION
   A. Locate, identify, and protect utilities indicated to remain, from damage.
   B. Protect trees, plant growth, and features designated to remain, as final landscaping as specified in Section 01 50 00 - Temporary Facilities and Controls.
   C. Protect bench marks, survey control points, and existing structures from damage or displacement.
2.4 UTILITY SERVICES

A. Maintain existing utilities indicated to remain in service and protect them against damage during demolition operations.

B. Do not interrupt existing utilities serving occupied or operating facilities, except when authorized in writing by Owner and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to governing authorities.

C. Provide not less than 72 hours' notice to Owner if shutdown of service is required during changeover.

D. Utility Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services serving structures to be demolished.

E. Owner will arrange to shut off indicated utilities when requested by Contractor.

F. Utility Requirements: Refer applicable specification sections for shutting off, disconnecting, removing, and sealing or capping utility services. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing.

2.5 PREPARATION

A. Drain, purge, or otherwise remove, collect, and dispose of chemicals, gases, explosives, acids, flammables, or other dangerous materials before proceeding with demolition operations.

B. Conduct demolition operations and remove debris to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

C. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

D. Conduct demolition operations to prevent injury to people and damage to adjacent buildings and facilities to remain. Ensure safe passage of people around demolition area.

E. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.

F. Protect existing site improvements, appurtenances, and landscaping to remain.

G. Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of buildings to be demolished or related and adjacent buildings to remain.

H. Strengthen or add new supports when required.

2.6 POLLUTION CONTROLS

A. Use water mist, temporary enclosures, and other suitable methods to limit the spread of dust and dirt. Comply with governing environmental protection regulations.

B. Do not create hazardous or objectionable conditions, such as ice, flooding, and pollution, when using water.

C. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

D. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level.
E. Clean adjacent buildings and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to condition existing before start of demolition.

2.7 CLEARING

A. General: Remove trees, shrubs, grass and other vegetation, improvements, or obstructions as required to permit installation of new construction. Remove similar items elsewhere on site or premises as specifically indicated. "Removal" includes digging out and off-site disposing of stumps, roots, and branches.

B. Cut minor roots and branches of trees indicated to remain in a clean and careful manner, where such roots and branches obstruct installation of new construction.

C. Topsoil: Topsoil is defined as friable clay loam surface soil found in a depth of not less than 4 inches. Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones, and other objects over ½” inch in diameter, and without weeds, roots, and other objectionable material.

D. Do not remove wet topsoil.

E. Strip topsoil to whatever depths encountered in a manner to prevent intermingling with underlying subsoil or other objectionable material.

F. Remove heavy growths of grass from areas before stripping.

G. Where existing trees are indicated to remain, leave existing topsoil in place within drip lines to prevent damage to root system.

H. Stockpile topsoil in storage piles. Construct storage piles on site to a depth not exceeding 8 feet and protect from erosion. Cover storage piles, if required, to prevent wind erosion.

I. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated.

J. Place fill material in horizontal layers not exceeding 6 inches loose depth, and thoroughly compact to a density equal to adjacent original ground.

K. Removal of Improvements: Remove existing above-grade and below-grade improvements as indicated and as necessary to facilitate new construction.

L. Clear areas required for access to site and execution of Work.

M. Clear undergrowth and deadwood, without disturbing subsoils.

N. Removed timber and stumps that are unwanted by the Owner or landowner shall be properly disposed of.

2.8 REMOVAL

A. Remove debris, rock, and extracted plant life from site.

B. Remove paving, walks and curbs as indicated on Drawings. Neatly saw cut edges at right angle to surface and at right angles to adjoining structures. Saw cut concrete pavement as indicated at locations shown on drawings nearest to existing joint.

C. Remove abandoned utilities. Indicated removal termination point for underground utilities on Record Documents.

D. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.

E. Do not burn or bury materials on site. Leave site in clean condition.
2.9 DEMOLITION

A. Building Demolition: Demolish buildings completely and remove all building debris from the site. Use methods required to complete Work within limitations of governing regulations and as follows:

B. Locate demolition equipment throughout the building and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

C. Dispose of demolished items and materials promptly. On-site storage or sale of removed items is prohibited.

D. Demolish concrete and masonry in small sections.

E. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.

F. Break up and remove concrete slab on grade, unless or shown to remain on drawings.

G. Below-Grade Construction: Demolish foundation walls and other below-grade construction, as follows:

H. Unless directed otherwise completely remove below-grade construction, including foundation walls and footings, and concrete slabs.

I. Break up and remove below-grade concrete slabs, unless indicated to remain.

J. Filling Below-Grade Areas: Completely fill below-grade areas and voids resulting from demolition of buildings and pavements with soil materials as required.

K. Damages: Promptly repair damages to adjacent facilities caused by demolition operations.

2.10 CLEARING

A. Clear areas required for access to site and execution of Work to minimum depth of 12 inches.

B. Remove trees and shrubs as indicated. Remove stumps, main root ball, root system to depth of 24 inches, surface rock, and above grade improvements required to complete new work.

C. Clear undergrowth and deadwood, without disturbing subsoil.

2.11 REMOVAL

A. Remove debris, rock, and extracted plant life from site.

B. Remove paving, curbs, and other above grade improvements as required to complete new work.

C. Neatly saw cut edges at right angle to surface and at proposed right angles to adjacent above grade improvements.

D. Remove abandoned utilities. Indicated removal termination point for underground utilities on Record Documents.

E. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.

F. Do not burn or bury materials on site. Leave site in clean condition.
2.12 TOPSOIL EXCAVATION

A. Excavate topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials for use in finish grading.

B. Do not excavate wet topsoil.

C. Stockpile in area designated on site to depth not exceeding 8 feet and protect from erosion.

D. Do not remove topsoil from site.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Removal of topsoil.
   B. Removal of subsoil.
   C. Rough grading cutting, filling, rough contouring, compacting, and finished grading the site for site structures, building pads, and trenches.
   D. Finish grading.

1.2 RELATED REQUIREMENTS
   A. Section 31 10 00 - Site Clearing.
   B. Section 31 05 13 - Soils for Earthwork.
   C. Section 30 05 16 - Aggregates for Earthwork.
   D. Section 31 23 16 - Excavation.
   E. Section 31 23 16.13 - Trenching: Trenching and backfilling for utilities.
   G. Section 31 23 23 - Fill: Filling and compaction.
   H. Section 32 92 19 - Seeding: Finish ground cover.
   I. Section 32 92 23 - Sodding: Finish ground cover.
   J. Section 32 93 00 - Plants: Topsoil in beds and pits.

1.3 PRICE AND PAYMENT PROCEDURES
   A. See Section 01 22 00 - Unit Prices, for general requirements relating to unit prices for this work.

1.4 QUALITY ASSURANCE
   A. Perform Work in accordance with [ ].
   B. Perform Work in accordance with State Municipality of Highways Public Work’s standards.
   C. Maintain one copy of all construction documents on site.

PART 2 PRODUCTS

2.1 MATERIALS
   A. Topsoil: See Section 31 05 13.
   B. Other Fill Materials: See Section 31 23 23.
PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that survey bench mark and intended elevations for the Work are as indicated.
B. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
C. Verify site conditions under provisions of this section.

3.2 PREPARATION

A. Call Local Utility Line Information service (Dig Safely New York) at not less than three working days before performing Work.
   1. Request underground utilities to be located and marked within and surrounding construction areas.
B. Identify required lines, levels, contours, and datum.
C. Stake and flag locations of known utilities.
D. Locate, identify, and protect from damage above- and below-grade utilities to remain.
E. Notify utility company to remove and relocate utilities.
F. Protect site features to remain, including but not limited to bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs, from damage by grading equipment and vehicular traffic.
G. Protect trees to remain by providing substantial fencing around entire tree at the outer tips of its branches; no grading is to be performed inside this line.
H. Protect plants, lawns, rock outcroppings, and other features to remain as a portion of final landscaping.

3.3 ROUGH GRADING

A. Remove topsoil from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials.
B. Do not remove topsoil when wet.
C. Remove subsoil from areas to be further excavated, re-landscaped, or re-graded.
D. Do not remove wet subsoil.
E. When excavating through roots, perform work by hand and cut roots with sharp axe.
F. Benching Slopes: Horizontally bench existing slopes greater than 1:4 to key fill material to slope for firm bearing.
G. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.

3.4 SOIL REMOVAL AND STOCKPILING

A. Stockpile topsoil to be re-used on site; remove remainder from site.
B. Stockpile subsoil to be re-used on site; remove remainder from site.
C. Stockpiles: Use areas designated on site; pile depth not to exceed 8 feet; protect from erosion.

3.5 FINISH GRADING

A. Before Finish Grading:
   1. Verify building and trench backfilling have been inspected.
   2. Verify subgrade has been contoured and compacted.

B. Remove debris, roots, branches, stones, in excess of 1 inch in size. Remove soil contaminated with petroleum products.

C. Where topsoil is to be placed, scarify surface to depth of 12 inches.

D. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 6 inches.

E. Place topsoil in areas where seeding are indicated.

F. Place topsoil where required to level finish grade.

G. Place topsoil to thickness 4-inches after settlement.

H. Place topsoil during dry weather.

I. Remove roots, weeds, rocks, and foreign material while spreading.

J. Near plants spread topsoil manually to prevent damage.

K. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.

L. Lightly compact placed topsoil.

3.6 TOLERANCES

A. Top Surface of Subgrade: Plus or minus 0.10 foot (1-3/16 inches) from required elevation.

B. Top Surface of Finish Grade: Plus or minus 0.04 foot (1/2 inch).

3.7 REPAIR AND RESTORATION

A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this work, repair or replace to original condition.

B. Trees to Remain: If damaged due to this work, trim broken branches and repair bark wounds; if root damage has occurred, obtain instructions from Architect as to remedy.

C. Other Existing Vegetation to Remain: If damaged due to this work, replace with vegetation of equivalent species and size.

3.8 FIELD QUALITY CONTROL

A. See Section 31 23 23 for compaction density testing.

B. Perform laboratory material tests in accordance with NYSDOT Standards.

C. Perform in place compaction tests in accordance with NYSDOT Standards.
D. When tests indicate work does not meet specified requirements, remove work, replace and retest.

3.9 CLEANING

A. Remove unused stockpiled topsoil and subsoil. Grade stockpile area to prevent standing water.

B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Excavating for footings, pile caps, slabs-on-grade, paving, site structures, and landscaping.
B. Trenching for utilities outside the building to utility main connections.
C. Soil densification

1.2 RELATED REQUIREMENTS
A. Section 31 05 13 - Soils for Earthwork: Stockpiling excavated materials.
B. Section 31 05 16 - Aggregates for Earthwork: Stockpiling excavated materials.
C. Section 31 22 00 - Grading: Soil removal from surface of site.
D. Section 31 23 16.13 - Trenching: Excavating for utility trenches outside the building to utility main connections.
F. Section 31 23 23 - Fill: Fill materials, filling, and compacting.
G. Section 31 37 00 - Riprap.

1.3 PRICE AND PAYMENT PROCEDURES
A. See Section 01 22 00 - Unit Prices, for general requirements applicable to unit prices for excavation.

1.4 SUBMITTALS
A. Section 01 30 00 - Administrative Requirements: Submittal Procedure
B. Excavation Protection Plan: Describe sheeting, shoring, and bracing materials and installation required to protect excavations, adjacent structures, and adjacent property; include structural calculations to support plan.
C. Shop Drawings: Indicated soil densification grid for each size and configuration footing requiring soils densification.

1.5 QUALITY ASSURANCE
A. Perform work in accordance with NYSDOT standards.
B. Prepare excavation protection plan under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of New York.
C. Fill Material Tests: A sieve analysis, loss on ignition, and magnesium sulfate soundness test shall be taken for each type of material from each source of material. Tests will be in accordance with appropriate ASTM methods. Tests shall be taken by an approved independent laboratory and results submitted directly to the Architect before such material is used for fill. Material which fails to meet the specified requirements shall be removed from the site. Payment for tests shall be as described in General Requirements.
PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 EXAMINATION
A. Verify that survey bench mark and intended elevations for the work are as indicated.

3.2 PREPARATION
A. Identify required lines, levels, contours, and datum locations.
B. Protect utilities that remain and protect from damage.
C. Call Local Utility Line Information service (UFPO) at 1-800-962-7962 not less than three working days before performing Work.
   1. Request underground utilities to be located and marked within surrounding construction areas.
D. Notify utility company to remove and relocate utilities.
E. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
F. Protect plants, lawns, and other features to remain.

3.3 GENERAL EXCAVATION
A. Underpin adjacent structures that could be damaged by excavating work.
B. Excavate to accommodate building foundations, slab on grade, and paving, construction operations and site structures.
C. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
D. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.
E. Do not interfere with 45 degree bearing splay of foundations.
F. Cut utility trenches wide enough to allow inspection of installed utilities.
G. Hand trim excavations. Remove loose matter.
H. Remove lumped subsoil, boulders, and rock up to 1/3 cu yd measured by volume. See Section 31 23 16.26 for removal of larger material.
I. Correct areas over-excavated and load-bearing surfaces that are disturbed with structural fill as directed by Architect and Section 31 23 23.
J. Grade top perimeter of excavation to prevent surface water from draining into excavation.
K. Remove excavated material that is unsuitable for re-use from site.
L. Stockpile excavated material to be re-used in area designated on site in accordance with Section 31 22 00.
M. Remove excess excavated material from site.
N. Compact disturbed load bearing soil in direct contact with foundations to original bearing capacity; perform compaction in accordance with Section 31 23 23 and Section 31 23 16.13.

O. Excavate to working elevation for piling work.

P. Repair or replace any items indicated to remain damaged by excavation.

3.4 TOPSOIL EXCAVATION

A. Excavate topsoil from areas to be further excavated, re-landscaped, or regraded, marked areas, entire site, without mixing with foreign materials for use in finish grading.

B. Do not excavate wet topsoil.

C. Stockpile in area designated on site to depth not exceeding 8 feet and protect from erosion. Stockpile material on impervious material 36 mil Hypalon material and cover over with same material, until disposal.

D. Do not remove topsoil from site.

3.5 SUBSOIL EXCAVATION

A. Do not excavate wet subsoil or excavate and process wet material to obtain optimum moisture content.

B. When excavating through roots, perform Work by hand and cut roots with sharp axe.

C. Remove excess subsoil not intended for reuse, from site.

D. Benching Slopes: Horizontally bench existing slopes greater than 1: 4 to key placed fill material to slope to provide firm bearing.

E. Stability: Replace damaged or displaced subsoil as specified for fill.

3.6 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.

B. Provide for visual inspection of load-bearing excavated surfaces before placement of foundations.

3.7 PROTECTION

A. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.

B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

C. Protect structures, utilities and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earth operations.

END OF SECTION
SECTION 31 23 16.13
TRENCHING

PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Excavation trenches for utilities outside the buildings to utility main connections.
   B. Compacted fill from top of utility bedding to subgrade elevations.
   C. Backfilling and compaction.

1.2 RELATED REQUIREMENTS
   A. Section 31 05 13 - Soils for Earthwork: Soils for fill.
   B. Section 31 05 16 - Aggregates for Earthwork: Aggregates for fill.
   C. Section 31 22 00 - Grading: Site grading.
   D. Section 31 23 16 - Excavation: Building and foundation excavating.
   F. Section 31 23 23 - Fill: Backfilling at building and foundations.

1.3 PRICE AND PAYMENT PROCEDURES
   A. See Section 01 22 00 - Unit Prices, for general requirements applicable to unit prices for earthwork.

1.4 DEFINITIONS
   A. Finish Grade Elevations: Indicated on drawings.
   B. Subgrade Elevations: Indicated on drawings.
   C. Utility: Any buried pipe, duct, conduit, or cable.

1.5 REFERENCES
   B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012.
   D. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN m/m³)); 2012.
   F. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 2005.
1.6 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Samples: 10 lb sample of each type of fill; submit in air-tight containers to testing laboratory.
   C. Materials Sources: Submit name of imported materials source.
   D. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
   E. Compaction Density Test Reports.
   G. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.7 DELIVERY, STORAGE, AND HANDLING
   A. When necessary, store materials on site in advance of need.
   B. When fill materials need to be stored on site, locate stockpiles where designated.
      1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
      2. Prevent contamination.
      3. Protect stockpiles from erosion and deterioration of materials.

1.8 QUALITY ASSURANCE
   A. Perform work in accordance with NSYDOT standards.

1.9 FIELD MEASUREMENTS
   A. Verify field measurements prior to fabrication.

1.10 COORDINATION
   A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
   B. Verify work associated with lower elevation utilities is complete before placing higher elevation utilities.

PART 2 PRODUCTS

2.1 FILL MATERIALS
   A. See Section 31 23 23 - Fill.
   B. See Section 31 05 13 - Soils for Earthwork.
   C. See Section 31 05 16 - Aggregates for Earthwork.

2.2 ACCESSORIES
   A. Geotextile Fabric: Non-biodegradable, woven.
2.3 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of soil material.

B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.

C. If tests indicate materials do not meet specified requirements, change material and retest.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that survey bench marks and intended elevations for the work are as indicated.

3.2 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. See Section 31 22 00 for additional requirements.

3.3 TRENCHING

A. Notify Architect of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

B. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.

C. Do not interfere with 45 degree bearing splay of foundations.

D. Cut trenches wide enough to allow inspection of installed utilities.

E. Hand trim excavations. Remove loose matter.

F. Remove large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.

G. Remove lumped subsoil, boulders, and rock up to 1/3 cu yd measured by volume. See Section 31 23 16.26 for removal of larger material.

H. Remove excavated material that is unsuitable for re-use from site.

I. Stockpile excavated material to be re-used in area designated in Section 31 22 00.

J. Remove excess excavated material from site.

K. Do not advance open trench more than 100 feet ahead of installed pipe.

L. Excavate bottom of trenches maximum of 2 feet wider than outside diameter of pipe or as indicated on plans.

M. Excavate trenches to depth indicated on drawings. Provide uniform and continuous bearing and support for bedding material and pipe utilities.

N. When Project conditions permit, slope side walls of excavation starting 2 feet above top of pipe. When side walls cannot be sloped, provide sheeting and shoring to protect excavation as specified in this section or as required by OSHA.
O. When subsurface materials at bottom of trench are loose or soft, excavate to greater depth as
directed by Architect/Engineer until suitable material is encountered. Notify Architect/Engineer,
and request instructions prior to excavation.

P. Cut out soft areas of sub-grade not capable of compaction in place. Backfill with approved fill
material and compact to density equal to or greater than requirements for subsequent backfill
material.

Q. Correct over excavated areas with compacted backfill as specified for authorized excavation or
replace with fill concrete as directed by Architect/Engineer.

3.4 PREPARATION FOR UTILITY PLACEMENT
A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
B. Compact subgrade to density equal to or greater than requirements for subsequent fill
material.
C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.5 BACKFILLING
A. Backfill to contours and elevations indicated using unfrozen materials.
B. Employ a placement method that does not disturb or damage other work.
C. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet,
frozen or spongy subgrade surfaces.
D. Maintain optimum moisture content of fill materials to attain required compaction density.
E. Slope grade away from building minimum 2 inches in 10 ft, unless noted otherwise. Make
gradual grade changes. Blend slope into level areas.
F. Correct areas that are over-excavated.
   1. Other areas: Use general fill, flush to required elevation, compacted to minimum 97
      percent of maximum dry density.
G. Compaction Density Unless Otherwise Specified or Indicated:
H. Reshape and re-compact fills subjected to vehicular traffic.
I. Place geotextile fabric over bedding fill prior to placing subsequent fill materials.
J. Place fill material in continuous layers and compact in accordance with schedule at end of this
section.
K. Employ placement method that does not disturb or damage foundation perimeter drainage,
utilities in trench, and other below grade improvements.
L. Do not leave open trenching at end of working day.
M. Protect open trenches at all times during installation of trenching.

3.6 BEDDING AND FILL AT SPECIFIC LOCATIONS
A. Use general fill unless otherwise specified or indicated.

3.7 TOLERANCES
A. Section 01 40 00 - Quality Requirements: Tolerances.
B. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.
C. Top Surface of Backfilling Under Paved Areas: Plus or minus 1 inch from required elevations.

3.8 FIELD QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.
B. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, ASTM D3017, or ASTM D6938.
C. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D 698 ("standard Proctor"), ASTM D 1557 ("modified Proctor"), or AASHTO T 180.
D. If tests indicate work does not meet specified requirements, remove work, replace and retest.
E. Frequency of Tests: 1 for every 50 feet of trench.

3.9 CLEANING
A. Leave unused materials in a neat, compact stockpile.
B. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.
C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION
SECTION 31 23 16.26
ROCK REMOVAL

PART 1  GENERAL

THIS SECTION INCLUDES REMOVAL OF SUBSURFACE ROCK DURING EXCAVATION BY MECHANICAL METHODS ONLY, EXPLOSIVES SHALL NOT BE USED.

2.1 SECTION INCLUDES
A. Removal of identified rock during excavation.

2.2 RELATED REQUIREMENTS
A. Section 31 22 00 - Grading.
B. Section 31 23 16 - Excavation.
C. Section 31 23 16.13 - Trenching.
D. Section 31 23 23 - Fill: Fill materials.

2.3 PRICE AND PAYMENT PROCEDURES
A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.

2.4 DEFINITIONS
A. Site Rock: Solid mineral material with a volume in excess of 1/3 cubic yard or solid material that cannot be removed with a 3/4 cubic yard capacity power shovel.
B. Trench Rock: Solid mineral material with a volume in excess of 1/6 cubic yard or solid material that cannot be removed with a 3/4 cubic yard capacity power shovel.
C. Rock: Solid mineral material of a size that cannot be removed with a 3/4 cubic yard capacity power shovel.

2.5 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements: Submittal procedures.
B. Survey Report: Submit a survey report on conditions of buildings near locations of rock removal.

2.6 SCHEDULING
A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
B. Schedule work to avoid working hours or disruption to occupied buildings nearby.
PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

4.1 EXAMINATION
   A. Verify site conditions and note subsurface irregularities affecting work of this section.

4.2 PREPARATION
   A. Identify required lines, levels, contours, and datum.

4.3 USE OF EXPLOSIVES

4.4 ROCK REMOVAL
   A. Excavate and remove rock by mechanical methods only; use of explosives is prohibited.
   B. Mechanical Methods: Drill holes and utilize expansive tools or wedges to fracture rock.
   C. If rock is uncovered requiring the explosives method for rock disintegration, notify the Architect.
   D. Form level bearing at bottom of excavations.
   E. Remove shaled layers to provide sound and unshattered base for footings.
   F. In utility trenches, excavate to 6 inches below invert elevation of pipe and 24 inches wider than pipe diameter.
   G. Remove excavated materials from site.
   H. Correct unauthorized rock removal in accordance with backfilling and compacting requirements of Section 31 23 23 as directed by Architect/Engineer.

4.5 FIELD QUALITY CONTROL
   A. Independent agency field inspection will be provided under provisions of Section 01 40 00 - Quality Requirements.
   B. Provide for visual inspection of foundation bearing surfaces and cavities formed by removed rock.

END OF SECTION
PART 1  GENERAL

1.1  SECTION INCLUDES

   A.  Filling, backfilling, and compacting for footings, slabs-on-grade, paving, and site structures.
   B.  Proof Rolling of filled and excavated roadways.
   C.  Backfilling and compacting for utilities outside the building to utility main connections.
   D.  Filling holes, pits, and excavations generated as a result of removal (demolition) operations.

1.2  RELATED REQUIREMENTS

   A.  Section 03 30 00 - Cast-in-Place Concrete.
   B.  Section 31 05 13 - Soils for Earthwork: Soils for fill
   C.  Section 31 05 16 - Aggregated for Earthwork: Aggregate for fill
   D.  Section 31 22 00 - Grading: Site grading.
   E.  Section 31 23 16 - Excavation: Removal and handling of soil to be re-used.
   F.  Section 31 23 16.13 - Trenching: Excavating for utility trenches outside the building to utility main connections.
   H.  Section 31 37 00 - Riprap.

1.3  DEFINITIONS

   A.  Finish Grade Elevations: Indicated on drawings.
   B.  Subgrade Elevations: 6 inches below finish grade elevations indicated on drawings, unless otherwise indicated.

1.4  REFERENCE STANDARDS

   B.  ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2012.
   D.  ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN m/m3)); 2012.
   F.  ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2011.
G. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 2005.

1.5 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Samples: 10 pounds sample of each type of fill; submit in air-tight containers to testing laboratory.
C. Materials Sources: Submit name of imported materials source.
D. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used, including manufactured fill.
E. Compaction Density Test Reports.
G. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

PART 2 PRODUCTS

2.1 FILL MATERIALS
A. General Fill - Fill Type on site soil: If it conforming to State of New York DOT type 4 standard.
B. Concrete for Fill: As specified in Section 03 30 00.
C. Topsoil: See Section 31 05 13.
D. Satisfactory soil materials are defined as those complying with ASTM D 2487 soil classification groups GW, GP, GM, SM, SW, and SP.
E. Unsatisfactory soil materials are defined as those complying with ASTM D 2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, and PT.
F. Subsoil Fill: as specified in Section 31 05 13.
G. Structural Fill: as specified in Section 31 05 13 and 31 05 16.
H. Granular Fill: as specified in Section 31 05 16.
I. Drainage Fill: Material shall consist of crushed stone, sand, gravel or screened gravel. The soundness of the material shall be tested and shall have a loss not exceeding 20 percent by weight after four (4) cycles of Magnesium Sulphate Soundness Test (NYS DOT 605-202, Under drain Filter Type 1 as follows:

<table>
<thead>
<tr>
<th>U.S. Sieve No.</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch</td>
<td>100</td>
</tr>
<tr>
<td>1/2 inch</td>
<td>30-100</td>
</tr>
<tr>
<td>1/4 inch</td>
<td>0-30</td>
</tr>
<tr>
<td>No. 10</td>
<td>0-10</td>
</tr>
<tr>
<td>No. 20</td>
<td>0-5</td>
</tr>
</tbody>
</table>

J. Backfill Material: Naturally or artificially graded mixture of sand, natural or crushed stone or gravel conforming to NYS DOT Item 304-2.02, Type 4 as follows:
<table>
<thead>
<tr>
<th>U.S. Sieve No.</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 inch</td>
<td>100</td>
</tr>
<tr>
<td>1/4 inch</td>
<td>30-65</td>
</tr>
<tr>
<td>No. 40</td>
<td>5-40</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-10</td>
</tr>
</tbody>
</table>

2.2 ACCESSORIES

A. Geotextile Fabric: Non-biodegradable, woven, fabric; 600X manufactured by Mirafi. Filter fabric shall be Mirafi 140N or approved equal.

B. Geotextile Fabric for Perforated Drain Pipe: Non-biodegradable, non-woven, fabric, four (4) ounces per square yard.

2.3 SOURCE QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of soil material.

B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.

C. If tests indicate materials do not meet specified requirements, change material and retest.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that survey bench marks and intended elevations for the Work are as indicated.

B. Identify required lines, levels, contours, and datum locations.

C. See Section 31 22 00 for additional requirements.

D. Verify subdrainage, dampproofing, or waterproofing installation has been inspected.

E. Verify structural ability of unsupported walls to support imposed loads by the fill.

F. Verify underground tanks are anchored to their own foundations to avoid flotation after backfilling.

3.2 PREPARATION

A. Scarify subgrade surface to a depth of 8 inches.

B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with structural fill and compact to density equal to or greater than requirements for subsequent fill material.

C. Compact subgrade to density requirements for subsequent fill material.

D. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

E. The subgrade and subbase shall be proof rolled. Contact engineer or owners representative 24 hours before testing. If subgrade stabilization or undercutting is designed for the project, then proof rolling shall be used to verify the undercut replacement material stability.
F. Proof rolling deflections and soil conditions that are observed during construction determine if
the plan subgrade treatment must be adjusted. Adjustment of subgrade treatment to fit field
conditions is essential and is the responsibility of the contractor.

G. Provide subgrade corrections prior to proof rolling

H. When rutting and deflection occur under wheels of 10-wheel dump truck engineer or
representative will require corrective action

I. Improve subbase or subgrade by undercutting wet material, aeration of wet soil or use of
additional subbase material. Compact material and proof roll again.

J. If needed, make the correction by excavating and disposing of soft grade, and replacing it with
NYSDOT type 4 subbase material.

K. Proof roll to identify soft spots; fill and compact to density equal to or greater than requirements
for subsequent fill material.

L. The proof rolling should be done immediately after the subgrade compaction operation, when
the moisture content of the subgrade soil is near optimum or at the moisture content that
achieved compaction. This minimizes the chances of the subgrade becoming too wet or too
dry for an effective proof rolling evaluation. If the subgrade is too wet, the material will displace
and rut. If the subgrade is too dry, a dry hard surface crust may carry the proof roller over an
undesirable soft wet underlying material without rutting or deflection, and the soft subgrade
may not be detected.

M. Proof rolling may be done either before or after pipe underdrains are installed. If done after
underdrains are installed, rolling should not be done directly over the underdrains. Proof rolling
must be performed at least 1-½ feet (0.5 meters) away from the underdrains because of the
potential damage to the underdrains.

3.3 FILLING

A. Fill to contours and elevations indicated using unfrozen materials.

B. Fill up to subgrade elevations unless otherwise indicated.

C. Employ a placement method that does not disturb or damage other work.

D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet,
frozen or spongy subgrade surfaces.

E. Maintain optimum moisture content of fill materials to attain required compaction density.

F. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches
compacted depth.

G. Subsoil Fill: Place and compact material in equal continuous layers not exceeding 8 inches
compacted depth.

H. Structural Fill: Place and compact material in equal continuous layers not exceeding 6 inches
compacted depth.

I. Slope grade away from building minimum 2 percent slope for minimum distance of 5 feet,
unless noted otherwise. Make gradual grade changes. Blend slope into level areas.

J. Place geo-textile fabric over approved fill prior to placing next lift of fill.

K. Backfill against supported foundation walls. Do not backfill against unsupported foundation
walls.
L. Backfill simultaneously on each side of unsupported foundation walls until supports are in place

M. Correct areas that are over-excavated.
   1. Load-bearing foundation surfaces: Use structural fill, flush to required elevation, compacted to 100 percent of maximum dry density.
   2. Other areas: Use structural fill, flush to required elevation, compacted to minimum 95 percent of maximum dry density.

N. Compaction Density Unless Otherwise Specified or Indicated:
   1. Under paving, slabs-on-grade, and similar construction: 95 percent of maximum dry density.

O. Reshape and re-compact fills subjected to vehicular traffic.

P. Remove surplus backfill materials from site.

Q. Leave fill material stockpile areas free of excess fill materials.

3.4 TOLERANCES
   A. Top Surface of General Filling: Plus or minus 1 inch from required elevations.
   B. Top Surface of Filling Under Paved Areas: Plus or minus 1 inch from required elevations.
   C. Top Surface of Filling Within Building Areas: Plus or minus 1/2 inch from required elevations.

3.5 FIELD QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.
   B. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, ASTM D3017, or ASTM D6938. Contractor shall be responsible for providing compaction testing as part of their base bid contract. Slab testing shall be every 100 square feet of area or every 50-ft of trench excavation.
   C. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D 698 ("standard Proctor"), ASTM D 1557 ("modified Proctor"), or AASHTO T 180.
   D. If tests indicate work does not meet specified requirements, remove work, replace and retest.
   E. Frequency of Tests: 1 test for every truck load of material delivered.
   F. Proof roll compacted fill at surfaces that will be under slabs-on-grade, pavers, and paving.

3.6 CLEANING
   A. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.
   B. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.
   C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

3.7 PROTECTION OF FINISHED WORK
   A. Section 01 70 00 - Execution and Closeout Requirements: Protecting finished work.
B. Reshape and re-compact fills subjected to vehicular traffic.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Prevention of erosion due to construction activities.
   B. Prevention of sedimentation of waterways, open drainage ways, and storm and sanitary sewers due to construction activities.
   C. Restoration of areas eroded due to insufficient preventive measures.
   D. Compensation of Owner for fines levied by authorities having jurisdiction due to non-compliance by Contractor.

1.2 RELATED REQUIREMENTS
   A. Section 31 10 00 - Site Clearing: Limits on clearing; disposition of vegetative clearing debris.
   B. Section 31 22 00 - Grading: Temporary and permanent grade changes for erosion control.
   C. Section 31 37 00 - Riprap: Temporary and permanent stabilization using riprap.

1.3 PERFORMANCE REQUIREMENTS
   A. Comply with all requirements of U.S. Environmental Protection Agency for erosion and sedimentation control, as specified for the National Pollutant Discharge Elimination System (NPDES), Phases I and II, under requirements for the 2003 Construction General Permit (CGP), whether the project is required by law to comply or not.
   B. Also comply with all more stringent requirements of State of New York Erosion and Sedimentation Control Manual.
   C. Comply with all requirements of New York State Department of Environmental Conservation for erosion and sedimentation control, even though this project is not required by law to comply.
   D. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained; furnish all documentation required to obtain applicable permits.
   E. Timing: Put preventive measures in place as soon as possible after disturbance of surface cover and before precipitation occurs.
   F. Storm Water Runoff: Control increased storm water runoff due to disturbance of surface cover due to construction activities for this project.
      1. Prevent runoff into storm and sanitary sewer systems, including open drainage channels, in excess of actual capacity or amount allowed by authorities having jurisdiction, whichever is less.
   G. Erosion On Site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.
      1. Control movement of sediment and soil from temporary stockpiles of soil.
      2. Prevent development of ruts due to equipment and vehicular traffic.
      3. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.
H. Erosion Off Site: Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this project.
   1. Prevent windblown soil from leaving the project site.
   2. Prevent tracking of mud onto public roads outside site.
   3. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

I. Sedimentation of Waterways On Site: Prevent sedimentation of waterways on the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
   1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
   2. If sediment basins are used as temporary preventive measures, pump dry and remove deposited sediment after each storm.

J. Sedimentation of Waterways Off Site: Prevent sedimentation of waterways off the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
   1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.

K. Open Water: Prevent standing water that could become stagnant.

L. Maintenance: Maintain temporary preventive measures until permanent measures have been established.

1.4 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Certificate: Mill certificate for silt fence fabric attesting that fabric and factory seams comply with specified requirements, signed by legally authorized official of manufacturer; indicate actual minimum average roll values; identify fabric by roll identification numbers.

PART 2 PRODUCTS

2.1 MATERIALS
   A. Mulch: Use one of the following:
      1. Straw or hay.
      2. Wood waste, chips, or bark.
      3. Erosion control matting or netting.
   B. Silt Fence Fabric: Polypropylene geotextile resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible; fabric including seams with the following minimum average roll lengths:
      1. Average Opening Size: 30 U.S. Std. Sieve, maximum, when tested in accordance with ASTM D4751.
      2. Permittivity: 0.05 sec^-1, minimum, when tested in accordance with ASTM D4491.
      3. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D4355 after 500 hours exposure.
      4. Tensile Strength: 100 lb-f, minimum, in cross-machine direction; 124 lb-f, minimum, in machine direction; when tested in accordance with ASTM D4632.
      5. Elongation: 15 to 30 percent, when tested in accordance with ASTM D4632.
6. Tear Strength: 55 lb-f, minimum, when tested in accordance with ASTM D4533.
7. Color: Manufacturer’s standard, with embedment and fastener lines preprinted.

C. Silt Fence Posts: One of the following, minimum 5 feet long:
   1. Steel U- or T-section, with minimum mass of 1.33 lb per linear foot.
   2. Hardwood, 2 by 2 inches in cross section.

D. Riprap: See Section 31 37 00.

PART 3 EXECUTION

3.1 EXAMINATION
   A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

3.2 PREPARATION
   A. Schedule work so that soil surfaces are left exposed for the minimum amount of time.

3.3 SCOPE OF PREVENTIVE MEASURES
   A. In all cases, if permanent erosion resistant measures have been installed temporary preventive measures are not required.
   B. Construction Entrances: Traffic-bearing aggregate surface.
      1. Width: As required; 20 feet, minimum.
      2. Length: 50 feet, minimum.
      3. Provide at each construction entrance from public right-of-way.
      4. Where necessary to prevent tracking of mud onto right-of-way, provide wheel washing area out of direct traffic lane, with drain into sediment trap or basin.
   C. Linear Sediment Barriers: Made of silt fences.
      1. Provide linear sediment barriers:
         a. Along downhill perimeter edge of disturbed areas, including soil stockpiles.
   D. Mulching: Use only for areas that may be subjected to erosion for less than 6 months.
      1. Wood Waste: Use only on slopes 3:1 or flatter; no anchoring required.
   E. Temporary Seeding: Use where temporary vegetated cover is required.

3.4 INSTALLATION
   A. Silt Fences:
      1. Store and handle fabric in accordance with ASTM D4873.
      2. Where slope gradient is less than 3:1 or barriers will be in place less than 6 months, use nominal 16 inch high barriers with minimum 36 inch long posts spaced at 6 feet maximum, with fabric embedded at least 4 inches in ground.
      3. Where slope gradient is steeper than 3:1 or barriers will be in place over 6 months, use nominal 28 inch high barriers, minimum 48 inch long posts spaced at 6 feet maximum, with fabric embedded at least 6 inches in ground.
      4. Where slope gradient is steeper than 3:1 and vertical height of slope between barriers is more than 20 feet, use nominal 32 inch high barriers with woven wire reinforcement and steel posts spaced at 4 feet maximum, with fabric embedded at least 6 inches in ground.
      5. Install with top of fabric at nominal height and embedment as specified.
7. Do not splice fabric width; minimize splices in fabric length; splice at post only, overlapping at least 18 inches, with extra post.
8. Fasten fabric to wood posts using one of the following:
   a. Four 3/4 inch diameter, 1 inch long, 14 gage nails.
   b. Five 17-gage staples with 3/4 inch wide crown and 1/2 inch legs.
10. Wherever runoff will flow around end of barrier or over the top, provide temporary splash pad or other outlet protection; at such outlets in the run of the barrier, make barrier not more than 12 inches high with post spacing not more than 4 feet.

B. Mulching Over Small and Medium Areas:
1. Dry Straw and Hay: Apply 4 to 6 inches depth.
2. Wood Waste: Apply 2 to 3 inches depth.
3. Erosion Control Matting: Comply with manufacturer's instructions.

C. Temporary Seeding:
1. When hydraulic seeder is used, seedbed preparation is not required.
2. When surface soil has been sealed by rainfall or consists of smooth undisturbed cut slopes, and conventional or manual seeding is to be used, prepare seedbed by scarifying sufficiently to allow seed to lodge and germinate.
3. Apply seed uniformly; if using drill or cultipacker seeders place seed 1/2 to 1 inch deep.
4. Irrigate as required to thoroughly wet soil to depth that will ensure germination, without causing runoff or erosion.
5. Repeat irrigation as required until grass is established.

3.5 MAINTENANCE
A. Inspect preventive measures weekly, within 24 hours after the end of any storm that produces 0.5 inches or more rainfall at the project site, and daily during prolonged rainfall.
B. Repair deficiencies immediately.
C. Silt Fences:
   1. Promptly replace fabric that deteriorates unless need for fence has passed.
   2. Remove silt deposits that exceed one-third of the height of the fence.
   3. Repair fences that are undercut by runoff or otherwise damaged, whether by runoff or other causes.
D. Clean out temporary sediment control structures weekly and relocate soil on site.
E. Place sediment in appropriate locations on site; do not remove from site.

3.6 CLEAN UP
A. Remove temporary measures after permanent measures have been installed, unless permitted to remain by Architect.
B. Clean out temporary sediment control structures that are to remain as permanent measures.
C. Where removal of temporary measures would leave exposed soil, shape surface to an acceptable grade and finish to match adjacent ground surfaces.

END OF SECTION
PART 1  GENERAL

1.1  SECTION INCLUDES
   A. Riprap placed loose.
   B. Riprap in sacks.

1.2  RELATED REQUIREMENTS
   A. Section 31 23 23 - Fill: Aggregate requirements.

1.3  PRICE AND PAYMENT PROCEDURES
   A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.

1.4  QUALITY ASSURANCE
   A. Perform Work in accordance with NYSDOT Standards.
   B. Maintain one copy of all construction documents on site.

PART 2  PRODUCTS

2.1  MATERIALS
   A. Riprap: Provide in accordance with NYSDOT Standards.
   B. Aggregate: Granular fill as specified in Section 31 23 23.
   C. Bags: Woven jute.
   E. Geotextile Fabric: Non-biodegradable, woven, and meeting NYSDOT Standards.

2.2  BAGGED RIPRAP
   A. Mix riprap, cement and aggregate dry. Limit quantity of cement to 10 percent of dry mixed materials by volume.
   B. Fill bags with dry ingredients to 70 percent capacity and close by sewing or stapling to a straight seam.

PART 3  EXECUTION

3.1  EXAMINATION
   A. Do not place riprap bags over frozen or spongy subgrade surfaces.
3.2 PLACEMENT
A. Place geotextile fabric over substrate, lap edges and ends.
B. Place riprap at culvert pipe ends, embankment slopes, ________, and as indicated.
C. Place bags into position. Knead, ram, or pack filled bags to conform to contour of adjacent material and other bags previously placed.
D. Place bags in a staggered pattern. Remove foreign matter from bag surfaces.
E. Installed Thickness: 5 inch average.
F. Place rock evenly and carefully over bagged riprap to minimize voids, do not tear bag fabric, place bags and rock in one consistent operation to preclude disturbance or displacement of substrate.
G. After placement, spray with water to moisten the bagged mix. Maintain moist for 24 hours.

3.3 SCHEDULES
A. Culvert Pipe Ends: Bagged, placed one layer thick, 6 inch average thickness, concealed with topsoil fill.
B. Sloped Grade At Retaining Wall: Individual riprap units, 6 inch thickness; placed prior to finish topsoil.

END OF SECTION
PART 1 General

1.1 Section includes

A. Maintain plants in manner that promotes health, growth, color and appearance, to quality levels specified; replace dead, dying, and damaged plants at no extra cost to Owner.
   1. It is Contractor's responsibility to determine type and quantity of soil amendments and fertilizer required.

B. Clean up landscaped areas.

C. Maintenance Period

1.2 Reference Standards


PART 2 Products

PART 3 Execution

3.1 Examination

A. If soil analysis has not already been performed, take sufficient samples to obtain a comprehensive analysis; perform analysis in accordance with ASTM D4972.

3.2 Landscape Maintenance - General

A. Protect existing vegetation, pavements, and facilities from damage due to maintenance activities; restore damaged items to original condition or replace, at no extra cost to Owner.

B. General Cleanup: Remove debris from all landscape areas at least once a week and from turf areas before each mowing.
   1. Debris consists of trash, rubbish, dropped leaves, downed branches and limbs of all sizes, dead vegetation, rocks, and other material not belonging in landscaped areas.
   2. Remove debris from site and dispose of properly.

C. Watering, Soil Erosion, and Sedimentation Control: Comply with federal, state, local, and other regulations in force; prevent over-watering, run-off, erosion, puddling, and ponding.
   1. Repair temporary erosion control mechanisms provided by others.
   2. Repair eroded areas and replant, when caused by inadequate maintenance.
   3. Prevent sediment from entering storm drains.

D. Trees: Exercise care to avoid girdling trees; provide protective collars if necessary; remove protective collars at end of maintenance period.

E. Fertilizing: Apply fertilizer only when necessary.

F. Drainage Channels: Remove obstructions in gutters, catch basins, storm drain inlets, yard drains, swales, ditches, and overflows.
1. Remove grates from catch basins to clean.
2. Prevent encroachment of other vegetation on turfed surface drainage channels.

G. Health Maintenance: Inspect all plants regularly for health:
1. Eradicate diseases and damaging pests, regardless of severity or speed of effect.
2. Treat accidental injuries and abrasions.
3. If a plant is unhealthy but not yet dead, according to specified definitions, determine reason(s) and take remedial action immediately.
4. Remove dead plants immediately upon determining that they are dead.

H. Pesticide and Herbicide Application: Comply with manufacturer's instructions and recommendations and applicable regulations.
1. Obtain Owner's approval prior to each application.
2. Apply in manner to prevent injury to personnel and damage to property due to either direct spray or drifting, both on and off Owner's property.
3. Use backflow preventers on hose bibbs used for mixing water; prevent spills.
4. Inspect equipment daily before application; repair leaks, clogs, wear, and damage.
5. Do not dispose of excess mixed material, unmixed material, containers, residue, rinse water, or contaminated articles on site; dispose of off site in legal manner.
6. Rinse water may be used as mix water for next batch of same formulation.
7. Contractor is responsible for all recordkeeping, submissions, and reports required by laws and regulations.

I. Replanting: Perform replacement and replanting immediately upon removal of dead plant.

3.3 IRRIGATION

A. Irrigation: Do not allow plants to wilt; apply water as required to supplement rainfall; do not waste water; do not water plants or areas not needing water; do not water during rainfall; shut off water flow when finished; repair leaks.
1. Provide backflow preventers on hose bibbs used for irrigation hoses.

3.4 CLEANING

A. Remove fallen deciduous leaves in Fall; removal may wait until all leaves have fallen.

B. Clean adjacent pavements of plant debris and other debris generated by maintenance activities.

C. Remove and dispose of general cleanup debris and biodegradable debris in a proper manner; Owner's trash collection facilities may be used.

D. Remove and dispose of general cleanup debris and biodegradable debris in a proper manner.
1. Biodegradable Debris: Owner will designate a compost pile on site where biodegradable debris may be deposited; branches and bark are not considered biodegradable.
2. Branches and Bark: Owner will designate a wood chip storage area; machine-chip all branch and bark debris.
3. Non-Biodegradable Debris: Owner's trash collection facilities may be used.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Aggregate base course.
B. Single course bituminous concrete paving.
C. Double course bituminous concrete paving.
D. Surface sealer.

1.2 RELATED REQUIREMENTS
A. Section 31 05 13 - Soils for Earthwork.
B. Section 31 05 16 - Aggregates for Earthwork.
C. Section 31 22 00 - Grading: Preparation of site for paving and base.
D. Section 31 23 23 - Fill: Compacted subgrade for paving.
E. Section 32 17 23.13 - Painted Pavement Markings.

1.3 PRICE AND PAYMENT PROCEDURES
A. See Section 01 22 00 - Unit Prices for requirements applicable to this section. Measurement and payment will be as follows:
B. Seal Coat: By the square yard. Includes preparing surfaces and applying.

1.4 REFERENCE STANDARDS
A. AI MS-2 - Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types; 1997.

1.5 QUALITY ASSURANCE
A. Perform Work in accordance with New York State Department of Transportation standards.
B. Mixing Plant: Conform to New York State Department of Transportation standards.
C. Obtain materials from same source throughout.

1.6 REGULATORY REQUIREMENTS
A. Conform to applicable code for paving work on public property.

1.7 FIELD CONDITIONS
A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
B. Do not place asphalt when ambient air or base surface temperature is less than 40 degrees F, or surface is wet or frozen.

C. Place bitumen mixture when temperature is not more than 15 F degrees below bitumen supplier's bill of lading and not more than maximum specified temperature.

1.8 QUALIFICATIONS
A. Installer: Company specializing in performing work of this section with minimum 10 years documented experience.

PART 2 PRODUCTS

2.1 MATERIALS
A. Asphalt Cement: in accordance with NYSDOT standards.
B. Aggregate for Base Course: Type 1 in accordance with NYSDOT standards.
C. Aggregate for Binder Course: Type 3 in accordance with NYSDOT standards.
D. Aggregate for Wearing Course: Type 7 in accordance with NYSDOT standards.
E. Fine Aggregate: Sand in accordance with NYSDOT Standards.
F. Mineral Filler: Finely ground particles of limestone, hydrated lime or other mineral dust, free of foreign matter.
G. Primer: Homogeneous, medium curing, liquid asphalt in accordance with NYSDOT standards.
H. Tack Coat: Homogeneous, Emulsified asphalt, and in accordance with NYSDOT standards.
J. Reclaimed Asphalt Pavement (RAP): Processed material obtained by milling or full depth removal of existing asphalt concrete pavements.

2.2 ASPHALT PAVING MIXES AND MIX DESIGN
A. Use dry material to avoid foaming. Mix uniformly.
B. Base Course: 4.0 to 6.0 percent of asphalt cement by weight in mixture in accordance with PennDOT standards.
C. Binder Course: 4.5 to 6.5 percent of asphalt cement by weight in mixture in accordance with PennDOT standards.
D. Wearing Course: 5.7 to 8.0 percent of asphalt cement by weight in mixture in accordance to PennDOT standards.
E. Submit proposed mix design of each class of mix for review prior to beginning of work.

2.3 SOURCE QUALITY CONTROL
A. Test mix design and samples in accordance with AI MS-2.
B. Section 01 40 00 - Quality Requirements: Testing, inspection and analysis requirements.
C. Submit proposed mix design of each class of mix for review prior to beginning of Work.
PART 3 EXECUTION

3.1 EXAMINATION
A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
B. Verify that compacted subgrade is dry and ready to support paving and imposed loads. Contractor shall conduct proof rolling of existing subgrade with loaded dump truck of 10 cubic yards or more of gravel.
C. Verify gradients and elevations of base are correct.
D. Verify gutter drainage grilles and frames manhole frames and curbing are installed in correct position and elevation.

3.2 BASE COURSE
A. Place and compact base course.

3.3 PREPARATION - PRIMER
A. Apply primer within areas of NYSDOT right-of-way in accordance with NYSDOT Standards.

3.4 PREPARATION - TACK COAT
A. Apply tack coat in accordance with manufacturer's instructions.
B. Apply tack coat on asphalt or concrete surfaces over subgrade surface at uniform rate of: New surfaces: 0.03 to 0.04 gal/sq. yd. Existing surfaces 0.05 to 0.06 gal/sq yd.
C. Apply tack coat to contact surfaces of curbs and gutters.
D. Coat surfaces of manhole frames with oil to prevent bond with asphalt pavement. Do not tack coat these surfaces.

3.5 PREPARATION – SURFACE SEALER
A. Surface must be clean and free of all loose material and dirt.
B. Pavement surface repairs shall be made with suitable hot or cold asphalt mix.
C. Cracks shall be filled with hot or cold pour filler.
D. Treat all grease, oil, gasoline spots or stains with SealMaster Petro Seal or Prep Seal, or approved equal.

3.6 PLACING ASPHALT PAVEMENT - SINGLE COURSE
A. Install Work in accordance with NYSDOT Standards.
B. Place asphalt within 24 hours of applying primer or tack coat.
C. Install gutter drainage grilles and frames in correct position and elevation.
D. Place asphalt wearing course to thickness as identified on construction drawings.
E. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
F. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

3.7 PLACING ASPHALT PAVEMENT - DOUBLE COURSE  
A. Place asphalt binder course within 24 hours of applying primer or tack coat.  
B. Place wearing course within two hours of placing and compacting binder course.  
C. Install gutter drainage grilles and frames in correct position and elevation.  
D. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.  
E. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.8 SEAL COAT  
A. Shall be applied by either pressurized spray application equipment or self propelled squeegee equipment. *Pressurized spray equipment shall be capable of spraying pavement sealer with sand added, maintain continuous agitation or mixing capabilities to maintain homogenous consistency of pavement sealer throughout the application process.* Self-propelled squeegee equipment shall have at least 2 squeegee or brush devices(one behind the other).  
B. Hand squeegee and brushes shall be acceptable in areas where practicality prohibits the use of mechanized equipment.  
C. Limitations: Shall not be applied when temperatures are expected to drop below 50 degrees F at anytime within a 24 hour period after application. New asphalt surfaces shall be allowed to cure a minimum of four weeks under ideal weather conditions (70 degrees F) before application of surface sealer.  
D. Mixing procedures for optimum results shall conform to product specifications.  
E. Apply a minimum of 2 coats.  
F. Apply at a rate of .11 to .13 gallon per square yard, (70-82 square feet per gallon) per coat.

3.9 TOLERANCES  
A. Section 01 40 00 - Quality Requirements: Tolerances.  
B. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.  
C. Compacted Thickness: Within 1/4 inch of specified or indicated thickness.  
D. Variation from True Elevation: Within 1/2 inch.

3.10 FIELD QUALITY CONTROL  
A. See Section 01 40 00 - Quality Requirements, for general requirements for quality control.  
B. Provide field inspection and testing. Take samples and perform tests in accordance with NYSDOT Standards.

3.11 PROTECTION  
A. Immediately after placement, protect pavement from mechanical injury for 3 days or until surface temperature is less than 140 degrees F.
B. Immediately after placement, protect pavement from mechanical injury for 72 hours or until surface temperature is less than 140 degrees F.

C. Surface Sealer drying time: 8 hours max.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Concrete sidewalks, stair steps, integral curbs, gutters, median barriers, parking areas, and roads.

1.2 RELATED REQUIREMENTS
   A. Section 03 10 00 - Concrete Forming and Accessories.
   B. Section 03 20 00 - Concrete Reinforcing.
   C. Section 03 30 00 - Cast-in-Place Concrete.
   D. Section 31 22 00 - Grading: Preparation of site for paving and base and preparation of subsoil at pavement perimeter for planting.
   E. Section 31 23 23 - Fill: Compacted subbase for paving.
   F. Section 32 12 16 - Asphalt Paving: Asphalt wearing course.

1.3 PRICE AND PAYMENT PROCEDURES
   A. Concrete paving is to be provided by the unit price method.
   B. See Section 01 22 00 - Unit Prices, for additional unit price requirements.

1.4 REFERENCE STANDARDS
   B. ACI 301 - Specifications for Structural Concrete; 2010 (Errata 2012).
   C. ACI 305R - Hot Weather Concreting; 2010.
   D. ACI 306R - Cold Weather Concreting; 2010.

1.5 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on joint filler, admixtures, and curing compound.
C. Samples: Submit two sample panels, 12 by 12 inch in size illustrating exposed aggregate finish.

PART 2 PRODUCTS

2.1 PAVING ASSEMBLIES
A. Comply with applicable requirements of NYSDOT Standards.

2.2 FORM MATERIALS
A. Form Materials: As specified in Section 03 10 00, conform to ACI 301.
B. Joint Filler: Preformed; non-extruding bituminous type (ASTM D1751) or sponge rubber or cork (ASTM D1752).

2.3 REINFORCEMENT
A. Reinforcing Steel and Welded Wire Reinforcement: Types specified in Section 03 20 00.
B. Dowels: ASTM A615/A615M, Grade 40 - 40,000 psi yield strength; deformed billet steel bars; unfinished finish.

2.4 CONCRETE MATERIALS
A. Obtain cementitious materials from same source throughout.
B. Concrete Materials: As specified in Section 03 30 00.

2.5 ACCESSORIES
A. Acid Etch Solution: Muriatic type mixed to a ____ percent solution.
B. Curing Compound: Meeting NYSDOT Standards.
C. Liquid Surface Sealer: Meeting NYSDOT Standards.
D. Surface Retarder: Meeting NYSDOT Standards.

2.6 CONCRETE MIX DESIGN
A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.
B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
   1. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.
C. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended by manufacturer.

D. Concrete Properties:
   1. Compressive strength, when tested in accordance with ASTM C39/C39M at 28 days; _____ psi.
   2. Fly Ash Content: Maximum 20 percent of cementitious materials by weight.
   3. Cement Content: Minimum 605 lb per cubic yard.
   4. Water-Cement Ratio: Maximum 40 percent by weight.
   5. Total Air Content: 5.0 to 8.0 percent, determined in accordance with ASTM C173/C173M.
   7. Maximum Aggregate Size: 1 inch.

2.7 MIXING

A. On Project Site: Mix in drum type batch mixer, complying with ASTM C685/C685M. Mix each batch not less than 1-1/2 minutes and not more than 5 minutes.

B. Transit Mixers: Comply with ASTM C94/C94M.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.

B. Verify gradients and elevations of base are correct.

3.2 SUBBASE

A. See Section 32 11 23 for construction of base course for work of this Section.

3.3 PREPARATION

A. Moisten base to minimize absorption of water from fresh concrete.

B. Coat surfaces of manhole frames with oil to prevent bond with concrete pavement.

C. Notify Architect minimum 24 hours prior to commencement of concreting operations.

3.4 FORMING

A. Place and secure forms to correct location, dimension, profile, and gradient.

B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.5 REINFORCEMENT

A. Place reinforcement at as indicated on the construction drawings.

B. Interrupt reinforcement at expansion joints.
3.6 COLD AND HOT WEATHER CONCRETING
   A. Follow recommendations of ACI 305R when concreting during hot weather.
   B. Follow recommendations of ACI 306R when concreting during cold weather.
   C. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

3.7 PLACING CONCRETE
   A. Coordinate installation of snow melting components.
   B. Place concrete as specified in Section 03 30 00.
   C. Do not place concrete when base surface is wet.
   D. Place concrete using the slip form technique.
   E. Ensure reinforcement, inserts, embedded parts, formed joints are not disturbed during concrete placement.
   F. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.
   G. Place concrete to pattern indicated.
   H. Apply surface retarder to all exposed surfaces in accordance with manufacturer’s instructions.

3.8 JOINTS
   A. Align curb, gutter, and sidewalk joints.
   B. Place 1/4 inch wide expansion joints at 20 foot intervals and to separate paving from vertical surfaces and other components and in pattern indicated.
      1. Form joints with joint filler extending from bottom of pavement to within 1/4 inch of finished surface.
      2. Secure to resist movement by wet concrete.
   C. Provide scored joints.
      1. As indicated on plan.
      2. At 5 feet intervals.
      3. Between sidewalks and curbs.
      4. Between curbs and pavement.
      5. Scores to be a 2” tooled joint.
   D. Provide keyed joints as indicated.
   E. Saw cut contraction joints 3/16 inch wide at an optimum time after finishing. Cut 1/3 into depth of slab.

3.9 EXPOSED AGGREGATE
   A. Wash concrete surfaces to which surface retarder has been applied with clean water, and scrub with stiff bristle brush exposing aggregate to match sample panel.

3.10 FINISHING
   A. Area Paving: Light broom, texture perpendicular to pavement direction.
B. Sidewalk Paving: Light broom, texture perpendicular to direction of travel with troweled and radiused edge 1/4 inch radius.

C. Median Barrier: Light broom, texture perpendicular to direction of travel with troweled and radiused edge 1/4 inch radius.

D. Curbs and Gutters: Light broom, texture parallel to pavement direction.

E. Inclined Vehicular Ramps: Broomed perpendicular to slope.

F. Place sealer on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

3.11 TOLERANCES

A. Maximum Variation of Surface Flatness: 1/4 inch in 10 ft.

B. Maximum Variation From True Position: 1/4 inch.

3.12 FIELD QUALITY CONTROL

A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.
   1. Provide free access to concrete operations at project site and cooperate with appointed firm.
   2. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
   3. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.

B. Compressive Strength Tests: ASTM C39/C39M; for each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cu yd or less of each class of concrete placed.
   1. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
   2. Perform one slump test for each set of test cylinders taken.

C. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.13 PROTECTION

A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.

B. Do not permit pedestrian or vehicular traffic over pavement for 7 days minimum after finishing.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Roadway lane markings and crosswalk markings.
   B. "No Parking" curb painting.

1.2 RELATED REQUIREMENTS
   A. Section 32 12 16 - Asphalt Paving.
   B. Section 32 13 13 - Concrete Paving.
   C. Section 32 17 26 - Tactile Warning Surfacing: Plastic tactile and detectable warning tiles for pedestrian walking surfaces.

1.3 PRICE AND PAYMENT PROCEDURES
   A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.

1.4 REFERENCE STANDARDS

1.5 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Manufacturer's data sheets on each product to be used, including:
      1. Preparation instructions and recommendations.
      2. Storage and handling requirements and recommendations.
      3. Installation methods.
   C. Certificates: Submit for each batch of paint and glass beads stating compliance with specified requirements.
   D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      1. See Section 01 60 00 - Product Requirements, for additional provisions.
      2. Extra Paint: 2 containers, 1 gallon size, of each type and color.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Deliver paint in containers of at least 5 gallons accompanied by batch certificate.
   B. Deliver glass beads in containers suitable for handling and strong enough to prevent loss during shipment accompanied by batch certificate.
   C. Store products in manufacturer's unopened packaging until ready for installation.
D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.7 FIELD CONDITIONS
   A. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.1 MATERIALS
   A. Line and Zone Marking Paint: MPI (APL) No. 97 Latex Traffic Marking Paint; color(s) as indicated.
   B. Temporary Marking Tape: Preformed, reflective, pressure sensitive adhesive tape in color(s) required; Contractor is responsible for selection of material of sufficient durability as to perform satisfactorily during period for which its use is required.

PART 3 EXECUTION

3.1 EXAMINATION
   A. Do not begin installation until substrates have been properly prepared.
   B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION
   A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of marking materials.
   B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
   C. Clean surfaces thoroughly prior to installation.
      1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods.
   D. Where oil or grease are present, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application; after cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint.
   E. Establish survey control points to determine locations and dimensions of markings; provide templates to control paint application by type and color at necessary intervals.
   F. Temporary Pavement Markings: When required or directed by Architect, apply temporary markings of the color(s), width(s) and length(s) as indicated or directed.
      1. After temporary marking has served its purpose, remove temporary marking by carefully controlled sandblasting, approved grinding equipment, or other approved method so that surface to which the marking was applied will not be damaged.
2. At Contractor's option, temporary marking tape may be used in lieu of temporary painted marking; remove unsatisfactory tape and replace with painted markings at no additional cost to Owner.

3.3 INSTALLATION

A. Begin pavement marking as soon as practicable after surface has been cleaned and dried.
B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F or more than 95 degrees F.
C. Apply in accordance with manufacturer's instructions using an experienced technician that is thoroughly familiar with equipment, materials, and marking layouts.
D. Comply with FHWA MUTCD manual (http://mutcd.fhwa.dot.gov) for details not shown.
E. Apply markings in locations determined by measurement from survey control points; preserve control points until after markings have been accepted.
F. Apply uniformly painted markings of color(s), lengths, and widths as indicated on the drawings true, sharp edges and ends.
   1. Apply paint in one coat only.
   2. Wet Film Thickness: 0.015 inch, minimum.
   3. Width Tolerance: Plus or minus 1/8 inch.
G. Roadway Traffic Lanes: Use suitable mobile mechanical equipment that provides constant agitation of paint and travels at controlled speeds.
   1. Conduct operations in such a manner that necessary traffic can move without hindrance.
   2. Place warning signs at the beginning of the wet line, and at points well in advance of the marking equipment for alerting approaching traffic from both directions. Place small flags or other similarly effective small objects near freshly applied markings at frequent intervals to reduce crossing by traffic.
   3. If paint does not dry within expected time, discontinue paint operations until cause of slow drying is determined and corrected.
   4. Skip Markings: Synchronize one or more paint "guns" to automatically begin and cut off paint flow; make length of intervals as indicated.
   5. Use hand application by pneumatic spray for application of paint in areas where a mobile paint applicator cannot be used.
H. Symbols: Use a suitable template that will provide a pavement marking with true, sharp edges and ends, of the design and size indicated.

3.4 DRYING, PROTECTION, AND REPLACEMENT

A. Protect newly painted markings so that paint is not picked up by tires, smeared, or tracked.
B. Provide barricades, warning signs, and flags as necessary to prevent traffic crossing newly painted markings.
C. Allow paint to dry at least the minimum time specified by the applicable paint standard and not less than that recommended by the manufacturer.
D. Remove and replace markings that are applied at less than minimum material rates; deviate from true alignment; exceed length and width tolerances; or show light spots, smears, or other deficiencies or irregularities.
E. Remove markings in manner to avoid damage to the surface to which the marking was applied, using carefully controlled sand blasting, approved grinding equipment, or other approved method.
F. Replace removed markings at no additional cost to Owner.

END OF SECTION
SECTION 32 17 26
TACTILE WARNING SURFACING

PART 1  GENERAL

1.1  SECTION INCLUDES
A. Plastic tactile and detectable warning tiles for pedestrian walking surfaces.

1.2  RELATED REQUIREMENTS
A. Section 03 30 00 - Cast-in-Place Concrete: Concrete for sidewalks and platforms.

1.3  REFERENCE STANDARDS
A. 49 CFR 27, 37, and 38 - Transportation for Individuals with Disabilities; Final Rule; Department of Transportation; current edition.
D. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.
1.4 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Submit manufacturer's product data, standard details, details specific to this project; written installation and maintenance instructions.
C. Samples: For each product specified provide two samples, 8 inches square, minimum; show actual product, color, and patterns.
D. Warranty: Submit manufacturer warranty; complete forms in Owner's name and register with manufacturer.

1.5 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years documented experience.
B. Installer Qualifications: Company certified in writing by product manufacturer as having successfully completed work substantially similar to the work of this section.

1.6 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Plastic Tiles: Provide manufacturer's standard five year warranty against manufacturing defects, breakage or deformation.

PART 2 PRODUCTS
2.1 MANUFACTURERS
A. Plastic Tactile and Detectable Warning Surface Tiles:

2.2 TACTILE AND DETECTABLE WARNING DEVICES
A. Plastic Tactile and Detectable Warning Tiles: ADA Standards compliant, glass fiber and carbon fiber reinforced, exterior grade, matte finish polyester sheet with truncated dome pattern, solid color throughout, internal reinforcing of sheet and of truncated domes, integral radius cut lines on back face of tile; with factory applied removable protective sheeting.
   1. Material Properties:
      a. Water Absorption: 0.20 percent, maximum, when tested in accordance with ASTM D570.
      b. Slip Resistance: 0.80 minimum combined wet/dry static coefficient of friction, when tested in accordance with ASTM C1028.
      c. Compressive Strength: 25,000 pounds per square inch, minimum, when tested in accordance with ASTM D695.
      d. Tensile Strength: 10,000 pounds per square inch, minimum, when tested in accordance with ASTM D638.
      e. Flexural Strength: 25,000 pounds per square inch minimum, when tested in accordance with ASTM D790.
f. Chemical Stain Resistance: No reaction to 1 percent hydrochloric acid, motor oil, calcium chloride, gum, soap solution, bleach, or antifreeze, when tested in accordance with ASTM D543.
g. Abrasion Resistance: 300, minimum, when tested in accordance with ASTM C501.
h. Flame Spread Index: 25, maximum, when tested in accordance with ASTM E84.
i. Accelerated Weathering: Delta-E of less than 5.0 at 2,000 hours exposure, when tested in accordance with ASTM G155.
j. Adhesion: No delamination of tile prior to board failure in a temperature range of 20 to 180 degrees F, when tested in accordance with ASTM C903.
k. Loading: No damage when tested according to AASHTO LRFD test method HS20.
l. Salt and Spray Performance: No deterioration or other defect after 200 hours of exposure, when tested in accordance with ASTM B117.

2. Installation Method: Cast in place.
3. Shape: Rectangular.
5. Pattern: In-line pattern of truncated domes complying with ADA Standards.

2.3 ACCESSORIES

A. Fasteners: ASTM A666, Type 304 stainless steel
   1. Type: Countersunk, color matched composite sleeve anchors
   2. Size: 1/4 inch diameter and 1-1/2 inches long.

PART 3 EXECUTION

3.1 EXAMINATION

A. When installation location is near site boundary or property line, verify required location using property survey.
B. Verify that work area is ready to receive work:
   1. If existing conditions are not as required to properly complete the work of this section, notify Architect.
   2. Do not proceed with installation until deficiencies in existing conditions have been corrected.
C. Verify that dimensions, tolerances, and attachment methods for work in this section are properly coordinated with other work on site.

3.2 INSTALLATION, GENERAL

A. Install in accordance with manufacturer’s written instructions.
   1. Do not install damaged, warped, bowed, dented, abraded, or otherwise defective units.
   2. Do not install when ambient or substrate temperature has been below 40 degrees F during the preceding 8 daylight hours.
B. Field Adjustment:
   1. Locate relative to curb line in compliance with ATBCB PROWAG, Sections 304 and 305.
   2. Orient so dome pattern is aligned with the direction of ramp.
C. Install units fully seated to substrate, square to straight edges and flat to required slope.
D. Align units so that tops of adjacent units are flush and joints between units are uniform in width.
3.3 INSTALLATION, CAST IN PLACE PLASTIC TILES

A. Concrete:
   1. See Section 03 30 00.
   2. Slump: 4 to 7 percent.
B. Tamp and vibrate units as recommended by manufacturer.
C. Place and position weights on units while concrete cures as recommended by manufacturer. Ensure no voids or air pockets exist between top surface of concrete and underside of units.

3.4 INSTALLATION - CAST IN PLACE

A. Concrete: See Section 03 30 00.
B. Install by method described in manufacturer’s written instructions.
C. Place units into wet concrete.
D. Press assembly into concrete to achieve final elevation.
E. Finish concrete adjacent to plate. Remove wet concrete spilled onto plate surface.

3.5 CLEANING PLASTIC UNITS

A. Remove protective plastic sheeting within 24 hours of installation.
B. Remove excess sealant or adhesive from joints and edges.
C. Clean four days prior to date of scheduled inspection.

3.6 PROTECTION

A. Protect installed units from traffic, subsequent construction operations or other imposed loads until concrete is fully cured.
B. Touch-up, repair or replace damaged products prior to Date of Substantial Completion.

END OF SECTION
PART 1  GENERAL

1.1  SECTION INCLUDES
A. Fence framework, fabric, and accessories.
B. Excavation for post bases; concrete foundation for posts and center drop for gates.
C. Manual gates and related hardware.
D. Softball and Baseball backstops.

1.2  RELATED REQUIREMENTS
A. Section 03 30 00 - Cast-in-Place Concrete: Concrete anchorage for posts.

1.3  REFERENCE STANDARDS
E. ASTM A428/A428M - Standard Test Method for Weight (Mass) of Coating on Aluminum-Coated Iron or Steel Articles; 2010 (Reapproved 2014).
G. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
K. ASTM F668 - Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric; 2011.
N. ASTM F1665 - Standard Specification for Poly(Vinyl Chloride)(PVC) and Other Conforming Organic Polymer-Coated Steel Barbed Wire Used with Chain-Link Fence; 2008 (Reapproved 2013).

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.
C. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components.
D. Samples: Submit two samples of fence fabric, slat infill, 12 inch by 12 inch in size illustrating construction and colored finish.
E. Manufacturer's Installation Instructions: Indicate installation requirements and shop drawings.
F. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines and easements.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Chain Link Fences and Gates:
   3. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 MATERIALS

A. Posts, Rails, and Frames: ASTM F1083 Schedule 40 hot-dipped galvanized steel pipe, welded construction, minimum yield strength of 50 ksi for sizes NPS 5 and larger.
B. Posts, Rails, and Frames: ASTM A 1011/A 1011M, Designation SS; hot-rolled steel strip, cold formed to pipe configuration, longitudinally welded construction, minimum yield strength of 50 ksi; zinc coating conforming to ASTM F1043 Type B on pipe exterior and interior.
D. Concrete: Ready-mixed, complying with ASTM C 94/C 94M; normal Portland cement; 3,500 psi strength at 28 days and 3 inch slump.

2.3 COMPONENTS

A. Line Posts: 2.38 inch diameter.
B. Corner and Terminal Posts: 3 inch O.D. Unless otherwise noted on details.
C. Gate Posts:
   1. 3 inch O.D. for fencing up to 10’ in height.
   2. 4 inch O.D. for fencing 10-12’ in height.
D. Top and Brace Rail: 1.66 inch diameter, plain end, sleeve coupled.
E. Gate Frame: 1.66 inch diameter for welded fabrication.

F. Fabric: 2 inch diamond mesh interwoven wire, 6 gage, 0.1620 inch thick, top selvage knuckle end closed, bottom selvage twisted tight.

G. Tension Wire: 6 gage, 0.1620 inch thick steel, single strand.

H. Tie Wire: 11 gauge steel wire.

2.4 ACCESSORIES

A. Caps: Cast steel galvanized; sized to post diameter, set screw retainer.

B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; steel.

C. Hardware for Single Swinging Gates: 180 degree hinges, 2 for gates up to 60 inches high, 3 for taller gates; fork latch with gravity drop and padlock hasp; keeper to hold gate in fully open position.

D. Hardware for Double Swinging Gates: 180 degree hinges, 2 for gates up to 60 inches high, 3 for taller gates; drop bolt on inactive leaf engaging socket stop set in concrete, active leaf latched to inactive leaf preventing raising of drop bolt, padlock hasp; keepers to hold gate in fully open position.

E. Privacy Slats: Vinyl strips, sized to fit fabric weave.

2.5 FINISHES

A. Components and Fabric: Vinyl coated over coating of 1.8 oz/sq ft galvanizing.

B. Hardware: Hot-dip galvanized to weight required by ASTM A153/A153M.

C. Accessories: Same finish as framing.

D. Color(s): As shown on drawings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install framework, fabric, accessories and gates in accordance with ASTM F 567.

B. Place fabric on outside of posts and rails.

C. Set intermediate posts plumb, in concrete footings with top of footing 6 inches below finish grade. Slope top of concrete for water runoff.

D. Line Post Footing Depth Below Finish Grade: ASTM F 567.

E. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: ASTM F 567.

F. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail one bay from end and gate posts.

G. Provide top rail through line post tops and splice with 6 inch long rail sleeves.

H. Install center brace rail on corner gate leaves.

I. Do not stretch fabric until concrete foundation has cured 28 days.

J. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.
K. Position bottom of fabric 2 inches above finished grade.

L. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on centers.

M. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.

N. Install bottom tension wire stretched taut between terminal posts.

O. Do not attach the hinged side of gate to building wall; provide gate posts.

P. Install gate with fabric to match fence. Install hardware.

Q. Provide concrete center drop to footing depth and drop rod retainers at center of double gate openings.

3.2 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch.

B. Maximum Offset From True Position: 1 inch.

C. Components shall not infringe adjacent property lines.

END OF SECTION
SECTION 32 92 19
SEEDING

PART 1  GENERAL

1.1  SECTION INCLUDES
A. Preparation of subsoil.
B. Placing topsoil.
C. Seeding, mulching and fertilizer.
D. Maintenance.

1.2  RELATED REQUIREMENTS
A. Section 31 22 00 - Grading: Preparation of subsoil and placement of topsoil in preparation for the work of this section.
B. Section 31 23 23 - Fill: Topsoil material.

1.3  PRICE AND PAYMENT PROCEDURES
A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.

1.4  DEFINITIONS

1.5  SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Topsoil samples.
C. Product Data: Submit data for seed mix, fertilizer, mulch, and other accessories.
D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
E. Maintenance Data: Include maintenance instructions, cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer.

1.6  REGULATORY REQUIREMENTS
A. Comply with regulatory agencies for fertilizer and herbicide composition.

1.7  DELIVERY, STORAGE, AND HANDLING
A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable. Deliver seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.
B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.
1.8 QUALIFICATIONS
   A. Seed Supplier: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
   B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.9 MAINTENANCE SERVICE
   A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance service.

PART 2 PRODUCTS

2.1 SEED MIXTURE
   A. Seed Mixture:
      1. Kentucky Blue Grass: 20 percent.
      2. Creeping Red Fescue Grass: 25 percent.
      3. Annual Rye: 20 percent.
      4. Perennial Rye: 35 percent.

2.2 SOIL MATERIALS
   A. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; pH value of minimum 5.4 and maximum 7.0.

2.3 ACCESSORIES
   A. Mulching Material: Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable.
   B. Fertilizer: Based on recommendations from Soil Tests; recommended for grass, with fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, as indicated by analysis.
   C. Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.
   D. Erosion Fabric: Jute matting, open weave. Provide on all disturbed slopes of 3:1 or greater.

2.4 TESTS
   A. Analyze to ascertain percentage of nitrogen, phosphorus, potash, soluble salt content, organic matter content, and pH value.
   B. Submit minimum 10 oz sample of topsoil proposed. Forward sample to approved testing laboratory in sealed containers to prevent contamination.
   C. Testing is not required if recent tests are available for imported topsoil. Submit these test results to the testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.
PART 3 EXECUTION

3.1 EXAMINATION
A. Verify that prepared soil base is ready to receive the work of this Section.

3.2 PREPARATION
A. Prepare subgrade in accordance with Section 31 22 00.
B. Place topsoil in accordance with Section 31 22 00.

3.3 FERTILIZING
A. Apply fertilizer at a rate of soil analysis recommendations.
B. Apply after smooth raking of topsoil and prior to roller compaction.
C. Do not apply fertilizer at same time or with same machine as will be used to apply seed.
D. Mix thoroughly into upper 2 inches of topsoil.
E. Lightly water to aid the dissipation of fertilizer.

3.4 SEEDING
A. Apply seed at a rate of 6 lbs per 1000 sq ft evenly in two intersecting directions. Rake in lightly.
B. Do not seed areas in excess of that which can be mulched on same day.
C. Do not sow immediately following rain, when ground is too dry, or during windy periods.
D. Roll seeded area with roller not exceeding 112 lbs.
E. Immediately following seeding and compacting, apply mulch to a thickness of 1/8 inches. Maintain clear of shrubs and trees.
F. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.
G. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches.

3.5 HYDROSEEDING
A. Apply seeded slurry with a hydraulic seeder at a rate of 6 lbs per 1000 sq ft evenly in two intersecting directions.
B. Do not hydroseed area in excess of that which can be mulched on same day.
C. Immediately following seeding, apply mulch to a thickness of 1/8 inches. Maintain clear of shrubs and trees.
D. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.
E. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches.
3.6 PROTECTION
A. Cover seeded slopes where grade is 36 inches per foot or greater with erosion fabric. Roll fabric onto slopes without stretching or pulling.
B. Lay fabric smoothly on surface, bury top end of each section in 6 inch deep excavated topsoil trench. Provide 12 inch overlap of adjacent rolls. Backfill trench and rake smooth, level with adjacent soil.
C. Secure outside edges and overlaps at 36 inch intervals with stakes.
D. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.
E. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches.

3.7 MAINTENANCE
A. Provide maintenance at no extra cost to Owner; Owner will pay for water.
B. See Section 01 70 00 - Execution Requirements, for additional requirements relating to maintenance service.
C. Maintain seeded areas immediately after placement until grass is well established and exhibits a vigorous growing condition.
D. Mow grass at regular intervals to maintain at a maximum height of 2-1/2 inches. Do not cut more than 1/3 of grass blade at any one mowing.
E. Neatly trim edges and hand clip where necessary.
F. Immediately remove clippings after mowing and trimming.
G. Water to prevent grass and soil from drying out.
H. Roll surface to remove minor depressions or irregularities.
I. Control growth of weeds.
J. Immediately reseed areas that show bare spots.
K. Protect seeded areas with warning signs during maintenance period.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Preparation of subsoil.
   B. Placing topsoil.
   C. Fertilizing.
   D. Sod installation.
   E. Maintenance.

1.2 RELATED REQUIREMENTS
   A. Section 31 22 00 - Grading: Topsoil material.
   B. Section 31 22 00 - Grading: Preparation of subsoil and placement of topsoil in preparation for the work of this section.
   C. Section 31 23 23 - Fill: Topsoil material.

1.3 DEFINITIONS

1.4 REFERENCE STANDARDS
   A. TPI (SPEC) - Guideline Specifications to Turfgrass Sodding; 2006.

1.5 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Certification: Submit certification of grass species and location of sod source.

1.6 QUALITY ASSURANCE
   A. Sod Producer: Company specializing in sod production and harvesting with minimum five years experience, and certified by the State of New York.

1.7 REGULATORY REQUIREMENTS
   A. Comply with regulatory agencies for fertilizer and herbicide composition.

1.8 DELIVERY, STORAGE, AND HANDLING
   A. Deliver sod on pallets. Protect exposed roots from dehydration.
   B. Do not deliver more sod than can be laid within 24 hours.
PART 2 PRODUCTS

2.1 MATERIALS

A. Sod: TPI (SPEC), Certified Turfgrass Sod quality; cultivated grass sod; type indicated in plant schedule on Drawings; with strong fibrous root system, free of stones, burned or bare spots; containing no more than 5 weeds per 1000 sq ft. Minimum age of 18 months, with root development that will support its own weight without tearing, when suspended vertically by holding the upper two corners.

1. Kentucky Blue Grass Type: 100 percent.

B. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay, or impurities, plants, weeds and roots; pH value of minimum 5.4 and maximum 7.0.

C. Fertilizer: ________________; recommended for grass, with fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, as indicated by analysis.

D. Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.

2.2 SOURCE QUALITY CONTROL

A. Provide analysis of topsoil fill under provisions of Section 01 40 00.

B. Analyze to ascertain percentage of nitrogen, phosphorus, potash, __________, soluble salt content, organic matter content, and pH value.

C. Testing is not required if recent tests are available for imported topsoil. Submit these test results to the testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that prepared soil base is ready to receive the work of this section.

3.2 PREPARATION

A. Prepare subgrade in accordance with Section 31 22 00.

B. Place topsoil in accordance with Section 31 22 00.

3.3 FERTILIZING

A. Apply fertilizer in accordance with manufacturer's instructions.

B. Apply after smooth raking of topsoil and prior to installation of sod.

C. Apply fertilizer no more than 48 hours before laying sod.

D. Mix thoroughly into upper 2 inches of topsoil.
E. Lightly water to aid the dissipation of fertilizer.

3.4 LAYING SOD
A. Moisten prepared surface immediately prior to laying sod.
B. Lay sod immediately after delivery to site to prevent deterioration.
C. Lay sod smooth and tight with no open joints visible, and no overlapping; stagger end joints 12 inches minimum. Do not stretch or overlap sod pieces.
D. Where new sod adjoins existing grass areas, align top surfaces.
E. Where sod is placed adjacent to hard surfaces, such as curbs, pavements, etc., place top elevation of sod 1/2 inch below top of hard surface.
F. On slopes 6 inches per foot and steeper, lay sod perpendicular to slope and secure every row with wooden pegs at maximum 2 feet on center. Drive pegs flush with soil portion of sod.
G. Water sodded areas immediately after installation. Saturate sod to 4 inches of soil.
H. After sod and soil have dried, roll sodded areas to ensure good bond between sod and soil and to remove minor depressions and irregularities. Roll sodded areas with roller not exceeding 110 lbs.

3.5 MAINTENANCE
A. Provide maintenance at no extra cost to Owner; Owner will pay for water.
B. Maintain sodded areas immediately after placement until grass is well established and exhibits a vigorous growing condition.
C. Mow grass at regular intervals to maintain at a maximum height of 2-1/2 inches. Do not cut more than 1/3 of grass blade at any one mowing.
D. Neatly trim edges and hand clip where necessary.
E. Immediately remove clippings after mowing and trimming.
F. Water to prevent grass and soil from drying out.
G. Roll surface to remove irregularities.
H. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.
I. Immediately replace sod to areas that show deterioration or bare spots.
J. Protect sodded areas with warning signs during maintenance period.

END OF SECTION
SECTION 32 93 00
PLANTS

PART 1 GENERAL

1.1 SECTION INCLUDES
A. Preparation of subsoil.
B. Topsoil bedding.
C. New trees, plants, and ground cover.
D. Relocated trees, plants, and ground cover.
E. Mulch and Fertilizer.
F. Maintenance.
G. Tree Pruning.

1.2 RELATED REQUIREMENTS
A. Section 31 22 00 - Grading: Topsoil material.
B. Section 31 23 23 - Fill: Topsoil material.

1.3 PRICE AND PAYMENT PROCEDURES
A. Unit Prices:
   1. See Section 01 22 00 - Unit Prices, for additional unit price requirements.
   2. Topsoil: By the cubic yard. Includes topsoil, placing topsoil.
   3. Plants: By the unit. Includes preparation of subsoil, placing topsoil, planting, watering and maintenance to specified time period.

1.4 DEFINITIONS
A. Weeds: Any plant life not specified or scheduled.
B. Plants: Living trees, plants, and ground cover specified in this Section, and described in ANSI Z60.1.

1.5 REFERENCE STANDARDS

1.6 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Maintenance Data: Include cutting and trimming method; types, application frequency, and recommended coverage of fertilizer; and ________.
C. Submit list of plant life sources.
D. Maintenance Contract.
1.7 QUALITY ASSURANCE
   A. Nursery Qualifications: Company specializing in growing and cultivating the plants with three years documented experience.
   B. Installer Qualifications: Company specializing in installing and planting the plants with 5 years experience.
   C. Tree Pruner Qualifications: Company specializing in pruning trees with proof of Arborist Certification.
   D. Maintenance Services: Performed by installer.

1.8 REGULATORY REQUIREMENTS
   A. Comply with regulatory agencies for fertilizer and herbicide composition.

1.9 DELIVERY, STORAGE, AND HANDLING
   A. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.
   B. Protect and maintain plant life until planted.
   C. Deliver plant life materials immediately prior to placement. Keep plants moist.

1.10 FIELD CONDITIONS
   A. Do not install plant life when ambient temperatures may drop below 35 degrees F or rise above 90 degrees F.
   B. Do not install plant life when wind velocity exceeds 30 mph.

1.11 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide one year warranty.
   C. Warranty: Include coverage for one continuous growing season; replace dead or unhealthy plants.
   D. Replacements: Plants of same size and species as specified, planted in the next growing season, with a new warranty commencing on date of replacement.

PART 2 PRODUCTS

2.1 PLANTS
   A. Plants: Species and size identified in plant schedule, grown in climatic conditions similar to those in locality of the work.

2.2 SOIL MATERIALS
   A. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; minimum pH value of 5.4 and maximum 7.0.
2.3 SOIL AMENDMENT MATERIALS
   A. Fertilizer: Containing fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, as indicated in analysis.
   B. Peat Moss: Shredded, loose, sphagnum moss; free of lumps, roots, inorganic material or acidic materials; minimum of 85 percent organic material measured by oven dry weight, pH range of 4 to 5; moisture content of 30 percent.
   C. Bone Meal: Raw, finely ground, commercial grade, minimum of 3 percent nitrogen and 20 percent phosphorous.
   D. Lime: Ground limestone, dolomite type, minimum 95 percent carbonates.
   E. Water: Clean, fresh, and free of substances or matter that could inhibit vigorous growth of plants.

2.4 MULCH MATERIALS
   A. Mulching Material: Double Ground Hardwood, Dark Brown in color species wood shavings, free of growth or germination inhibiting ingredients.

2.5 ACCESSORIES
   A. Wrapping Materials: Burlap.
   B. Stakes: Softwood lumber, pointed end.
   C. Cable, Wire, Eye Bolts and Turnbuckles: Non-corrosive, of sufficient strength to withstand wind pressure and resulting movement of plant life.
   D. Plant Protectors: Rubber sleeves over cable to protect plant stems, trunks, and branches.

2.6 PLANT SOIL MIX
   A. A uniform mixture of 1 part peat and 3 parts topsoil by volume.

2.7 SOURCE QUALITY CONTROL
   A. Provide analysis of topsoil; comply with requirements of Section 01 40 00.
   B. Provide testing of imported topsoil.
   C.
   D. Testing is not required if recent tests are available for imported topsoil. Submit these test results to the testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION

3.1 EXAMINATION
   A.
   B. Verify that prepared subsoil and planters are ready to receive work.
   C. Saturate soil with water to test drainage.
D. Verify that required underground utilities are available, in proper location, and ready for use.

3.2 PREPARATION OF SUBSOIL
A. Prepare subsoil to eliminate uneven areas. Maintain profiles and contours. Make changes in grade gradual. Blend slopes into level areas.
B. Remove foreign materials, weeds and undesirable plants and their roots. Remove contaminated subsoil.
C. Scarify subsoil to a depth of 3 inches where plants are to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.
D. Dig pits and beds 6 inches larger than plant root system.

3.3 PLACING TOPSOIL
A. Spread topsoil to a minimum depth of 4 inches over area to be planted. Rake smooth.
B. Place topsoil during dry weather and on dry unfrozen subgrade.
C. Remove vegetable matter and foreign non-organic material from topsoil while spreading.
D. Grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.
E. Install topsoil into pits and beds intended for plant root balls, to a minimum thickness of 6 inches.

3.4 FERTILIZING
A. Apply fertilizer in accordance with manufacturer's instructions.
B. Apply after initial raking of topsoil.
C. Mix thoroughly into upper 2 inches of topsoil.
D. Lightly water to aid the dissipation of fertilizer.

3.5 PLANTING
A. Place plants for best appearance for review and final orientation by Architect.
B. Set plants vertical.
C. Remove non-biodegradable root containers.
D. Set plants in pits or beds, partly filled with prepared plant mix, at a minimum depth of 6 inches under each plant. Remove burlap, ropes, and wires, from the root ball.
F. Saturate soil with water when the pit or bed is half full of topsoil and again when full.

3.6 PLANT RELOCATION AND RE-PLANTING
A. Relocate plants as indicated by Architect.
B. Replant plants in pits or beds, partly filled with prepared topsoil mixture, at a minimum depth of 6 inches under each plant. Remove burlap, ropes, and wires, from the root ball.
D. Saturate soil with water when the pit or bed is half full of topsoil and again when full.

3.7 INSTALLATION OF ACCESSORIES
A. Wrap deciduous shade and flowering tree trunks and place tree protectors.

3.8 PLANT SUPPORT
A. Brace plants vertically with plant protector wrapped guy wires and stakes to the following:
   1. Tree Caliper: 1 inch; Tree Support Method: 1 stake with one tie
   2. Tree Caliper: 1 to 2 inches; Tree Support Method: 2 stakes with two ties
   3. Tree Caliper: 2 to 4 inches; Tree Support Method: 3 stakes with 2 ties
   4. Tree Caliper: Over 4 inches; Tree Support Method: 4 guy wires with eye bolts and turn buckles

3.9 TREE PRUNING
A. Prune trees as recommended in ANSI A300 Part 1.
B. Prune newly planted trees as required to remove dead, broken, and split branches.

3.10 FIELD QUALITY CONTROL
A. Perform field inspection and testing in accordance with Section 01 40 00.
B. Plants will be rejected if a ball of earth surrounding roots has been disturbed or damaged prior to or during planting.

3.11 MAINTENANCE
A. Provide maintenance at no extra cost to Owner; Owner will pay for water.
B. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
C. Provide a separate maintenance contract for specified maintenance service.
D. Maintain plant life immediately after placement and until plants are well established and exhibit a vigorous growing condition. Continue maintenance until termination of warranty period.
E. Irrigate sufficiently to saturate root system and prevent soil from drying out.
F. Remove dead or broken branches and treat pruned areas or other wounds.
G. Neatly trim plants where necessary.
H. Immediately remove clippings after trimming.
I. Control growth of weeds.
J. Control insect damage and disease.
K. Maintain wrappings, guys, turnbuckles, and stakes. Adjust turnbuckles to keep guy wires tight. Repair or replace accessories when required.

END OF SECTION
PART 1  GENERAL

1.1  SUMMARY
A.  SECTION INCLUDES
   1.  Monolithic concrete manholes with drywells and structures or masonry transition to cover frame, covers, anchorage, and accessories.
   2.  Modular precast concrete manholes and structures sections with tongue-and-groove joints with masonry transition to frame, dry wells and structures, covers, anchorage, and accessories.
   3.  Monolithic FRP manholes, drywells, and structures with transition to lid frame, covers, anchorage, and accessories.
   4.  Masonry manholes, drywells, and structures sections with masonry transition to lid frame, covers, anchorage, and accessories.
   5.  Bedding and cover materials.

1.2  RELATED REQUIREMENTS
A.  Section 01 40 00 - Quality Requirements.
B.  Section 01 70 00 - Execution and Closeout Requirements.
C.  Section 03 30 00 - Cast-in-Place Concrete.
D.  Section 04 05 11 - Mortar and Masonry Grout.
E.  Section 31 23 16 - Excavation.
F.  Section 31 23 23 - Fill.

1.3  PRICE AND PAYMENT PROCEDURES
A.  See Section 01 22 00 - Unit Prices, for additional unit price requirements
B.  Manhole:  By the unit.  Includes excavating, concrete base pad, bedding, backfill, manhole, drywell on structure sections, masonry transition to cover frame, cover frame and cover, to indicated depth, forming and sealing pipe inlets and outlets.

1.4  REFERENCE STANDARDS
E.  ASTM C62 - Standard Specification for Building Brick (Solid Masonry Units Made From Clay or Shale); 2013.


1.5 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate manhole, dry wells and structure locations, elevations, piping and opening sizes and elevations of penetrations.
C. Product Data: Provide frame and cover construction, features, configuration, and dimensions.

1.6 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
B. Perform work in accordance with New York State Department of Transportation.

1.7 FIELD CONDITIONS
A. Cold and Hot Weather Requirements: Comply with requirements of ACI 530/530.1/ERTA or applicable building code, whichever is more stringent.

PART 2  PRODUCTS

2.1 MATERIALS
B. Manhole Sections: ASTM D3753, glass-fiber reinforced polyester with integral steps.
C. Concrete: As specified in Section 03 30 00.
D. Mortar and Grout: As specified in Section 04 05 11, Type S.
E. Reinforcement: Formed steel wire, galvanized finish, wire diameter as indicated on drawings.
F. Concrete Reinforcement: As specified in Section 03 30 00.

2.2 COMPONENTS
A. Lid and Frame: ASTM A48/A48M, Class 30B Cast iron construction, machined flat bearing surface, removable lockable lid, closed lid design; live load rating of ____ psf; sealing gasket; lid molded with identifying name. Provide ________ manufactured by ____________.
B. Manhole, Catch Basin and Structure Steps: Formed aluminum or polypropylene plastic rungs; 3/4 inch diameter. Formed integral with manhole, catch basin and structure sections.
C. Frame and Cover: Cast iron construction, machined flat bearing surface, removable cover rated for H-20 loading, provide frame and cover type as indicated on drawings. Sanitary sewer manhole covers are to be water tight.
   1. Manufacturers
      a. EJ Castings
      b. Jamestown Iron Works
      c. American Cast Iron
      d. Neenah Foundry
      e. Or Approved Equal

2.3 CONFIGURATION
   A. Shaft Construction: Concentric with concentric cone top section; lipped male/female dry joints; sleeved to receive pipe sections.
   B. Shape: As indicated on drawings.
   C. Clear Inside Dimensions: As indicated on drawings.
   D. Design Depth: As indicated on drawings.
   E. Clear Lid Opening: As indicated on drawings.
   F. Pipe Entry: Provide openings as indicated on drawings.
   G. Steps: 16 inches wide, 12 inches on center vertically, set into manhole wall as indicated on drawings or required by code.

2.4 BEDDING AND BACKFILL MATERIALS
   A. Bedding: Shall be a minimum six (6) inches of crushed stone or as indicated on drawings in accordance with Section 31 23 23.
   B. Backfill above pipe to grade: Shall be select native fill in accordance with Section 31 23 23 or as indicated on drawings.

PART 3 EXECUTION

3.1 EXAMINATION
   A. Verify items provided by other sections of Work are properly sized and located.
   B. Verify that built-in items are in proper location, and ready for roughing into Work.
   C. Verify correct size of manhole dry well and structure excavation.
   D. Verify excavation for manholes is correct.

3.2 PREPARATION
   A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.
   B. Do not install structures where site conditions induce loads exceeding structural capacity of structures.
   C. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage. Remove and replace damaged units.
3.3 INSTALLATION

A. Excavation and Backfill:
   1. Excavate for manholes and structures in accordance with Section 31 23 16 in location and to depth shown. Provide clearance around sidewalls of structure for construction operations.
   2. When groundwater is encountered, prevent accumulation of water in excavations. Place manholes, dry well and structures in dry trench.
   3. Where possibility exists of watertight structure becoming buoyant in flooded excavation, anchor structure to avoid flotation.

B. Place base pad, trowel top surface level.

C. Place manhole and structure sections plumb and level, trim to correct elevations, anchor to base pad.

D. Backfill excavations for manholes and structures in accordance with Section 31 23 16, 31 23 23.

E. Form and place manhole and structures cylinder plumb and level, to correct dimensions and elevations

F. Fit for pipe.

G. Grout base of shaft sections to achieve slope to exit piping. Trowel smooth. Contour to form continuous drainage channel.

H. Set cover frames and covers level without tipping, to correct elevations.

I. Coordinate with other sections of Work to provide correct size, shape, and location.

3.4 PRECAST CONCRETE MANHOLE, DRYWELLS AND STRUCTURE INSTALLATION

A. Lift precast components at lifting points designated by manufacturer.

B. When lowering manholes and structures into excavations and joining pipe to units, take precautions to ensure interior of pipeline and structure remains clean.

C. Set precast structures bearing firmly and fully on crushed stone bedding, compacted in accordance with provisions of Section 31 23 16, 31 23 23 or on other support system shown on Drawings.

D. Assemble multi-section structures by lowering each section into excavation. Lower, set level, and firmly position base section before placing additional sections.

E. Remove foreign materials from joint surfaces and verify sealing materials are placed properly. Maintain alignment between sections by using guide devices affixed to lower section.

F. Joint sealing materials may be installed on site or at manufacturer’s plant.

G. Verify manholes and structures installed satisfy required alignment and grade.

H. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe. Fill annular space with mortar.

I. Cut pipe to finish flush with interior of structure.

J. Shape inverts through manhole and structures as shown on Drawings.
3.5 FRAME AND COVER INSTALLATION
A. Set frames using mortar and masonry. Install radially laid concrete brick with 1/4 inch thick vertical joints at inside perimeter. Lay concrete brick in full bed of mortar and completely fill joints. Where more than one course of concrete brick is required, stagger vertical joints.

B. Set frame and cover 2 inches above finished grade for manholes and structures with covers located within unpaved areas to allow area to be graded away from cover beginning 1 inch below top surface of frame.

3.6 FIELD QUALITY CONTROL
A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Test cast-in-place concrete in accordance with Section 03 30 00.

C. Vertical Adjustment of Existing Manholes and Structures:
   1. Where required, adjust top elevation of existing manholes and structures to finished grades shown on Drawings.
   2. Reset existing frames, grates and covers, carefully removed, cleaned of mortar fragments, to required elevation in accordance with requirements specified for installation of castings.
   3. Remove concrete without damaging existing vertical reinforcing bars when removal of existing concrete wall is required. Clean vertical bars of concrete and bend into new concrete top slab or splice to required vertical reinforcement, as indicated Drawings.

D. Vacuum Testing
   1. Vacuum testing in accordance with ASTM C1244 and as follows:
      a. Inflate compression band to effect seal between vacuum base and structure; connect vacuum pump to outlet port with valve open; draw vacuum to 10 inches of Hg; close valve; start test.
      b. Test:
         1) Determine test duration for manhole test from the following Table 1:

<table>
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<tr>
<th>Depth (ft)</th>
<th>Diameter, in.</th>
<th>Times, in seconds</th>
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<tbody>
<tr>
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<td>36</td>
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<td>42</td>
</tr>
</tbody>
</table>

**Table 1 Minimum Test Times for Various Manhole Diameters (30 - 120 in.), in Seconds**
2) Record vacuum drop during test period; when vacuum drop is greater than 1 inch of Hg during test period, repair and retest manhole; when vacuum drop of 1 inch of Hg does not occur during test period, discontinue test and accept manhole.

3) When vacuum test fails to meet 1 inch Hg drop in specified time after repair, repair and retest manhole.

E. Exfiltration/Infiltration Testing (Alternative Method)

1. All sewers entering and leaving each manhole shall be plugged as for air testing. Those manholes which are constructed in a high ground water table location will be allowed to remain plugged for a period of not less than four (4) hours, after which the quantity of inward leakage accumulation will be measured by bailing and measuring and/or computation against depth of water and diameter of the manhole. Those manholes constructed above the ground water table will be filled with water to the top of the cast iron frame and allowed to stand until the walls are well soaked. The manhole shall then be refilled to the full or overflow point, and remain undisturbed for a period of not less than four (4) hours. The loss of water shall be measured by refilling to the top with a pre measured quantity of water and/or computation against depth of water loss and diameter of the manhole.

2. Allowable leakage (gain or loss) by the respective methods shall not exceed the following:
   0.04 gal. per hour, per vertical ft. of depth in barrel section
   0.03 gal. per hour, per vertical ft. of depth in cone section
   0.02 gal. per hour, per vertical ft. of depth in top section

3. Should any test of any manhole disclose leakage greater than that permitted, the CONTRACTOR shall, at his own expense and at no additional cost to the OWNER, locate and repair the defects joints and/or pipe until the leakage is within the permitted allowance utilizing materials and methods approved by the OWNER/ENGINEER.

END OF SECTION
SECTION 33 11 16
WATER UTILITY DISTRIBUTION PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Exterior Ductile Iron Pipe and Fittings.
B. Tracer Wire, Underground Warning tape.
C. Bedding and cover materials.
D. Pipe Supports.
E. Joint Restraint Appurtenances.
F. Valves, Fire hydrants, and Domestic water hydrants.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete for thrust restraints.
B. Section 31 23 16 - Excavation: Excavating of trenches.
D. Section 31 23 23 - Fill: Bedding and backfilling.
E. Section 33 13 00 - Disinfecting of Water Utility Distribution: Disinfection of site service utility water piping.

1.3 PRICE AND PAYMENT PROCEDURES

A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.
B. Pipe and Fittings: By the linear foot. Includes hand trimming excavation, pipe and fittings, bedding, concrete thrust restraints, connection to building service piping, and to municipal utility water source.

1.4 REFERENCES

E. AWWA C153/A21.53 - American National Standard for Ductile-Iron Compact Fittings, 3-inch through 24-inch and 54-inch through 64-inch, for Water Service.
F. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service; 2009.
G. AWWA C502 - Dry-Barrel Fire Hydrants; 2014.
H. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service; 2009.
I. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances; 2010.
J. UL 246 - Hydrants for Fire-Protection Service; Current Edition, Including All Revisions.


1.5 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with NYSDOH standards and requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers with labeling in place.

PART 2 PRODUCTS

2.1 WATER PIPE

A. Exterior Ductile Iron Pipe: AWWA C151:
   1. Pipe: Ductile iron, having a wall thickness Class 52. Pipe shall be furnished with cement mortar lining in conformance with AWWA C-104.
   2. Fittings: Ductile iron, having a wall thickness Class 52. Fittings shall conform in all respects to AWWA C-153. Fittings shall be furnished with cement mortar lining in conformance with AWWA C-104. All M/J fittings shall be restrained using a wedge action retainer gland as approved by the engineer or specified on the engineering drawings. Push on joints located within two joints of the restrained fitting shall have a bolt-less restraining gasket as approved by the engineer or specified on the engineering drawings.
   3. Joints: Unless otherwise specified on the drawings, all pipe shall have rubber gasket joints conforming to AWWA C-111 unless otherwise noted.

2.2 VALVES

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Gate Valves 3 Inches and Over:
   1. Manufacturers:
      a. Kennedy.
      b. Mueller.
   2. AWWA C509, ductile iron body, bronze trim, non-rising stem with square nut, single wedge, resilient seat, flanged ends, stainless steel bonnet bolts, valve key, and extension box.

C. Swing Check Valves From 2 Inches to 24 Inches:
1. AWWA C508, iron body, bronze trim, 45 degree swing disc, renewable disc and seat, flanged ends.

2.3 HYDRANTS
   A. Hydrants: Type as required by water provider.
   B. Hydrants: AWWA C502, UL 246, dry barrel type.
      1. Manufacturer: Kennedy Valve, Model # K81D Guardian Hydrant.
      2. Inside dimension: 7 inches minimum, with minimum 5 inches diameter valve seat opening.
      3. Minimum net water area of barrel not less than 190 percent of valve opening.
      4. 6 inch bell or mechanical joint inlet connection with accessories, gland bolts, and gaskets.
   C. Hydrant Extensions: Fabricate in multiples of 6 inches with rod and coupling to increase barrel length.
   D. Hose and Streamer Connection: Match sizes with utility company, two hose nozzles, one pumper nozzle.
   E. Finish: Primer and two coats of enamel in color required by utility company.

2.4 BEDDING AND COVER MATERIALS
   A. Bedding: As specified in Section 31 23 16.13.
   B. Cover: As specified in Section 31 23 16.13.

2.5 ACCESSORIES
   A. Concrete for Thrust Restraints: Concrete type specified in Section 03 30 00.

2.6 UNDERGROUND WARNING TAPE
   A. Plastic Ribbon Tape: Bright colored, continuously printed, minimum 6 inches (150 mm) wide by 4 mil (0.10 mm) thick, manufactured for direct burial service. Tape shall be placed 12-inches above crown of pipe.

2.7 UNDERGROUND PIPE MARKER
   A. Utility Witness marker shall be lightweight, flat-style marker installed using a manual driving tool. Marker shall be made from fiberglass reinforced composite material.
   B. Marker color & size: Blue; 66" L x 3.75" W

2.8 UNDERGROUND TRACE WIRE
   A. Magnetic detectable conductor, clear plastic covering, imprinted with "Water Service " in large letters.

2.9 JOINT RESTRAINT APPURTEINANCES
   A. M/J Joint Thrust Restraint Glands shall meet consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of AWWA C110 and have a working pressure rating of 350 psi.
   B. Push on Joint Thrust Restraint shall meet or exceed the performance criteria of U.S. Pipe Field Lok Gaskets, Gripper Gaskets, or Approved Equal.
PART 3 EXECUTION

3.1 EXAMINATION
A. Verify that building service connection and municipal utility water main size, location, and invert are as indicated.

3.2 PREPARATION
A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.
B. Remove scale and dirt on inside and outside before assembly.
C. Prepare pipe connections to equipment with flanges or unions.
D. All PVC or Polyethylene Pipe shall not be left exposed to the sun and shall be covered. The contractor shall also provide documentation to the Construction Inspector as to the pipe’s age and handling prior to being delivered to the site. This is to prevent pipe that has been left exposed to the sun at a storage yard from being used on the project. Lack of documentation of PVC or HDPE history will cause said pipe to be rejected.

3.3 TRENCHING
A. See the sections on excavation and fill for additional requirements.
B. Hand trim excavation for accurate placement of pipe to elevations indicated.
C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.4 BEDDING
A. Place bedding material according to the trench details provided on the Engineering Drawings.
B. Backfill around sides and to top of pipe with cover fill, tamp in place and compact to 95 percent.
C. Place fill material in accordance with Section 31 23 23.

3.5 INSTALLATION - PIPE
A. Maintain separation of water main from sanitary and storm piping in accordance with NYSDOH code requirements.
B. Ductile Iron:
   1. Maintain 10-feet horizontal and 18 inch vertical separation distance between water mains and sanitary sewer piping.
   2. Install pipe to indicated elevation to within tolerance of 5/8 inches.
   3. Install ductile iron piping and fittings to AWWA C600.
   4. Route pipe in straight line.
   5. Install pipe to allow for expansion and contraction without stressing pipe or joints.
   6. Install access fittings to permit disinfection of water system performed under Section 33 13 00.
   7. All mechanical joint fittings shall be reinforced with a thrust restrain joint gland. Boltless restraining gaskets shall be used two push on joints each side of a mechanical joint fitting. Mechanical Joint Fittings located within 15 ft. from one another shall be rodded together.
Manufacturer’s specifications for gaskets or glands shall be submitted to the engineer according to 01 33 00 - Submittal Procedures.

8. Install water pipe with a minimum 5 ft of cover.
9. Backfill trench in accordance with Section 31 23 23.
10. Group piping with other site piping work whenever practical.

3.6 INSTALLATION - VALVES AND HYDRANTS

A. Set valves on solid bearing.
B. Center and plumb valve box over valve. Set box cover flush with finished grade.
C. Set hydrants plumb; locate pumper nozzle perpendicular to and facing roadway.
D. Set hydrants to grade, with nozzles at least 20 inches above ground.
E. Locate control valve 4 inches away from hydrant.
F. Provide a drainage pit 36 inches square by 24 inches deep filled with 2 inches washed gravel. Encase elbow of hydrant in gravel to 6 inches above drain opening. Do not connect drain opening to sewer.
G. Paint hydrants in color yellow.

3.7 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01 40 00.
B. Pressure test water piping to 200 psi.
   1. After completion of pipeline installation, including backfill, but prior to final connection to existing system, conduct, in presence of Architect/Engineer, concurrent hydrostatic pressure and leakage tests in accordance with AWWA C600.
   2. Provide equipment required to perform leakage and hydrostatic pressure tests.
   3. Test Pressure: Not less than 200 psi or 50 psi in excess of maximum static pressure, whichever is greater.
   4. Conduct hydrostatic test for at least two-hour duration.
   5. No pipeline installation will be approved when pressure varies by more than 5 psi at completion of hydrostatic pressure test.
   6. Before applying test pressure, completely expel air from section of piping under test. Provide corporation cocks so air can be expelled as pipeline is filled with water. After air has been expelled, close corporation cocks and apply test pressure. At conclusion of tests, remove corporation cocks removed and plug resulting piping openings.
   7. Slowly bring piping to test pressure and allow system to stabilize prior to conducting leakage test. Do not open or close valves at differential pressures above rated pressure.
   8. Examine exposed piping, fittings, valves, hydrants, and joints carefully during hydrostatic pressure test. Repair or replace damage or defective pipe, fittings, valves, hydrants, or joints discovered, following pressure test.
   9. No pipeline installation will be approved when leakage is greater than that determined by the following formula:

   \[ L = \frac{(S \times D \times V^{-\frac{1}{2}} \times P)}{133,200} \]

   L = allowable, in gallons per hour
   S = length of pipe tested, in inches
   D = nominal diameter of pipe, in inches
   p = average test pressure during leakage test, in pounds per square inch (gauge)

10. When leakage exceeds specified acceptable rate, locate source and make repairs. Repeat test until specified leakage requirements are met.
C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

END OF SECTION
SECTION 33 13 00
DISINFECTING OF WATER UTILITY DISTRIBUTION

PART 1 GENERAL

1.1 SECTION INCLUDES
A. Disinfection of site domestic water lines and site fire water lines specified in Section 33 11 16.
B. Disinfection of building domestic water piping specified in Section 22 10 05.
C. Disinfection of water well.
D. Disinfection of water storage tanks.
E. Testing and reporting results.

1.2 RELATED REQUIREMENTS
A. Section 22 10 05 - Plumbing Piping and Specialties: Disinfection of building domestic water piping system.
B. Section 33 11 16 - Water Utility Distribution Piping.
C. Section 33 21 00 - Water Supply Wells.

1.3 PRICE AND PAYMENT PROCEDURES
A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.
B. Disinfection: By the linear foot. Includes preparing, disinfecting, testing, and reporting.

1.4 REFERENCE STANDARDS
A. AWWA B300 - Hypochlorites; 2011.
B. AWWA B301 - Liquid Chlorine; 2010.
C. AWWA B302 - Ammonium Sulfate; 2010.
D. AWWA B303 - Sodium Chlorite; 2010.
E. AWWA C651 - Disinfecting Water Mains; 2005.

1.5 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Test Reports: Indicate results comparative to specified requirements.
C. Certificate: From authority having jurisdiction indicating approval of water system.
D. Certificate: Certify that cleanliness of water distribution system meets or exceeds specified requirements.
E. Disinfection report:
   1. Type and form of disinfectant used.
   2. Date and time of disinfectant injection start and time of completion.
   3. Test locations.
4. Initial and 24 hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
5. Date and time of flushing start and completion.
6. Disinfectant residual after flushing in ppm for each outlet tested.

F. Bacteriological report:
1. Date issued, project name, and testing laboratory name, address, and telephone number.
2. Time and date of water sample collection.
3. Name of person collecting samples.
4. Test locations.
5. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
6. Coliform bacteria test results for each outlet tested.
7. Certification that water conforms, or fails to conform, to bacterial standards of ________.

1.6 QUALITY ASSURANCE
A. Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this Section with minimum three years documented experience.
B. Testing Firm: Company specializing in testing potable water systems, certified by governing authorities of the State in which the Project is located.
C. Submit bacteriologist's signature and authority associated with testing.

PART 2 PRODUCTS

2.1 DISINFECTION CHEMICALS
A. Chemicals: AWWA B300, Hypochlorite, AWWA B301, Liquid Chlorine, AWWA B302, Ammonium Sulfate, and AWWA B303, Sodium Chlorite.

PART 3 EXECUTION

3.1 NO HEAVILY CHLORINATED WATER SHALL BE DISCHARGED INTO ANY WATERWAY OR SEWER SYSTEM. A MINIMUM OF 150’ OF OVERLAND FLOW SHALL BE REQUIRED BEFORE ENTERING THE ABOVE REFERENCED DISCHARGE LOCATIONS. IN ALL CASES, HEAVILY CHLORINATED WATER DISPOSAL SHALL BE IN ACCORDANCE WITH AWWA C651 - SECTION 6.2, AND APPENDIX B.

3.2 PRELIMINARY FLUSHING
A. The main shall be flushed prior to disinfection at a flushing velocity of not less than 2.5 ft/sec. The rate of flow required to produce this velocity in various diameters is shown below.

Required Opening to Flush Pipelines (40-psi Residual Pressure)

<table>
<thead>
<tr>
<th>Pipe size in.</th>
<th>Flow required to produce 2.5 fps velocity gpm</th>
<th>Orifice size in dia.</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>220</td>
<td>1-3/8</td>
</tr>
<tr>
<td>8</td>
<td>390</td>
<td>1-7/8</td>
</tr>
<tr>
<td>10</td>
<td>610</td>
<td>2-5/16</td>
</tr>
</tbody>
</table>
3.3 NO SITE FOR FLUSHING SHOULD BE CHOSEN UNLESS IT HAS BEEN DETERMINED THAT DRAINAGE IS ADEQUATE AT THAT SITE.

3.4 FORM OF CHLORINE FOR DISINFECTION

A. The most common forms of chlorine used in the disinfecting solutions are calcium hypochlorite granules or sodium hypochlorite solutions.

B. Calcium Hypochlorite: Calcium hypochlorite contains 70 percent available chlorine by weight. Calcium hypochlorite is packaged in containers of various types and sizes ranging from small plastic bottles to 100-lb drums.
1. A chlorine-water solution is prepared by dissolving the granules in water in the proportion requisite for the desired concentration.

C. Sodium Hypochlorite: Sodium hypochlorite is supplied in strengths from 5.25 to 16 percent available chlorine. It is packaged in liquid form in glass, rubber or plastic containers ranging in size from 1-qt. bottles to 5-gal. carboys. It may also be purchased in bulk for delivery by tank truck.
1. The chlorine-water solution is prepared by adding hypochlorite to water. Product deterioration must be reckoned with in computing the quantity of sodium hypochlorite required for the desired concentration.
2. Application: The hypochlorite solutions shall be applied to the water main with a gasoline or electrically-powered chemical feed pump designed for feeding chlorine solutions. For small applications the solutions may be fed with a hand pump, for example, a hydraulic test pump. Feed lines shall be of such material and strength as to withstand safely the maximum pressures that may be created by the pumps. All connections shall be checked for tightness before the hypochlorite solution is applied to the main.

3.5 METHODS OF CHLORINE APPLICATION

A. Continuous Feed Method: This method is suitable for general application.

B. Chlorine Required to Produce 50 Mg/l Concentration in 100 ft. of Pipe by Diameter

<table>
<thead>
<tr>
<th>Pipe size in.</th>
<th>100 percent chlorine - lb.</th>
<th>1 percent chlorine solutions - gal.</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>0.027</td>
<td>0.33</td>
</tr>
<tr>
<td>6</td>
<td>0.061</td>
<td>0.73</td>
</tr>
<tr>
<td>8</td>
<td>0.108</td>
<td>1.30</td>
</tr>
<tr>
<td>10</td>
<td>0.170</td>
<td>2.04</td>
</tr>
<tr>
<td>12</td>
<td>0.240</td>
<td>2.88</td>
</tr>
<tr>
<td>14</td>
<td>0.327</td>
<td>3.92</td>
</tr>
</tbody>
</table>

C. Water from the existing distribution system or other approved sources of supply shall be made to flow at a constant, measured rate. The two rates shall be proportioned so that the chlorine concentration in the water in the pipe is maintained at a minimum of 50 mg/L available chlorine. To assure that this concentration is maintained, the chlorine residual should be
measured at regular intervals in accordance with the procedures described in the current edition of Standard Methods and AWWA M12-Simplified Procedures for Water Examination.

1. **NOTE:** In the absence of a meter, the rate may be determined either by placing a Pitot gage at the discharge or by measuring the time to fill a container of known volume.

D. The table in paragraph above gives the amount of chlorine residual required for each 100 ft. of pipe of various diameters. Solutions of 1 percent chlorine may be prepared with sodium hypochlorite or calcium hypochlorite. The latter solution requires approximately 1 lb. of calcium hypochlorite in 8.5 gal of water.

E. During the application of the chlorine, valves shall be manipulated to prevent the treatment dosage from flowing back into the line supplying the water. Chlorine application shall not cease until the entire main is filled with the chlorine solution. The chlorinated water shall be retained in the main for at least 24 hr., during which time all valves and hydrants in the section treated shall be operated in order to disinfect the appurtenances. At the end of this 24 hr. period, the treated water shall contain no less than 25 mg/L chlorine throughout the length of the main.

3.6 **FINAL FLUSHING**

A. After the applicable retention period, the heavily chlorinated water shall be flushed from the main until the chlorine concentration in the water leaving the main is no higher than that generally prevailing in the system, or less than 1 mg/L. Chlorine residual determination shall be made to ascertain that the heavily chlorinated water has been removed from the pipeline.

3.7 **BACTERIOLOGIC TESTS**

A. After final flushing, and before the water main is placed in service, a sample or samples shall be collected from the end of the line and tested for bacteriologic quality and shall show the absence of coliform organisms. If the number and frequency of samples is not prescribed by the public health authority having jurisdiction, at least one sample shall be collected from throughout the new main from unchlorinated supplies at least two samples shall be collected at least 24 hours apart.

1. **NOTE:** In the case of extremely long mains, it is desirable that samples be collected the length of the line as well as at its end.

B. Samples for bacteriologic analysis shall be collected in sterile bottles treated with sodium thiosulphate. No hose or fire hydrant shall be used in collection of samples. A suggested sampling tap consists of a standard corporation cock installed in the main with a copper tube gooseneck assembly. After samples have been collected the gooseneck assembly may be removed, and retained for future use.

3.8 **EXAMINATION**

A. Verify that piping system and water well has been cleaned, inspected, and pressure tested.

B. Schedule disinfecting activity to coordinate with start-up, testing, adjusting and balancing, demonstration procedures, including related systems.

3.9 **DISINFECTION**

A. Use method prescribed by the applicable state or local codes, or health authority or water purveyor having jurisdiction, or in the absence of any of these follow AWWA C651.

B. Provide and attach equipment required to perform the work.

C. Inject treatment disinfectant into piping system.

D. Maintain disinfectant in system for 24 hours.
E. Flush, circulate, and clean until required cleanliness is achieved; use municipal domestic water.

F. Replace permanent system devices removed for disinfection.

G. Pressure test system to ____ psi. Repair leaks and re-test.

3.10 FINAL FLUSHING

A. After the applicable retention period, the heavily chlorinated water shall be flushed from the main until the chlorine concentration in the water leaving the main is no higher than that generally prevailing in the system, or less than 1 mg/L. Chlorine residual determination shall be made to ascertain that the heavily chlorinated water has been removed from the pipeline.

3.11 BACTERIOLOGIC TESTS

A. After final flushing, and before the water main is placed in service, a sample or samples shall be collected from the end of the line and tested for bacteriologic quality and shall show the absence of coliform organisms. If the number and frequency of samples is not prescribed by the public health authority having jurisdiction, at least one sample shall be collected from throughout the new main from unchlorinated supplies at least two samples shall be collected at least 24 hours apart. NOTE: In the case of extremely long mains, it is desirable that samples be collected the length of the line as well as at its end.

B. Samples for bacteriologic analysis shall be collected in sterile bottles treated with sodium thiosulphate. No hose or fire hydrant shall be used in collection of samples. A suggested sampling tap consists of a standard corporation cock installed in the main with a copper tube gooseneck assembly. After samples have been collected the gooseneck assembly may be removed, and retained for future use.

3.12 REPETITION OF PROCEDURE

A. If the initial disinfection fails to produce satisfactory samples, disinfection shall be repeated until satisfactory samples have been obtained.

3.13 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01 40 00.

B. Test samples in accordance with AWWA C651.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Sanitary sewerage drainage piping, fittings, and accessories.
B. Connection of building sanitary drainage system to municipal sewers.

1.2 RELATED REQUIREMENTS
A. Section 31 23 16 - Excavation: Excavating of trenches.
B. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.
C. Section 31 23 23 - Fill: Bedding and backfilling.
D. Section 33 05 13 - Manholes and Structures.

1.3 PRICE AND PAYMENT PROCEDURES
A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.
B. Pipe and Fittings:
   1. Basis of Measurement: By the linear foot.
   2. Basis of Payment: Includes hand trimming excavation, bedding, pipe and fittings, connection to building service piping and to municipal sewer.
C. Cleanout:
   1. Basis of Measurement: By the ________ for a nominal depth of ____ feet.
   2. Basis of Payment: Includes hand trimming excavating, foundation pad, unit installation with accessories, connection to sewer piping.

1.4 DEFINITIONS
A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.5 REFERENCE STANDARDS

1.6 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data indicating pipe and pipe accessories.
C. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
E. Project Record Documents:
   1. Record location of pipe runs, connections, manholes, cleanouts, and invert elevations.
   2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

2.1 SEWER PIPE MATERIALS
   A. Provide products that comply with applicable code(s).
   B. Plastic Pipe: ASTM D2729, Poly(Vinyl Chloride) (PVC) material; inside nominal diameter of 4-15 inches, bell and spigot style solvent sealed joint end.
   C. Plastic Pipe: ASTM D3034, Type PSM, Poly(Vinyl Chloride) (PVC) material; inside nominal diameter of 4-15 inches, bell and spigot style solvent sealed joint end.
   D. Plastic Pipe: ASTM D1785, Schedule 40, Poly(Vinyl Chloride) (PVC) material; inside nominal diameter of 4-18 inches, bell and spigot style solvent sealed joint end.
   E. 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.

2.2 PIPE ACCESSORIES
   A. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Sewer Service" in large letters. Tracer wire shall be a minimum of 10 gauge copper wire with UF insulation.

2.3 CLEANOUT
   A. Lid and Frame: Cast iron construction, hinged lid.
      1. Lid Design: solid cover imprinted with "SEWER".
      2. Cleanout lid shall be a minimum of 12 inches or unless otherwise shown on the engineering drawings.

2.4 BEDDING AND COVER MATERIALS

PART 3 EXECUTION

3.1 GENERAL
   A. Perform work in accordance with applicable code(s).
3.2 TRENCHING
   A. See Section 31 23 16.13 for additional requirements.
   B. Hand trim excavation for accurate placement of pipe to elevations indicated.
   C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.3 INSTALLATION - PIPE
   A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.
   B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
      1. Plastic Pipe: Also comply with ASTM D2321.
   C. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch in 10 feet.
   D. Connect to building sanitary sewer outlet and municipal sewer system, through installed sleeves.
   E. Install trace wire 6 inches above top of pipe; coordinate with Section 31 23 16.13.

3.4 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. Establish elevations and pipe inverts for inlets and outlets as indicated.
   D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

3.5 FIELD QUALITY CONTROL
   A. Perform field inspection and testing in accordance with Section 01 40 00.
   B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.
   C. Pressure Test
      1. Low-pressure Air Test (applies to all piping materials):
         a. Test each section of gravity sewer piping between manholes.
         b. Where customer service connections are installed under the Contract, test connections and service lines concurrently with the main, unless directed otherwise by the Engineer.
         c. Introduce air pressure slowly to approximately 4 psig.
            1) Determine ground water elevation above spring line of pipe for every foot of ground water above spring line of pipe, increase starting air test pressure by 0.43 psig; do not increase pressure above 10 psig.
            d. Allow pressure to stabilize for at least five minutes. Adjust pressure to 3.5 psig or increased test pressure as determined above when ground water is present. Start test.
            e. Test:
1) Determine test duration for sewer section with single pipe size from the following table. Do not make allowance for laterals.

**AIR TEST TABLE**

<table>
<thead>
<tr>
<th>Nominal Pipe Size, Inches</th>
<th>T (time), min/100 feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0.2</td>
</tr>
<tr>
<td>4</td>
<td>0.3</td>
</tr>
<tr>
<td>6</td>
<td>0.7</td>
</tr>
<tr>
<td>8</td>
<td>1.2</td>
</tr>
<tr>
<td>10</td>
<td>1.5</td>
</tr>
<tr>
<td>12</td>
<td>1.8</td>
</tr>
<tr>
<td>15</td>
<td>2.1</td>
</tr>
<tr>
<td>18</td>
<td>2.4</td>
</tr>
<tr>
<td>21</td>
<td>3.0</td>
</tr>
<tr>
<td>24</td>
<td>3.6</td>
</tr>
</tbody>
</table>

2) Record drop in pressure during test period; when air pressure has dropped more than 1.0 psig during test period, piping has failed; when 1.0 psig air pressure drop has not occurred during test period, discontinue test and piping is accepted.

3) When piping fails, determine source of air leakage, make corrections and retest; test section in incremental stages until leaks are isolated; after leaks are repaired, retest entire section between manholes.

**D. Deflection Test (Applies to Plastic Sewer Pipe)**

1. Perform vertical ring deflection testing after backfilling has been in place for at least 30 days but not longer than 12 months.
2. Allowable maximum deflection for installed plastic sewer pipe limited to 5 percent of original vertical internal diameter.
3. Perform deflection testing using properly sized rigid ball or 'Go, No-Go' mandrel.
4. Furnish rigid ball or mandrel with diameter not less than 95 percent of base or average inside diameter of pipe as determined by ASTM standard to which pipe is manufactured. Measure pipe in compliance with ASTM D2122.
5. Perform test without mechanical pulling devices.

**E. Lamp Test**

1. Lamp gravity piping after flushing and cleaning.
2. Perform lamping operation by shining light at one end of each pipe section between manholes; observe light at other end; reject pipe not installed with uniform line and grade; remove and reinstall rejected pipe sections; re-clean and lamp until pipe section achieves uniform line and grade.

**3.6 PROTECTION**

A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION
SECTION 33 31 13
SANITARY SEWERAGE FORCE MAIN PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES
A. Sanitary sewerage force main and inverted siphon piping, fittings, and accessories.
B. Connection of facility sanitary force main and inverted siphon system to headworks.

1.2 RELATED REQUIREMENTS
A. Section 31 23 16 - Excavation: Excavating of trenches.
B. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.
C. Section 31 23 23 - Fill: Bedding and backfilling.
D. Section 33 05 13 - Manholes and Structures.

1.3 PRICE AND PAYMENT PROCEDURES
A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.

1.4 REFERENCE STANDARDS
F. ASTM F1483 - Oriented Poly(Vinyl Chloride), PVCO, Pressure Pipe; 2012.
G. AWWA C508 - Swing-Check Valves for Waterworks Service, 2 In. (50 mm) Through 24 In. (600 mm) NPS; 2011.

1.5 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data indicating pipe, pipe accessories, and ________.
C. Product Data: Manufacturer's data sheets for each item of equipment and material provided, showing compliance with requirements; include materials, pressure ratings, seats and seals, clearances for operation and maintenance, and other characteristics.
D. Hydrostatic Test Report: Document results of field quality control testing. Submit copies of all reports of field tests.
E. Project Record Documents:
1. Record location of piping, connections, valves, valve vaults, valve manholes, ________, thrust restraints, and invert elevations.
2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

2.1 FORCE MAIN PIPE MATERIALS
   A. Polypropylene (PP) Pipe: ASTM D2122 and ASTM D4101, Polypropylene (PP) material; pipe and fittings same material utilizing transition fittings when connecting to existing piping.
   B. 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.

2.2 PIPE ACCESSORIES
   A. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Force Main Sewer Service" in large letters.

2.3 CHECK VALVES
   A. Check Valves - General Requirements: These requirements apply to all check valves unless otherwise indicated.
      1. Function: Permit free flow forward and provide positive check against backflow.
      3. Body: In metallic pipelines, iron body; in thermoplastic pipelines, thermoplastic body of same material as pipe.
      4. Identification: Directly cast on body; manufacturer's name, initials, or trademark; size of valve, working pressure; direction of flow.

2.4 AIR RELEASE VALVES
   A. Air Release Valves:
      1. Locate and vent in manner that upon operation a hazardous atmosphere will not be created.
      2. Provide air release valves at all piping high points and where indicated on layout drawings.

2.5 BEDDING AND COVER MATERIALS
   A. Pipe Bedding Material: As specified in Section 31 23 23.

PART 3 EXECUTION

3.1 GENERAL
   A. Perform work in accordance with applicable code(s).

3.2 EXCAVATION, TRENCHING, AND BACKFILLING
   A. Hand trim excavation for accurate placement of pipe to elevations indicated.
3.3 PREPARATION

3.4 INSTALLATION - PIPE

A. Maintain horizontal separation of force main from water main piping of at least 10 feet in all horizontal directions.

B. Maintain vertical separation of force main from water main piping of at least 18 inches in all vertical directions.

C. Before lowering and while suspended, inspect pipe and each fitting for defects. Installation of defective material is not permitted.

D. Begin pipe laying from discharge end and proceed toward Pump Station with bell ends facing upstream, unless otherwise shown on layout drawings.

E. Install force mains with a minimum grade of one percent downhill slope away from sewage air release valve to force entrapped air to accumulate at air release valve, unless otherwise shown on layout drawings.

F. Install pipe, fittings, and accessories at the locations indicated on layout drawings and in accordance with manufacturer’s instructions. Seal watertight.
   2. Polypropylene: Comply with ASTM D2774.

G. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch in 10 feet.

H. Backfill trenches immediately after the pipe has been installed. Do not displace or damage pipe when compacting.

I. Connect to building sanitary sewer outlet and municipal sewer system, through installed sleeves.

J. Install trace wire 6 inches above top of pipe; coordinate with Section 31 23 16.13.

3.5 JOINTING

A. Polypropylene (PP) Pipe:
   1. Heat Fusion Joints: Comply with manufacturer’s instructions concerning equipment, temperature, melt time, heat coat, and joining time.

3.6 DRAIN LINES

A. Install drain lines as indicated on layout drawings. Drain line consists of a tee in the force main line with 4 inch diameter branch, 4 inch diameter elbow, and 4 inch gate valve.

3.7 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01 40 00 - Quality Requirements.
   1. If tests indicate Work does not meet specified requirements, remove defective Work, replace and retest at no cost to Owner.
   2. Schedule tests to allow the Owner and engineer to witness the event.

B. Hydrostatic Tests
   1. Pipeline testing includes both a pressure test and a leakage test.
      a. Submit proposed method for disposal of waste water from hydrostatic tests to Owner for approval.
b. Testing is the responsibility of the Contractor.

2. Leakage Test:
   a. Conduct leakage test subsequent to, or concurrently with, the pressure test.
   b. Place the volume of water permitted as leakage for the line in a sealed container attached to the supply side of the test pump.
   c. No other source of supply is permitted to be applied to the pump or line under test.
   d. Pump water into line by test pump, as required, to maintain the specified test pressure as described for pressure test for a two hour period.
   e. Exhaustion of the supply or the inability to maintain the required pressure is considered test failure.
   f. Anticipate the issue PE pipe can experience diametric expansion and pressure elongation during initial testing.
   g. Consult manufacturer prior to testing for special testing considerations.
   h. Allowable leakage shall be determined by following I-P formula; \( L = \frac{NDP}{K} \).

Where letters in formula are equivalent to the following:
- \( L \) = Allowable leakage in gallons per hour.
- \( N \) = Number of joints in length of pipeline tested.
- \( D \) = Nominal diameter of the pipe in inches.
- \( P \) = Square root of the test pressure in psig.
- \( K \) = 7400 for pipe materials.

At conclusion of test, measure amount of water remaining in container and record results in test report.

3. Retesting:
   a. If any deficiencies are revealed during any test, identify and correct deficiencies and reconduct tests and correct new deficiencies revealed until the results of the tests are within specified allowances, without additional cost to the Owner.

3.8 PROTECTION

A. Water is not permitted to run or stand in trench while pipe laying is in progress, before the joints are completely set, or before trench has been backfilled.

B. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION
PART GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pump Design.
   2. Pump Construction.
   3. Cooling System.
   4. Cable Entry Seal.
   5. Motor.
   7. Mechanical Seal.
  10. Protection.
  11. Sump Mixing Valve.
  13. Lifting System.
  14. Station Cover With Safety Hatch.
  15. Modifications.

1.2 REFERENCES

A. ASTM International:
   1. ASTM A48 - Standard Specification for Gray Iron Castings,

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Manufacturer's installation instructions.

P2 PRODUCTS

2.1 REQUIREMENTS

A. Furnish and install 2 submersible non-clog wastewater pumps. Ebara model number 50DVU61.5 or equal.

B. Each pump shall be equipped with a 2 HP, submersible electric motor connected for operation on 208 volts, 3 phase, 60 hertz, with 15 feet of submersible cable (SUBCAB) suitable for submersible pump applications.

C. The power cable shall be sized according to NEC and ICEA standards and also meet with P-MSHA Approval.

D. The pump shall be supplied with a mating cast iron 2 inch discharge connection and be capable of delivering 47 GPM at 25 FT. TDH. Pump control panel shall be mounted within utility room of building. A warning light shall be mounted at the pump location that indicates when pump(s) have failed.
E. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact.

F. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable.

G. No portion of the pump shall bear directly on the sump floor. Each pump shall be fitted with 20 feet of stainless steel lifting chain.

H. The working load of the lifting system shall be 50% greater than the pump unit weight.

2.2 PUMP DESIGN

A. The pumps shall be automatically and firmly connected to the discharge connection, guided by no less than two guide bars extending from the top of the station to the discharge connection.

B. There shall be no need for personnel to enter the wet-well.

2.3 PUMP CONSTRUCTION

A. Major pump components shall be of grey cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities.

B. The lifting handle shall be of stainless steel.

C. All exposed nuts or bolts shall be AISI type 316 stainless steel construction.

D. All metal surfaces coming into contact with the pumpage, other than stainless steel or brass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

E. Sealing design shall incorporate metal-to-metal contact between machined surfaces.

F. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile rubber O-rings.

G. Fittings will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific torque limit.

H. Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal.

I. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

2.4 COOLING SYSTEM

A. Motors are sufficiently cooled by the surrounding environment or pumped media.

B. A water cooling jacket is not required.

2.5 CABLE ENTRY SEAL

A. The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal.

B. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable.

C. The assembly shall provide ease of changing the cable when necessary using the same entry seal.
2.6 MOTOR
   A. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type
design, housed in an air filled, watertight chamber.
   B. The stator windings shall be insulated with moisture resistant Class H insulation rated for
180°C (356°F).
   C. The stator shall be insulated by the trickle impregnation method using Class H monomer-free
polyester resin resulting in a winding fill factor of at least 95%.
   D. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31. The stator shall
be heat-shrink fitted into the cast iron stator housing.
   E. The use of multiple step dip and bake-type stator insulation process is not acceptable.
   F. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is
not acceptable.
   G. The motor shall be designed for continuous duty handling pumped media of 40°C (104°F) and
capable of no less than 15 evenly spaced starts per hour.
   H. The rotor bars and short circuit rings shall be made of cast aluminum.
   I. The motor and the pump shall be produced by the same manufacturer.
   J. The combined service factor (combined effect of voltage, frequency and specific gravity) shall
be a minimum of 1.15.
   K. A performance chart shall be provided upon request showing curves for torque, current, power
factor, input/output kW and efficiency. This chart shall also include data on starting and
no-load characteristics.
   L. The power cable shall be sized according to the NEC and ICEA standards and shall be of
sufficient length to reach the junction box without the need of any splices.
   M. The outer jacket of the cable shall be oil resistant chlorinated polyethylene rubber.
   N. The motor and cable shall be capable of continuous submergence underwater without loss of
watertight integrity to a depth of 65 feet or greater.
   O. The motor horsepower shall be adequate so that the pump is non-overloading throughout the
entire pump performance curve from shut-off through run-out.

2.7 BEARINGS
   A. The pump shaft shall rotate on two bearings.
   B. Motor bearings shall be permanently grease lubricated.
   C. The upper bearing shall be a single deep groove ball bearing.
   D. The lower bearing shall be a two row angular contact bearing to compensate for axial thrust
and radial forces.
   E. Single row lower bearings are not acceptable.

2.8 MECHANICAL SEAL
   A. Each pump shall be provided with a tandem mechanical shaft seal system consisting of two
totally independent seal assemblies.
B. The seals shall operate in a lubricant reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate.

C. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating, corrosion resistant tungsten-carbide ring.

D. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary tungsten-carbide seal ring and one positively driven rotating tungsten-carbide seal ring.

E. Each seal interface shall be held in contact by its own spring system.

F. The seals shall require neither maintenance nor adjustment nor depend on direction of rotation for sealing.

G. The position of both mechanical seals shall depend on the shaft.

H. Mounting of the lower mechanical seal on the impeller hub will not be acceptable.

I. For special applications, other seal face materials shall be available.

J. Each pump shall be provided with a lubricant chamber for the shaft sealing system.

K. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity.

L. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside.

M. The seal system shall not rely upon the pumped media for lubrication.

N. The motor shall be able to operate dry without damage while pumping under load.

O. The following seal types shall not be considered acceptable or equal to the dual independent seal specified: shaft seals without positively driven rotating members, or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces. No system requiring a pressure differential to offset pressure and to effect sealing shall be used.

2.9 PUMP SHAFT

A. Pump and motor shaft shall be the same unit.

B. The pump shaft is an extension of the motor shaft.

C. Couplings shall not be acceptable.

D. The pump shaft shall be stainless steel – ASTM A479 S43100-T.

E. If a shaft material of lower quality than stainless steel – ASTM A479 S43100-T is used, a shaft sleeve of stainless steel – ASTM A479 S43100-T is used to protect the shaft material. However, shaft sleeves only protect the shaft around the lower mechanical seal. No protection is provided in the lubricant housing and above. Therefore, the use of stainless steel sleeves will not be considered equal to stainless steel shafts.

2.10 IMPELLER

A. The impellers shall be of gray cast iron, Class 35B, dynamically balanced, semi-open, multi-vane, back-swept, non-clog design.

B. The impeller vane leading edges shall be mechanically self-cleaned upon each rotation as they pass across a spiral groove located on the volute bottom.
C. The internal volute bottom shall provide effective sealing between the pump volute and the multi-vane, semi-open impeller.

D. The sharp spiral grooves shall provide the shearing edges across which each impeller vane leading edge shall cross during its rotation in order to remain unobstructed.

E. The clearance between the internal volute bottom and the impeller leading edges shall be adjustable.

F. The impellers vanes shall have screw-shaped leading edges that are hardened to Rc 45 and shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in waste water.

G. The screw shape of the impeller inlet shall provide an inducing effect for the handling of sludge and rag-laden wastewater.

H. Impellers shall be locked to the shaft and held by an impeller bolt.

2.11 PROTECTION

A. All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding.

B. The thermal switches shall open at 125°C (260°F), stop the motor and activate an alarm.

C. A leakage sensor shall be available as an option to detect water in the stator chamber.

D. The Float Leakage Sensor (FLS) is a small float switch used to detect the presence of water in the stator chamber.

E. When activated, the FLS will stop the motor and send an alarm both local and/or remote.

F. USE OF VOLTAGE SENSITIVE SOLID STATE SENSORS AND TRIP TEMPERATURE ABOVE 125°C (260°F) SHALL NOT BE ALLOWED.

G. The thermal switches and FLS shall be connected to a Mini CAS (Control and Status) monitoring unit.

H. The Mini CAS shall be designed to be mounted in any control panel.

2.12 CONTROLS

A. 1. Shall be configured to provide a maximum of 7 pumping cycles per 24-hour period.

2. Each pumping cycle shall provide 135 gallons per cycle for a maximum volume of 950 gallons over a 24 hour period. Pumping period shall reset each night at 12:00 am. Additional pumping beyond 7 cycles per day shall not be allowed unless fluid elevation in pumping tank reaches emergency level. Emergency pumping shall be provided if fluid level, in pumping tank, is greater than 43-inches from bottom of tank. Controls shall record each time emergency pumping is necessary and shall provide the following information to operator: Date and time for each emergency pumping and amount of time pumps were run during each emergency pumping cycle. Controls shall provide easy access to operator of all emergency pumping. Emergency pumping shall be provided in a continuous list starting at first emergency pumping and ending at latest occurrence of emergency pumping required.

3. Pump tank shall be a 1000 gallon concrete precast holding tank.

4. Liquid levels in pump chamber shall be controled by mechanical floats. The distance between low level pump shut off and pump on shall be approximately 5.5 inches to control volume pumped per cycle. Volume pumped per cycle shall be a maximum of 135 gallons.
2.13 GUIDE RAIL

A. The submersible pumps shall be installed on a guide rail system to allow for removal and installation of the pump without entering the wet well.

B. The guide rail assembly shall include all components necessary to provide a complete and fully functional assembly including:
   1. Cast iron discharge base (size as indicated on drawing)
   2. Stainless steel guide rails (2” Schedule 40)
   4. Intermediate guide bar brackets for guide pipe lengths greater than 20’

C. The guide rail assembly shall be provided by pump manufacturer. The guide rail assembly shall be provided.

2.14 LIFTING SYSTEM

A. Each submersible pump shall be furnished with a pump lifting-chain positive-recovery system consisting of the following components:
   1. 20 feet of stainless steel lifting chain, connected to the lifting eye or lifting bail of the submersible pump.
   2. A forged “grip-eye” of wrought alloy steel, provided separately to connect to the end of the lifting cable or chain of the pump lifting device.

B. The operation of the pump lifting-chain positive-recovery system shall be as follows:
   1. Connect small eye of grip-eye to end of chain or cable of external mechanical of lifting device.
   2. Slip top end of chain through large eye of grip-eye.
   3. Lower grip-eye to top of pump while maintaining a taut chain.
   4. Release tension on chain when grip-eye has reached pump top. Make certain upper end of chain has been secured.
   5. Take up tension on cable or chain of lifting device, grip-eye will engage links of short chain and lift pump.

2.15 STATION COVER WITH SAFETY HATCH

A. The access cover unit shall be equipped with a Safe-Hatch hinged safety grate to provide protection against fall-through and to control access into the confined space.

B. Grate openings shall be sized to allow for routine maintenance inspection without having to open the safety grate.

C. The closed safety grate shall be designed to support the weight of one pump to facilitate site pump wash-down and inspection.

D. The hatch opening will have a 4” elevated toe board to prevent tools from being kicked into the wet well (per OSHA 1926.502 (j)).

2.16 MODIFICATIONS

A. EXPLOSION-PROOF PUMPS (X)
   1. The pump system including the pump, motor and power cable shall be approved for use in areas classified as hazardous locations in accordance with the NEC Class I, Div. 1, Group C and D service as determined and approved by a U.S. nationally recognized testing laboratory (U.L., FM, CSA) at the time of the bidding of the project.
   2. Control panel shall be installed within utility room of building by sanitary installation contractor.
   3. Motor thermal switches shall monitor and protect the motor from excessive temperature.
4. An internal Float Switch shall be available, as an option, in the motor chamber.
5. Service of explosion-proof submersible units shall be performed by qualified FM experienced personnel.
6. The pump manufacturer must provide training schools to qualify personnel in the proper service and repair of explosion proof pumps.

END OF SECTION
PART 1 GENERAL

1.1 SECTION INCLUDES
A. Septic tank, distribution box, and filter drainage field system.

1.2 RELATED REQUIREMENTS
A. Section 31 23 16.13 - Trenching: General requirements for trenching for drainage field and connecting piping including compaction testing.
B. Section 31 23 23 - Fill: General requirements for backfilling piping trenches including compaction testing.
C. Section 31 23 23 - Fill: Soil cover over tank and drainage field.

1.3 PRICE AND PAYMENT PROCEDURES
A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.

1.4 REFERENCE STANDARDS

1.5 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate plan, location and inverts of filter field, inverts of connecting piping.
C. Product Data: Provide data on tank accessories and ________.

1.6 QUALITY ASSURANCE
A. Conform to applicable code and regulations for work of this section.

PART 2 PRODUCTS

2.1 SEPTIC TANK AND DISTRIBUTION BOX
A. Manufacturers:
   1. Ziser Vault
      b. ____________.
      c. Substitutions: See Section 01 60 00 - Product Requirements.
B. Septic Tank: Reinforced precast concrete construction, 4,000 psi 28 day minimum strength, concrete partitioned chambers, concrete lid with 24-inch riser sections to finish grade. 12 inches below effluent level.

C. Tank Capacity: 4000 gallon.

D. Distribution Box: Reinforced concrete, single inlet, 6 outlets, gate, removable cover with lift ring.

2.2 CONNECTING PIPE MATERIALS

A. Cast Iron Pipe Type ____: ASTM A74 extra heavy grade, hub and spigot joint; nominal inside diameter of ____ inch:

B. Plastic Pipe (PVC) Type SDR-35: ASTM D3034 Type PSM; nominal inside diameter of ____ inch, bell and spigot solvent sealed joints.

2.3 FILTER DRAIN PIPE MATERIALS

A. Use perforated pipe at filter field system; unperforated through sleeves and at junction with distribution box.

2.4 BEDDING AND BACKFILL MATERIALS

A. Provide bedding and backfill materials as specified in Section 31 23 23 and as follows:

B. Tank Bedding Material: Granular fill.

C. Tank Backfill Material: Granular fill.

D. Connecting Piping Bedding Material: Granular fill.

E. Connecting Piping Backfill Material: Granular fill.

F. Filter Drain Bedding Material: Granular fill.

G. Filter Drain Cover Material: Granular fill.


PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that building sanitary sewer connection, size, location and invert are as indicated.

3.2 PREPARATION

A. Ream pipe ends and remove burrs.

B. Remove scale and dirt from components before assembly.

C. Establish invert elevations for all components in the system.
3.3 EXCAVATING AND TRENCHING

3.4 TANK INSTALLATION
   A. Hand trim excavation for accurate placement of tank to elevations indicated.
   B. Place bedding material level in one continuous layer not exceeding 6 inches compacted depth, compact to 95 percent.
   C. Install septic tank and distribution box and related components on bedding in accordance with manufacturer's instructions.
   D. Backfill around sides of tank, tamped in place and compacted to 95 percent.

3.5 CONNECTING PIPING INSTALLATION
   A. Connect outlet between building sanitary piping and septic tank, between septic tank and distribution box, between distribution box and filter field header with Type ____ pipe and fittings.
   B. Cover pipe with backfill, sides and top. Place geotextile fabric over cover prior to backfilling.

3.6 INSTALLATION - FILTER FIELD
   A. Place field pipe header, Type ____, sloping down from header inlet, 1/8 inch per foot.
   B. Place filter drain bedding 18 inch thick, tamp compact firm. Establish slope of bed to suit established invert elevations.
   C. Place pipe sloping away from header minimum of 1/16 inch per foot, with perforations facing down.
   D. Wrap pipe joints with paper, cover with filter drain bedding material, sides and top. Place geotextile fabric over cover prior to backfilling.
   E. Cover entire field with filter drain backfill material, 12 inch thick, lightly compacted; level for subsequent placement of soil cover.

3.7 PROTECTION
   A. Do not permit vehicular traffic over drainage field.

END OF SECTION
SECTION 33 41 11
SITE STORM UTILITY DRAINAGE PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Storm drainage piping, fittings, and accessories.
   B. Catch basins, Trench drains, Plant area drains, Paved area drainage, Site surface drainage, Detention tank, and Detention basin.
   C. Catch basins, Plant area drains, Paved area drainage, and Site surface drainage.
   D. Cleanouts.
   E. Bedding and cover materials.

1.2 RELATED REQUIREMENTS
   A. Section 03 30 00 - Cast-in-Place Concrete: Concrete for cleanout base pad construction.
   B. Section 31 23 16 - Excavation: Excavating of trenches.
   D. Section 31 23 23 - Fill: Bedding and backfilling.
   E. Section 33 05 13 - Manholes and Structures.

1.3 PRICE AND PAYMENT PROCEDURES
   A. See Section 01 22 00 - Unit Prices, for additional unit price requirements.
   B. Pipe and Fittings:
      1. Basis of Measurement: By the linear foot.
      2. Basis of Payment: Includes hand trimming excavation, bedding and backfilling, pipe and fittings, connection to building service piping and to municipal sewer.
   C. Catch Basins and Cleanouts:
      1. Basis of Measurement: By the unit or per lineal foot of height installed.
      2. Basis of Payment: Includes hand trimming excavating, bedding and backfilling, foundation pad, unit installation with accessories, connection to sewer piping.

1.4 DEFINITIONS
   A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.5 REFERENCE STANDARDS
1.6 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data indicating pipe and pipe accessories.
   C. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
   D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
   E. Project Record Documents:
      1. Record location of pipe runs, connections, catch basins, cleanouts, and invert elevations.
      2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.7 REGULATORY REQUIREMENTS
   A. Coordinate the Work with termination of storm sewer connection outside building, and trenching.
   B. Conform to applicable code for materials and installation of the Work of this section.

PART 2 PRODUCTS

2.1 SEWER PIPE MATERIALS
   A. Plastic Pipe: ASTM D 2729, Poly(Vinyl Chloride) (PVC) material; inside nominal diameter of 4-15 inches, bell and spigot style.
   B. HDPE Pipe: Double Wall (Type S) Corrugated High Density Polyethylene pipe (HDPE) with a smooth interior meeting all requirements of ASTM F2648 and fittings having smooth interior with bell and spigot joints.

2.2 PIPE ACCESSORIES
   A. Pipe Joints: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene ribbed gasket for positive seal.
   B. 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.
   C. Filter Fabric: Filter fabric shall be provided as specified on the Engineering Drawings.
   D. Trace Wire: Magnetic detectable conductor, clear plastic covering, minimum 6 inches wide by 4 mil thick, imprinted with "Storm Sewer Service" in large letters, for direct burial service.

2.3 BEDDING AND COVER MATERIALS
   A. Bedding: As specified in Section 31 23 16.13.
   B. Cover: As specified in Section 31 23 16.13.
PART 3  EXECUTION

3.1  TRENCHING
A. See Section 31 23 16.13 for additional requirements.
B. Hand trim excavation for accurate placement of pipe to elevations indicated.
C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling to provide top cover to minimum compacted thickness of 12 inches exclusive of asphalt or concrete, compacted to 95%.

3.2  INSTALLATION - PIPE
A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.
B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
   1. Plastic Pipe: Also comply with ASTM D2321.
C. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch in 10 feet.
D. Connect to building storm drainage system, foundation drainage system, and utility/municipal sewer system.
E. Make connections through walls through sleeved openings, where provided.
F. Install continuous trace wire 6 inches above top of pipe; coordinate with Section 31 23 16.13.

3.3  INSTALLATION - CATCH BASINS, TRENCH DRAINS AND 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. Establish elevations and pipe inverts for inlets and outlets as indicated.
D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

3.4  FIELD QUALITY CONTROL
A. Perform field inspection in accordance with Section 01 40 00 - Quality Requirements.

3.5  PROTECTION
A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.
B. Repair or replace pipe that is damaged or displaced from construction operations.

END OF SECTION
PART 1  GENERAL

1.1  DESCRIPTION

A. Scope
   1. The Contractor shall furnish all labor, equipment and materials necessary to install the
      stormwater treatment unit (STU) and appurtenances specified in the Drawings and these
      specifications.

B. Related Sections
   1. Section 31 23 19: Dewatering
   2. Section 31 23 16: Excavation and Fill
   3. Section 33 05 13: Manholes and Structures

C. Requirements
   1. Treat __________ cfs of stormwater runoff for 80% total suspended solid removal.

1.2  QUALITY ASSURANCES

A. Inspection
   1. All components shall be subject to inspection by the Engineer at the place of manufacture
      and/or installation. All components are subject to be rejected or identified for repair if the
      quality of materials and manufacturing do not comply with the requirements of this
      specification. Components which have been identified as defective may be subject for
      repair. Final acceptance of the component is contingent upon the discretion of the
      Engineer.

B. Warranty
   1. The manufacturer shall guarantee the STU components against all manufacturer
      originated defects in materials or workmanship for a period of twelve (12) months from
      the date the components are delivered to the owner for installation. The manufacturer
      shall be notified of repair/replacement issues in writing within the referenced warranty
      period. The manufacturer shall, upon its determination of repair, correct or replace any
      manufacturer originated defects identified by written notice within the referenced warranty
      period. The use of STU components shall be limited to the application for which it was
      specifically designed.

C. Manufacturer’s Performance Certificate
   1. The STU manufacturer shall submit to the Engineer of Record a “Manufacturer’s
      Performance Certification” certifying that each STU is capable of achieving the specified
      removal efficiencies as listed in these specifications. The certification shall be supported
      by independent third-party research.

1.3  SUBMITTALS

A. Shop Drawings
   1. The contractor shall prepare and submit shop drawings for the Engineer approval. The
      shop drawings shall detail horizontal and vertical dimensioning, reinforcement and joint
      type and locations.

B. Calculations
   1. The contractor shall submit certified testing data confirming the manufacturer stated
      removal efficiencies.
2. The contractor shall prepare and submit project specific hydraulic calculations showing the treatment capacity of the proposed unit and its ability to accommodate the specified peak conveyance capacity.

PART 2 PRODUCTS

2.1 MATERIALS AND DESIGN

A. Precast Concrete Components - Precast concrete components shall conform to applicable sections of ASTM C 478, ASTM C 857 and ASTM C 858 and the following:
   1. Concrete shall achieve a minimum 28-day compressive strength of 4,000 pounds per square-inch (psi);
   2. Unless otherwise noted, the precast concrete sections shall be designed to withstand lateral earth and AASHTO H-20 traffic loads;
   3. Cement shall be Type III Portland Cement conforming to ASTM C 150;
   4. Aggregates shall conform to ASTM C 33;
   5. Reinforcing steel shall be deformed billet-steel bars, welded steel wire or deformed welded steel wire conforming to ASTM A 615, A 185 or A 497, respectively;
   6. Joints shall be sealed with preformed joint sealing compound conforming to ASTM C 990 and
   7. Shipping of components shall not be initiated until a minimum compressive strength of 4,000 psi is attained or five (5) calendar days after fabrication has expired, whichever occurs first.

B. Internal Components and Appurtenances - Internal Components and appurtenances shall conform to the following:
   1. Screen and support structure shall be manufactured of Type 316 and 316L stainless steel conforming to ASTM F 1267-01;
   2. Hardware shall be manufactured of Type 316 stainless steel conforming to ASTM A 320;
   3. Fiberglass components shall conform to the National Bureau of Standards PS-15 and coated with an isophalic polyester gelcoat and
   4. Access system(s) conform to the following:
      a. Manhole castings shall be designed to withstand AASHTO H-20 loadings and manufactured of cast-iron conforming to ASTM A 48 Class 30.
      b. Hatch systems shall be designed to withstand AASHTO H-20 loadings. Hatch systems not subject to direct traffic shall be manufactured of Grade 5086 aluminum. Hatch systems subject to direct traffic loads shall be manufactured of steel conforming to ASTM A 36-93a, supplied with a hot-dip galvanized finish conforming to ASTM A 123 and access doors bolted to the frame.

2.2 PERFORMANCE

A. Removal Efficiencies
   1. The STU shall be capable of achieving an 80 percent average annual reduction in the total suspended solid load.
   2. The STU shall be capable of capturing and retaining 100 percent of pollutants greater than or equal to 2.4 millimeters (mm) regardless of the pollutant's specific gravity (i.e.: floatable and neutrally buoyant materials) for flows up to the device's rated-treatment capacity. The STU shall be designed to retain all previously captured pollutants addressed by this subsection under all flow conditions.

B. Hydraulic Capacity
   1. The STU shall provide treatment for the water quality flow rate of __________ cfs.
   2. The STU shall provide a rated-treatment capacity of _____ gpm/square feet.
3. The STU shall maintain the peak conveyance capacity of the drainage network of __________ cfs.

2.3 MANUFACTURER

A. The manufacturer of the STU shall be one that is regularly engaged in the engineering design and production of systems deployed for the treatment of storm water runoff for at least five (5) years and which have a history of successful production, acceptable to the Engineer. In accordance with the Drawings, the STU(s) shall be manufactured by an American or Canadian based company.

PART 3 EXECUTION

3.1 HANDLING AND STORAGE

A. The contractor shall exercise care in the storage and handling of the STU components prior to and during installation. Any repair or replacement costs associated with events occurring after delivery is accepted and unloading has commenced shall be born by the contractor.

3.2 INSTALLATION

A. The STU shall be installed in accordance with the manufacturer’s recommendations and related sections of the contract documents. The manufacturer shall provide the contractor installation instructions and offer on-site guidance during the important stages of the installation as identified by the manufacturer at no additional expense. A minimum of 72 hours notice shall be provided to the manufacturer prior to their performance of the services included under this subsection.

B. The contractor shall fill all voids associated with lifting provisions provided by the manufacturer. These voids shall be filled with non-shrinking grout providing a finished surface consistent with adjacent surfaces. The contractor shall trim all protruding lifting provisions flush with the adjacent concrete surface in a manner which leaves no sharp points or edges.
SECTION 33 51 11
SITE GAS DISTRIBUTION

PART 2 PRODUCTS

1.1 PIPE

1.2 GAS COCKS AND VALVES

END OF SECTION