PROJECT MANUAL

DATE: JULY 2024
ISSUED FOR BID: JANUARY 2025

SPECIFICATIONS FOR:

CAPITAL PROJECTS 2023 – PHASE 2A
HILTON CENTRAL SCHOOL DISTRICT
225 WEST AVENUE
HILTON, NEW YORK

Book 2 of 2 Divisions 0 - 32

1.	High School	**SED PROJECT #26-11-01-06-0-007-023**
2.	Middle School	**SED PROJECT #26-11-01-06-0-005-020**
3.	Northwood Elementary School	**SED PROJECT #26-11-01-06-0-003-023**
4.	Quest Elementary School	**SED PROJECT #26-11-01-06-0-001-027**
5.	Village Elementary School	**SED PROJECT #26-11-01-06-0-004-024**

Labella Project #2221581.02

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COMPOSITE SPECIFICATIONS CONSIST OF BOOK 1 & 2 – ARCHITECTURAL, PLUMBING, ELECTRICAL, MECHANICAL AND SITE WORK

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SECTION 220517
SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe sleeves.

B. Pipe sleeve-seals.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

B. Section 220719 - Plumbing Piping Insulation.

1.03 REFERENCE STANDARDS

A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2023a.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing work of the type specified this section.

B. Plumbing Code of New York State.

C. State Education Department Planning Standards.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store sleeve and sleeve seals in shipping containers, with labeling in place.

PART 2 PRODUCTS

2.01 PIPE SLEEVES

A. Vertical Piping:
   1. Sleeve Length: 1 inch above finished floor.
   2. Provide sealant for watertight joint.
   3. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.

B. Sheet Metal: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.

C. Clearances:
   1. Provide allowance for insulated piping.
   2. Wall, Floor, Partitions, and Beam Flanges: 1 inch greater than external pipe diameter.
   3. All Rated Openings: Caulked tight with fire stopping material complying with ASTM E814 in accordance with Section 078400 to prevent the spread of fire, smoke, and gases.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and foreign material, from inside and outside, before assembly.

3.02 INSTALLATION

A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

B. Install piping to conserve building space, to not interfere with use of space and other work.

C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

D. Structural Considerations: Do not penetrate building structural members unless indicated.

E. Provide sleeves when penetrating floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
   1. Aboveground Piping:
      a. Pack solid using mineral fiber complying with ASTM C592.
      b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.
   2. All Rated Openings: Caulk tight with fire stopping material complying with ASTM E814 in accordance with Section 078400 to prevent the spread of fire, smoke, and gases.

F. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

END OF SECTION

SECTION 220519
METERS AND GAUGES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pressure gauges.

B. Thermometers.

1.02 RELATED REQUIREMENTS

A. Section 221316 - Domerstic Water Piping.

1.03 REFERENCE STANDARDS

A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2022.

B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014 (Reapproved 2020).

C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014 (Reapproved 2021).

D. NSF 61 - Drinking Water System Components - Health Effects; 2023, with Errata.

E. NSF 372 - Drinking Water System Components - Lead Content; 2022.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide red-marked product data sheets for each furnished item with associated components and accessories.

PART 2 PRODUCTS

2.01 PRESSURE GAUGES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Ashcroft, Inc.
   2. Weksler Glass Thermometer Corp.
   3. Winters Instruments.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Bourdon Tube for Liquids and Gases:
   1. Dial Size and Cover: 4-1/2 inch diameter scale with polycarbonate window.
   2. Dial Text and Markings: Black color on white background with scaled kPa and psi units.
   3. Accuracy: ASME B40.100, adjustable commercial grade (D) with 5 percent of span.
   4. Process Connection: Lower-back, 1/4 inch NPT male except where noted.

C. Accessories:
   1. Needle Valve: Carbon steel, 1/4 inch NPT female for noncorrosive service.
   2. Pressure Snubber (Pulsation Damper): Brass, 1/4 inch NPT male.

2.02 THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Dwyer Instruments, Inc.
   2. Watts Water Technologies, Inc.
   3. Weiss Instruments, LLC.
   4. Weksler Glass Thermometer Corp.
   5. Substitutions: See Section 016000 - Product Requirements.

B. General:
   1. Product Compliance: ASTM E1.

2. Lens: Clear glass, except where stated.
3. Accuracy: One percent, when tested in accordance with ASTM E77, except where stated.
4. Scale: Black markings depicting single scale in degrees F where expected process value falls half-span of standard temperature range.

C. Thermometers - Adjustable Angle: 7 inch v-shape aluminum case with clear glass window scale, 6 inch NPT stem, red or blue organic non-toxic liquid filled glass tube, and adjustable joint with positive locking device allowing 360 degrees in horizontal plane or 180 degrees in vertical plane adjustments.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Verify Utility Service Provider piping readiness to receive meter.

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

3.02 INSTALLATION

A. Install metering products in accordance with manufacturer's instructions for intended fluid type and service.

B. Install pressure gauges as follows:
1. At Pumps: Place single gauge before strainer, suction side and discharge side.
2. Include gauge cock and pressure snubber (pulsation-damper) to isolate each gauge and extend nipples for insulation clearance.
3. Adjust gauges to selected viewing angle, clean thoroughly, and calibrate to zero.

C. Install thermometers as follows:
1. Hot Water Heaters: Place upstream and downstream of heater. Add one on the inlet end when using steam as the water heating medium.
2. Piping: Install thermometers in branch butt weld connection fitting or socket-weld thermowell. Enlarge pipes smaller than 2-1/2 inch to accommodate sockets. Ensure sockets are above insulation clearance.

3.03 SCHEDULES

A. Pressure Gauges, Location and Scale Range:
1. Pumps, 0 to 200 psi.

B. Stem Type Thermometers, Location and Scale Range:
1. Domestic hot water supply and recirculation, 0 to 200 degrees F.

END OF SECTION

SECTION 220523
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Ball valves.

B. Check valves.

C. Lubricated plug valves.

1.02 RELATED REQUIREMENTS

A. Section 220553 - Identification for Plumbing Piping and Equipment.

B. Section 220719 - Plumbing Piping Insulation.

C. Section 221005 - Plumbing Piping.

1.03 ABBREVIATIONS AND ACRONYMS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

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

D. WOG: Water, oil, and gas.

1.04 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).

B. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.

C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.

D. ASME B16.34 - Valves — Flanged, Threaded, and Welding End; 2020.

E. ASME B31.9 - Building Services Piping; 2020.

F. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.

G. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2023).

H. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017.

I. MSS SP-45 - Drain and Bypass Connections; 2020.

J. MSS SP-78 - Gray Iron Plug Valves, Flanged and Threaded Ends; 2011.

K. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.

L. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

M. NSF 61 - Drinking Water System Components - Health Effects; 2023, with Errata.

N. NSF 372 - Drinking Water System Components - Lead Content; 2022.

1.05 SUBMITTALS

A. See Section 013000 - 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.

E. Maintenance Materials: Furnish Owner with one wrench for every five plug valves, in each size of square plug valve head.
   1. See Section 016000 - Product Requirements for additional provisions.

1.06 QUALITY ASSURANCE

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

1.07 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
   2. Protect valve parts exposed to piped medium against rust and corrosion.
   3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.

B. Use the following precautions during storage:
   1. Maintain valve end protection and protect flanges and specialties from dirt.
      a. Provide temporary inlet and outlet caps.
      b. Maintain caps in place until installation.
   2. Store valves in shipping containers and maintain in place until installation.
      a. Store valves indoors in dry environment.
      b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

PART 2 PRODUCTS

2.01 APPLICATIONS

A. Listed pipe sizes shown using nominal pipe sizes (NPS) and nominal diameter (DN).

B. Provide the following valves for the applications if not indicated on drawings:
   1. Shutoff: Ball Vavles.
   2. Swing Check (Pump Outlet):
      a. 2 inch and Smaller: Bronze swing check valves with bronze or nonmetallic disc.

C. Required Valve End Connections for Non-Wafer Types:
   1. Copper Tube:
      a. 2 inch and Smaller: Threaded ends except where solder-joint valve-end or pressure-seal option is indicated in valve schedules below.

D. Domestic, Hot and Cold Water Valves:
   1. 2-1/2" inch and Smaller:
      a. Bronze and Brass: Provide with solder-joint ends.

E. Natural Gas Valves:
   1. 2 inch and Smaller:
      a. Bronze and Brass: Provide with threaded.
      b. Ball: Two piece, full port, brass with brass trim.
   2. 2-1/2 inch and Larger:
      a. Lubricated Plug: Class 125, regular gland.

2.02 GENERAL REQUIREMENTS

A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Actuator Types:
   1. Hand Lever: Quarter-turn valves 6 inch and smaller except plug valves.
   2. Wrench: Plug valves with square heads.

D. Insulated Piping Valves: With 2 inch stem extensions and the following features:

1. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

E. Valve-End Connections:
1. Threaded End Valves: ASME B1.20.1.
2. Solder Joint Connections: ASME B16.18.
3. Pressure-seal ends.

F. General ASME Compliance:
1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
2. Solder-joint Connections: ASME B16.18.
3. Building Services Piping Valves: ASME B31.9.

G. Potable Water Use:
1. Certified: Approved for use in compliance with NSF 61 and NSF 372.
2. Lead-Free Certified: Wetted surface material includes less than 0.25 percent lead content.

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

2.03 BRASS, BALL VALVES

A. Two Piece, Full Port with Brass Trim and Female Thread or Solder Connections:
1. Comply with MSS SP-110.
2. WOG Rating: 600 psi.
3. Body: Forged brass.
4. Seats: PTFE.
5. Ball: Chrome-plated brass.
6. Operator: Lockable handle and memory stop.
7. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Apollo Valves.
b. FNW.
c. Kitz Corporation of America.
d. Watts
e. Substitutions: See Section 016000 - Product Requirements.

B. Two Piece, Full Port with Press Connections:
1. WOG Rating: 250 psi.
2. Body: Forged brass.
3. Seats: EPDM.
4. Ball: Chrome-plated brass.
5. Blow-out Proof Stem: Forged brass.
6. Operator: Provide lockable handle.
7. Maximum Service Temperature: 250 degrees F.
8. Manufacturers:
a. Effebi; Gladiator Press.
b. FNW.
c. Watts.

2.04 BRONZE, BALL VALVES

A. General:
1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

B. Two Piece, Full Port with Bronze Trim:
1. Comply with MSS SP-110.

2. WSP Rating: 150 psi.
3. WOG Rating: 600 psi.
4. Body: Forged bronze or dezincified-brass alloy.
5. Ends Connections: Pipe thread or solder.
6. Seats: PTFE.
7. Stem: Bronze, blowout proof.
8. Operator: Provide lockable handle and stem extension.
9. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    a. Apollo Valves.
    b. FNW.
    c. Watts.
    d. Substitutions: See Section 016000 - Product Requirements.

2.05 BRONZE, SWING CHECK VALVES

A. General:
1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

B. Class 125:
1. Pressure and Temperature Rating: MSS SP-80, Type 3.
2. Design: Y-pattern, horizontal or vertical flow.
3. WOG Rating: 200 psi.
4. Body: Bronze, ASTM B62.
5. End Connections: Threaded.
6. Disc: Bronze.
7. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    a. Apollo Valves.
    b. Watts

2.06 LUBRICATED PLUG VALVES

A. Regular Gland with Flanged Ends:
1. Comply with MSS SP-78, Type II.
2. Class 125: CWP Rating: 200 psi.
3. Body: ASTM A48/A48M or ASTM A126, cast iron with lubrication sealing system.
4. Pattern: Regular or short.
5. Plug: Cast iron or bronze with sealant groove.

PART 3 EXECUTION

3.01 EXAMINATION

A. Discard all packing materials and verify that valve interior, including threads and flanges are completely clean without signs of damage or degradation that could result in leakage.

B. Verify valve parts to be fully operational in all positions from closed to fully open.

C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.

D. Should valve is determined to be defective, replace with new valve.

3.02 INSTALLATION

A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.

B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

C. Install check valves where necessary to maintain direction of flow as follows:
   1. Swing Check: Install horizontal maintaining hinge pin level.

END OF SECTION

SECTION 220529
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Strut systems for pipe or equipment support.

B. Beam clamps.

C. Pipe hangers.

D. Pipe supports, guides, shields, and saddles.

E. Anchors and fasteners.

1.02 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 055000 - Metal Fabrications.

1.03 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping; 2023.

D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.

F. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2023.

G. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.

H. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2022.

I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023c.

J. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
   2. Coordinate the work with other trades to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.

5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems and thermal insulated pipe supports.

C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

1.06 QUALITY ASSURANCE

A. Plumbing Code of New York State.

B. State Education Department Planning Standards.

1.07 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Provide required hardware to hang or support piping, equipment, or fixtures with related accessories as necessary to complete installation of plumbing work.

B. Provide hardware products listed, classified, and labeled as suitable for intended purpose.

C. Materials for Metal Fabricated Supports: Comply with Section 055000.
   1. Zinc-Plated Steel: Electroplated in accordance with ASTM B633 unless stated otherwise.
   2. Galvanized Steel: Hot-dip galvanized in accordance with ASTM A123/A123M or ASTM A153/A153M unless stated otherwise.

D. Corrosion Resistance: Use corrosion-resistant metal-based materials fully compatible with exposed piping materials and suitable for the environment where installed.
   1. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.

2.02 STRUT SYSTEMS FOR PIPE OR EQUIPMENT SUPPORT

A. Strut Channels:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. ABB Installation Products.
      b. Gripple, Inc; Universal Bracket.
      c. Unistrut, a brand of Atkore International Inc.
      d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
   2. ASTM A653/A653M galvanized steel bracket with clamps for surface mounting of piping or plumbing equipment support.
   3. Channel or Bracket Kits: Include rods, brackets, end-fixed fittings, covers, clips, and other related hardware required to complete sectional trapeze section for piping or other support.

B. Hanger Rods:
   1. Threaded zinc-plated steel unless otherwise indicated.
   2. Minimum Size, Unless Otherwise Indicated or Required:
      a. Piping up to 1 inch: 1/4 inch diameter.
      b. Piping larger than 1 inch: 3/8 inch diameter.
      c. Trapeze Support for Multiple Pipes: 3/8 inch in length.

C. Channel Nuts:

1. Provide carbon steel channel nut with epoxy copper or zinc finish and long, regular, or short spring as indicated on drawings.

2.03 BEAM CLAMPS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. B-Line, a brand of Eaton Corporation.
   2. FNW; 7201.
   3. Unistrut, a brand of Atkore International, Inc.

B. MSS SP-58 types 19 through 23, 25 or 27 through 30 based on required load.

C. C-Clamp: MSS SP-58 type 23, malleable iron and steel with plain, stainless steel, and zinc finish.

D. Small or Junior Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish. For inverted usage provide manufacturer listed size(s).

E. Wide Mouth Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish.

F. Centerload Beam Clamp with Extension Piece: MSS SP-58 type 30, malleable iron with plain finish.

G. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.

H. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.

2.04 PIPE HANGERS

A. Clevis Hangers, Adjustable:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. B-Line, a brand of Eaton Corporation.
      b. FNW
      c. Carpenter Patterson.
      d. Substitutions: See Section 016000 - Product Requirements.
      e. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
   2. Copper Tube: MSS SP-58 type 1, epoxy-plated copper.
   3. Standard-Duty: MSS SP-58 type 1, zinc-colored, epoxy plated.

B. Nonmetallic Pipe Hangers:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. B-Line, a brand of Eaton Corporation.
      b. DecoShield Systems, Inc.
      c. Gregory Industries, Inc.
      d. Substitutions: See Section 016000 - Product Requirements.
   2. CPVC fabricated, snap-action hanger for pendant or sidewall applications.

2.05 PIPE CLAMPS

A. Riser Clamps:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. B-Line, a brand of Eaton Corporation.
      b. FNW.
      c. Substitutions: See Section 016000 - Product Requirements.

d. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.

2. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
3. MSS SP-58 type 1 or 8, carbon steel or steel with epoxy plated, plain, stainless steel, or zinc plated finish.

B. Strut Clamps:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. B-Line, a brand of Eaton Corporation.
b. FNW.
c. Unistrut, a brand of Atkore International, Inc.
d. Substitutions: See Section 016000 - Product Requirements.
2. Pipe Clamp: Two-piece rigid, universal, or outer diameter type, carbon steel with epoxy copper or zinc finish.
3. Cushioned Pipe or Tubing Strut Clamp: Provide strut clamp with thermoplastic elastomer cushion having dielectric strength of 670 V/mil.
4. Service Temperature Range: Minus 65 to 275 degrees F.

2.06 PIPE SUPPORTS, GUIDES, SHIELDS, AND SADDLES

A. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.

B. Pipe Shields for Insulated Piping:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Anvil International.
b. FNW.
c. Gregory Industries, Inc.
d. Substitutions: See Section 016000 - Product Requirements.
e. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
2. MSS SP-58 type 40, ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.
3. General Construction and Requirements:
a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
b. Shields Material: UV-resistant polypropylene with glass fill.
c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch.
d. Service Temperature: Minus 40 to 178 degrees F.
e. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.

C. Pipe Supports:
1. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
2. Liquid Temperatures Up to 122 degrees F:
a. Overhead Support: MSS SP-58 types 1, 3 through 12 clamps.
b. Support From Below: MSS SP-58 types 35 through 38.

D. Pipe Supports, Thermal Insulated:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Buckaroos, Inc.

2. General Requirements:
   a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
   b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
   c. Insulation inserts to consist of rigid phenolic foam insulation surrounded by 360 degree, PVC jacketing.

E. Copper Pipe Supports:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. B-Line, a brand of Eaton Corporation.
      b. HoldRite, a brand of Reliance Worldwide Corporation.
      c. Substitutions: See Section 016000 - Product Requirements.
      d. Source Limitations: Furnish supports, associated fittings, accessories, and hardware produced by single manufacturer.

2.07 ANCHORS AND FASTENERS

A. Manufacturers - Mechanical Anchors: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Hilti, Inc.
   2. ITW Red Head, a division of Illinois Tool Works, Inc.
   3. Powers Fasteners, Inc.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Manufacturers - Powder-Actuated Fastening Systems: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Hilti, Inc.
   2. ITW Ramset, a division of Illinois Tool Works, Inc.
   3. Powers Fasteners, Inc; _____: www.po.
   4. Substitutions: See Section 016000 - Product Requirements.

C. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

D. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.

E. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.

F. Hollow Masonry: Use toggle bolts.

G. Hollow Stud Walls: Use toggle bolts.

H. Steel: Use beam ceiling clamps, beam clamps, machine bolts, or welded threaded studs.

I. Beam Ceiling Flanges: ASTM A47/A47M Grade 32510, malleable iron or stainless steel with copper, plain, stainless steel, or zinc finish.

J. Sheet Metal: Use sheet metal screws.

K. Wood: Use wood screws.

L. Plastic and lead anchors are not permitted.

M. Powder-actuated fasteners are not permitted.

N. Hammer-driven anchors and fasteners are not permitted.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

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

B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

C. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

D. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

F. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

G. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Unless otherwise indicated, mount floor-mounted equipment on properly sized 4 inch high concrete pad constructed in accordance with Section 033000.
   3. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

H. Secure fasteners according to manufacturer's recommended torque settings.

I. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

A. Inspect support and attachment components for damage and defects.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 220553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Pipe markers.

1.02 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.

B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2017.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Schedules:
   1. Submit plumbing component identification schedule listing equipment, piping, and valves.
   2. Detail proposed component identification data in terms of of wording, symbols, letter size, and color coding to be applied to corresponding product.
   3. Valve Data Format: Include id-number, location, function, and model number.

C. Product Data: Provide manufacturers catalog literature for each product required.

D. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

E. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 PLUMBING COMPONENT IDENTIFICATION GUIDELINE

A. Nameplates:
   1. Water heaters, and other heat transfer products.
   2. Pumps, tanks and other plumbing equipment products.

B. Tags:
   1. Piping: 3/4 inch diameter and smaller.
   2. Manual operated valves.

C. Pipe Markers: 3/4 inch diameter and higher.

2.02 NAMEPLATES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Brimar Industries, Inc.
   2. Kolbi Pipe Marker Co.
   3. Seton Identification Products.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Description: Laminated piece with up to three lines of text.
   1. Letter Color: White.
   2. Letter Height: 1/2 inch.
   3. Background Color: Black.
   4. Nameplate Height: 3/4 inch.
   5. Nameplate Material:
      a. Flexible: Vinyl with adhesive backing per ASTM D709.

2.03 TAGS

A. Manufacturers:

1. Brimar Industries, Inc.
2. Craftmark Pipe Markers.
3. Seton Identification Products.

B. Metal: Brass, 19 gauge 1-1/2 inch in diameter with smooth edges, blank, smooth edges, and corrosion-resistant ball chain. Up to three lines of text.

C. Valve Tag Chart: Typewritten 12-point letter size list in anodized aluminum frame.

D. Piping: 3/4 inch diameter and smaller. Include corrosion resistant chain. Identify service, flow direction, and pressure.

2.04 PIPE MARKERS

A. Manufacturers:
1. Brimar Industries, Inc.
2. Craftmark Pipe Markers.
3. Seton Identification Products.
4. Substitutions: See Section 016000 - Product Requirements.

B. Comply with ASME A13.1.

C. Flexible Marker: Factory fabricated, semi-rigid, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid conveyed.

D. Flexible Tape Marker: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.

E. Identification Scheme, ASME A13.1:
1. Primary: External Pipe Diameter, Uninsulated or Insulated.
   a. 3/4 to 1-1/4 inches: Use 8 inch field-length with 1/2 inch text height.
   b. 1-1/2 to 2 inches: Use 8 inch field-length with 3/4 inch text height.
   c. 2-1/2 to 6 inches: Use 12 inch field-length with 1-1/4 inch text height.
2. Secondary: Color scheme per fluid service.
   a. Domestic Water Piping: White text on green background.
   b. Sanitary, waste and Vent Piping: While text on gray background.

PART 3 EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive identification products.

B. Prepare surfaces for stencil painting, see Section 099123.

3.02 INSTALLATION

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

B. Install tags in clear view and align with axis of piping

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

D. Install plastic tape pipe marker around pipe in accordance with manufacturer's instructions.

E. Apply ASME A13.1 Pipe Marking Rules:
1. Place pipe marker adjacent to changes in direction.
2. Place pipe marker adjacent each valve port and flange end.
3. Place pipe marker at both sides of floor and wall penetrations.
4. Place pipe marker every 25 to 50 feet interval of straight run.

END OF SECTION

SECTION 220719
PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Glass fiber insulation.

B. Jacketing and accessories.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

B. Section 221005 - Plumbing Piping: Placement of hangers and hanger inserts.

1.03 REFERENCE STANDARDS

A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019, with Editorial Revision (2023).

B. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2019).

C. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2019).

D. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2022a.

E. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013 (Reapproved 2019).

F. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2023).

G. ASTM C1423 - Standard Guide for Selecting Jacketing Materials for Thermal Insulation; 2021.

H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023c.

I. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2023.

J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 013000 - 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.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section.

B. State Education Department Planning Standards.

C. Energy conservation construction Code of New York State.

1.06 DELIVERY, STORAGE, AND HANDLING

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

1.07 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

2.01 REGULATORY REQUIREMENTS

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

2.02 GLASS FIBER INSULATION

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. CertainTeed Corporation; _____: www.certainteed.com/#sle.
   2. Johns Manville Corporation.
   3. Knauf Insulation.
   4. Owens Corning Corporation.
   5. Substitutions: See Section 016000 - 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: 0.2 percent by volume.

C. Vapor Barrier Jacket: White Kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm.

D. Vapor Barrier Lap Adhesive: Compatible with insulation.

E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

F. Indoor Vapor Barrier Finish:
   1. Cloth: Untreated; 9 oz/sq yd weight.

G. Insulating Cement: ASTM C449.

2.03 JACKETING AND ACCESSORIES

A. PVC Plastic Jacket:
   1. Manufacturers:
      a. Johns Manville Corporation; _____: www.jm.com/#sle.
      b. Substitutions: See Section 016000 - 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, 0.010 inch.
      e. Connections: Brush on welding adhesive.

PART 3 EXECUTION

3.01 EXAMINATION

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

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

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Exposed Piping: Locate insulation and cover seams in least visible locations.

C. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion

joints.

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

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

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

G. Inserts and Shields:
   1. Application: Piping 1-1/2 inches diameter or larger.
   2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
   3. Insert Location: Between support shield and piping and under the finish jacket.
   4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
   5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

H. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 078400.

I. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with canvas jacket sized for finish painting.

3.03 SCHEDULES

A. Plumbing Systems:
   1. Domestic Hot Water Supply:
      a. Glass Fiber Insulation:
         1) Pipe Size Range: 1-1/4 inch and less: 1" thick
         2) Pipe Size Range: 1-1/2" and larger; 1-1/2" think
   2. Domestic Hot Water Recirculation:
      a. Glass Fiber Insulation:
         1) Pipe Size Range: All sizes.
         2) Thickness: 1 inch.
   3. Domestic Cold Water
      a. Glass Fiber Insulation:
         1) Pipe Size Range: 1-1/4 inch and less: 1/2" thick
         2) Pipe Size Range: 1-1/2" and larger; 1" think
   4. Plumbing Vents within 10 feet of Exterior:
      a. Glass Fiber Insulation:
         1) Pipe Size Range: All sizes: 1/2" thick
         2) Pipe Size Range: 1-1/2" and larger; 1-1/2" think

END OF SECTION

SECTION 221005
PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sanitary waste piping, buried within 5 feet of building.
B. Sanitary waste piping, above grade.
C. Domestic water piping, above grade.
D. Natural gas piping, buried beyond 5 feet of building.
E. Natural gas piping, above grade.
F. Pipe flanges, unions, and couplings.
G. Pipe hangers and supports.
H. Strainers.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.
B. Section 099113 - Exterior Painting.
C. Section 099123 - Interior Painting.
D. Section 220529 - Hangers and Supports for Plumbing Piping and Equipment.
E. Section 220553 - Identification for Plumbing Piping and Equipment.
F. Section 220719 - Plumbing Piping Insulation.
G. Section 330110.58 - Disinfection of Water Utility Piping Systems.

1.03 REFERENCE STANDARDS

A. ANSI LC 1/CSA 6.26 - Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing; 2019.
B. ANSI Z223.1 - National Fuel Gas Code; 2024.
C. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
F. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings: DWV; 2021.
G. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings—DWV; 2022.
H. ASME B31.1 - Power Piping; 2022.
I. ASME B31.9 - Building Services Piping; 2020.
J. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.
K. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2021.
L. ASTM B32 - Standard Specification for Solder Metal; 2020.
M. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes; 2020.
N. ASTM B75/B75M - Standard Specification for Seamless Copper Tube; 2020.
O. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
P. ASTM B302 - Standard Specification for Threadless Copper Pipe, Standard Sizes; 2017.
Q. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV); 2020.

R. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2016.

S. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2023.

T. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2020a.

U. ASTM C1277 - Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2020.

V. ASTM C1540 - Standard Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2020.

W. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.

X. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2023.

Y. ASTM D2513 - Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings; 2020.

Z. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2020.

AA. ASTM D2609 - Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe; 2021.

BB. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2020.

CC. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2021.

DD. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets; 2020.

EE. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2023.

FF. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023c.

GG. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2021.

HH. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2020.

II. FM 1680 - Approval Standard for Couplings Used in Hubless Cast Iron Systems for Drain, Waste or Vent, Sewer, Rainwater or Storm Drain Systems Above and Below Ground, Industrial/ Commercial and Residential; 1989.

JJ. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

KK. NSF 61 - Drinking Water System Components - Health Effects; 2023, with Errata.

LL. NSF 372 - Drinking Water System Components - Lead Content; 2022.

MM. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

C. Welders' Certificates: Submit certification of welders' compliance with ASME BPVC-IX.

1.05 QUALITY ASSURANCE

A. Welder Qualifications: Certified in accordance with ASME BPVC-IX.

B. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

C. Plumbing Code of New York State.

D. State Education Department Planning Standards.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

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

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

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

B. Plenum-Installed Acid Waste Piping: Flame-spread index equal or below 25 and smoke-spread index equal or below 50 according to ASTM E84 or UL 723 tests.

2.02 SANITARY WASTE PIPING, BURIED WITHIN 5 FEET OF BUILDING

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

B. PVC Pipe: ASTM D2665 or ASTM D3034.
   1. Fittings: PVC.
   2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.03 SANITARY WASTE PIPING, ABOVE GRADE

A. Cast Iron Pipe: ASTM A74, service weight.
   1. Fittings: Cast iron.
   2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.

B. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.
   2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.

C. Copper Tube: ASTM B306, DWV.
   1. Fittings: ASME B16.29, wrought copper, or ASME B16.23, sovent.
   2. Joints: ASTM B32, alloy Sn50 solder.
   3. Copper not to be used on urinal waste piping.

D. PVC Pipe: ASTM D2665.
   1. Fittings: PVC.
   2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.04 DOMESTIC WATER PIPING, ABOVE GRADE

A. Copper Pipe: ASTM B88 (ASTM B88M), Type K (A), Drawn (H).
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
   2. Fittings: Cast iron, coated.

3. Joints: ASTM B32, alloy Sn95 solder.
4. Mechanical Press Sealed Fittings: Double-pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, nontoxic, synthetic rubber sealing elements.

2.05 NATURAL GAS PIPING, BURIED BEYOND 5 FEET OF BUILDING

A. Polyethylene Pipe: ASTM D2513, SDR 11.
   1. Fittings: ASTM D2683 or ASTM D2513 socket type.
   2. Joints: Fusion welded.

2.06 NATURAL GAS PIPING, ABOVE GRADE

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

B. Flexible Gas Piping:
   1. Corrugated Stainless Steel Tubing: Comply with ANSI LC 1/CSA 6.26.
   2. Comply with ASTM E84.
   3. Fittings: Provided by piping system manufacturer.

2.07 PIPE FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 inch and Under:
   1. Ferrous Pipe: Class 150 malleable iron threaded unions.
   2. Copper Tube and Pipe: Class 150 bronze unions with soldered joints.

B. Flanges for Pipe Sizes Over 1 inch:
   1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
   2. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

C. No-Hub Couplings:
   1. Testing: In accordance with ASTM C1277 and CISPI 310.
   2. Gasket Material: Neoprene complying with ASTM C564.
   3. Band Material: Stainless steel.
   4. Eyelet Material: Stainless steel.

D. Shielded, Heavy Duty No-Hub Couplings:
   1. Testing: In accordance with ASTM C1540 and FM 1680.
   2. Gasket Material: Neoprene complying with ASTM C564.
   3. Band Material: Stainless steel.
   4. Eyelet Material: Stainless steel.

2.08 PIPE HANGERS AND SUPPORTS

A. See Section 220529 for additional requirements.

B. Provide hangers and supports that comply with MSS SP-58.
   1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
   2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
   3. Trapeze Hangers: Welded steel channel frames attached to structure.
   4. Vertical Pipe Support: Steel riser clamp.

C. Plumbing Piping - Drain, Waste, and Vent:
   1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
   2. Hangers for Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
   3. Wall Support for Pipe Sizes to 3 inch: Cast iron hook.
   4. Wall Support for Pipe Sizes 4 inch and Over: Welded steel bracket and wrought steel clamp.

5. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
6. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

D. Plumbing Piping - Water:
1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
2. Hangers for Cold Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
3. Hangers for Hot Pipe Sizes 2 to 4 inch: Carbon steel, adjustable, clevis.
4. Wall Support for Pipe Sizes Up to 3 inch: Cast iron hook.
5. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
6. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

E. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
1. Concrete Wedge Expansion Anchors: Comply with ICC-ES AC193.
2. Masonry Wedge Expansion Anchors: Comply with ICC-ES AC01.
3. Concrete Screw Type Anchors: Comply with ICC-ES AC193.
4. Masonry Screw Type Anchors: Comply with ICC-ES AC106.
5. Concrete Adhesive Type Anchors: Comply with ICC-ES AC308.

2.09 STRAINERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Armstrong International, Inc.
2. Green Country Filter Manufacturing.
3. Watts.
4. Substitutions: See Section 016000 - Product Requirements.

B. Size 1/2 inch to 3 inch:
1. Class 150, threaded forged bronze Y-pattern body, stainless steel perforated mesh screen with cap, and rated for 150 psi, 250 deg F WOG service.

C. Size 2 inch and Smaller:
1. Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
2. Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

C. Install piping to maintain headroom, conserve space, and not interfere with use of space.

D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. See Section 220516.

E. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

F. Provide access where valves and fittings are not exposed.
   1. Coordinate size and location of access doors with General Contractor.

G. Install vent piping penetrating roofed areas to maintain integrity of roof assembly.

H. Install water piping to ASME B31.9.

I. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.

J. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.

K. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9.
   2. Support horizontal piping as indicated.
   3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   4. Place hangers within 12 inches of each horizontal elbow.
   5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   6. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
   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. Support cast iron drainage piping at every joint.

3.04 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.

3.05 TOLERANCES

A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/4 inch per foot slope.

B. Water Piping: Slope at minimum slope of 1% and arrange to drain at low points.

3.06 FIELD TESTS AND INSPECTIONS

A. Verify and inspect systems according to requirements by the Authority Having Jurisdiction. In the absence of specific test and inspection procedures proceed as indicated below.

B. Domestic Water Systems:
   1. Perform hydrostatic testing for leakage prior to system disinfection.
   2. Test Preparation: Close each fixture valve or disconnect and cap each connected fixture.
   3. General:
      a. Fill the system with water and raise static head to 10 psi above service pressure. Minimum static head of 50 to 150 psi. As an exception, certain codes allow a maximum static pressure of 80 psi.

C. Gas Distribution Systems:
   1. Test Preparation: Close each appliance valve or disconnect and cap each connected appliance.
   2. General Systems:
      a. Inject a minimum of 10 psi of compressed air into the piping system for a duration of 15 minutes and verify with a gauge that no perceptible pressure drop is measured.

b. Ensure test pressure gauge has a range of twice the specific pressure rate selected with an accuracy of 1/10 of 1 pound.

3. Welded Pipes or Systems with Service Pressures Above 14 in-wc:
   a. Inject a minimum of 60 psi of compressed air into the piping system for a duration of 30 minutes and verify with a gauge that no perceptible pressure drop is measured.
   b. Ensure test pressure gauge has a range of twice the specific pressure rate selected with an accuracy of 1/10 of 1 pound with 1 psi increments.

D. Test Results: Document and certify successful results, otherwise repair, document, and retest.

3.07 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Disinfect water distribution system in accordance with Section 330110.58.

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

C. 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).

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

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

F. Maintain disinfectant in system for 24 hours.

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

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

I. 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.

3.08 SERVICE CONNECTIONS

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

3.09 SCHEDULES

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

END OF SECTION

SECTION 221006
PLUMBING PIPING SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Floor Drains.
B. Cleanouts.
C. Hose bibbs.
D. Hydrants.
E. Backflow preventers.
F. Water hammer arrestors.
G. Mixing valves.
H. Air Admittance Valves
I. Floor drain trap seals.
J. Temperature Activated Balancing Valves

1.02 RELATED REQUIREMENTS

A. Section 221005 - Plumbing Piping.
B. Section 223000 - Plumbing Equipment.
C. Section 224000 - Plumbing Fixtures.

1.03 REFERENCE STANDARDS

A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
B. ASME A112.6.3 - Floor Drains; 2022.
C. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers; 2023.
D. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies; 2021.
E. ASSE 1017 - Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems; 2023.
F. ASSE 1070 - Performance Requirements for Water Temperature Limiting Devices; 2020.
G. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
H. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV); 2020.
I. NSF 61 - Drinking Water System Components - Health Effects; 2023, with Errata.
J. NSF 372 - Drinking Water System Components - Lead Content; 2022.
K. PDI-WH 201 - Water Hammer Arresters; 2017.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.
B. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
C. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.
D. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section.
B. Plumbing code of New york State.

C. State Education Department Planning Standards

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept specialties on site in original factory packaging. Inspect for damage.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

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

2.02 DRAINS

A. Floor Drains:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Jay R. Smith Manufacturing Company.
      b. Zurn Industries, LLC.
      c. Watts Drainage Products.
      d. Substitutions: See Section 016000 - Product Requirements.

B. Floor Drain (FD-1):
   1. ASME A112.6.3; lacquered cast iron, two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer.

2.03 CLEANOUTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Jay R. Smith Manufacturing Company.
   2. Josam Company.
   3. Zurn Industries, LLC.
   4. Watts Drainage Products
   5. Substitutions: See Section 016000 - Product Requirements.

2.04 HOSE BIBBS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. T & S Brass.
   2. Chicago Faucets.
   3. Woodford Inc.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Interior Hose Bibbs:
   1. Bronze or brass with integral mounting flange, replaceable hexagonal disc, hose thread spout, chrome-plated where exposed with handwheel, integral vacuum breaker in compliance with ASSE 1011.

2.05 HYDRANTS

A. Manufacturers:
   1. Jay R. Smith Manufacturing Company.
   2. Zurn Industries, LLC.
   3. Watts Drainage Products.

B. Wall Hydrants:
   1. ASSE 1019; non-freeze, self-draining type with chrome-plated wall plate hose thread spout, handwheel, and integral vacuum breaker.

2.06 BACKFLOW PREVENTERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Watts Regulator Company, a part of Watts Water Technologies; _____: www.wattsregulator.com/#sle.
   2. Zurn Industries, LLC; 375XL: www.zurn.com/#sle.

B. Reduced Pressure Backflow Preventer Assembly:
   1. ASSE 1013 and NSF 61 compliant reinforced-nylon body and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure, integral male test fittings, and non-threaded vent outlet.
   2. Size: 3/4 to 2 inch assembly with threaded gate valves.
   3. Maximum Working Parameters: 175 psi at 180 degrees F.
   4. Accessories: Provide quarter turn ball valves, air gap fitting, lead-free Y-strainer, and test cocks.

2.07 WATER HAMMER ARRESTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Precision Plumbing Products
   2. Jay R. Smith Manufacturing Company.
   3. Watts Regulator Company.
   4. Zurn Industries, LLC.
   5. Substitutions: See Section 016000 - Product Requirements.

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

2.08 MIXING VALVES

A. Thermostatic Master Mixing Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Leonard Valve Company.
      b. Watts Water Technologies; POWERS.
      c. Substitutions: See Section 016000 - Product Requirements.
   2. Valve: ASSE 1017, bronze or brass body; thermostatic element; corrosion- and lime-resistant internal components; integral locking temperature adjustment.
   3. Capacity: As scheduled on plans.
   4. Finish: Rough bronze.
   5. Accessories:
      a. Strainer stop checks on inlets.
      b. Shut-off valve on outlet.
      c. Stem thermometer on outlet.

B. Water Temperature Limiting Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Leonard Valve Company.
      b. Watts Water Technologies; POWERS.
      c. Substitutions: See Section 016000 - Product Requirements.

2. Valve: ASSE 1070, bronze or brass body; thermostatic element; corrosion- and lime-resistant internal components; integral locking temperature adjustment with high-temperature limit stop; integral check valves with strainer screens on inlets.
3. Mixed-Water Temperature Setting: 90 degrees F.

2.09 AIR ADMITTANCE VALVES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Oatey.
   2. Pro-Vent Systems.
   3. Studor, Inc.
   4. Sioux Chief

B. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.

C. Housing: Plastic.

D. Operation: Mechanical sealing diaphram.

E. Size: Same as connected fixcture or branch vent piping.

2.10 FLOOR DRAIN TRAP SEALS

A. Manufacturers:
   1. Green Drains.
   2. MIFAB, Inc.
   3. Sure-Seal.
   4. Substitutions: See Section 016000 - Product Requirements.

B. Description: Push-fit EPDM or silicone fitting with a one-way membrane. ASSE 1072 compliant "Performance Requirements for Barrier-Type Floor Drain Trap Seal Protection Devices".

2.11 TEMPERATURE ACTIVATED BALANCING VALVES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Acorn Controls.
   2. Therm Omega Tech.
   3. Caleffi Hydronic solutions.
   4. Controls, A Member of Morris Group.

B. Balancing Valve assembly shall be self-contained and fully automatic without additional piping or control mechanisms.

C. Body: Lead free Brass or stainless steel.

D. Balancing valve shall regulate the flow of recirculated domestic hot water based on water temperature entering the valve, regardless of system pressure. As temperature increases the valve proportionally closes dynamically adjusting flow to meet the specific temperature.

E. Temperature adjustment scale for manual setting and tamperproof adjustment locking screw.

F. Valve shall be suitable for a thermal disinfection by-pass function.

G. Assemble shall include a check valve.

H. Temperature shall be adjustable from 95 to 140 degrees.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

C. Install floor cleanouts at elevation to accommodate finished floor.

D. Pipe outlet of backflow preventer air gap fitting, full size to nearest floor drain.

E. Install wall hydrants flush with exterior wall and caulk weathertight to building structrue.

F. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping as indicated on plans.

G. Install fxture air admittance valves on fixture drain piping in accordance with manufactuer's written installation instructions.

H. Install balancing valves in hot return piping to maintain constant hot water temperature at plumbing fixtures.

END OF SECTION

SECTION 221123
DOMESTIC WATER PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Circulators.

1.02 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.

B. NSF 61 - Drinking Water System Components - Health Effects; 2023, with Errata.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data:
   1. Provide certified pump curve with duty point marked over pump and system operating conditions and NPSH curve and power requirement by pump tag.
   2. Manufacturer's catalog sheets for fixtures, fittings, accessories, and supplies.

C. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

D. Warranty Documentation: Submit manufacturer warranty and ensure that 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 016000 - Product Requirements for additional provisions.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing type of products specified in this section.

B. Certifications: Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc, as suitable for purpose specified and indicated.

C. Identification: Provide pumps with manufacturer's name, model number, and rated capacity identified by permanently attached label.

D. Performance: Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

E. Plumbing code of New york State.

F. Energy conservation construction code of New York State.

G. State Education Department Planning Standards

1.05 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.06 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide 1-year manufacturer warranty for pumps except circulator type. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 CIRCULATORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Bell & Gossett, a Brand of Xylem, Inc.
   2. Grundfos Pumps Corporation..

3. Taco, Inc.
4. Substitutions: See Section 016000 - Product Requirements.

B. Casing: Stainless steel with bronze cast or plastic impeller, and stainless steel rotor assembly.

C. Shaft: Alloy steel with integral thrust collar and two oil-lubricated bronze sleeve bearings.

D. Mechanical Seal: Carbon rotating against a stationary ceramic seat.

E. Performance: As scheduled on plans.

F. Pipe-End Connection: Union connection.

G. Maximum Discharge Pressure: 145 psi.

H. Motor: 1,750 rpm, ECM duty with flexible coupling.

I. Service Temperature Range: Minus 30 to 250 degrees F.

J. BMS or Other Integrated Automation Link: Provide auxiliary contacts for fault and run status.

K. Accessories: Include inlet-outlet temperature and pressure gauges with 2-way isolation valves.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products with related fittings, and accessories according to manufacturer instructions.

B. Potable and Drinking Water Service: Provide NSF 61 certified; comply with ICC (IPC).

C. Ensure that small pressure gauges are installed on both upstream and downstream ends.

D. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are nonoverloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

3.02 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Operational Tests: Upon completion and sterilization of plumbing systems, conduct operating tests to demonstrate satisfactory, functional, and operating efficiency.

3.03 PROTECTION

A. Protect installed products from damage due from subsequent construction operations.

B. Repair or replace products damaged before Date of Substantial Completion.

END OF SECTION

SECTION 221435
DRAINAGE PUMPS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Packaged drainage-pump units.

1.03 ACTION SUBMITTALS

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

B. Shop Drawings:
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, and required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with manufacturer's written instructions for handling.

1.06 QUALITY ASSURANCE

A. Energy Conservation Construction Code of New York State.

B. Plumbing Code of New York State.

C. State Education Department Planning Standards.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

2.02 PACKAGED DRAINAGE-PUMP UNITS

A. Packaged Submersible Drainage-Pump Units ???Insert drawing designation???:
   1. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, sump-pump unit.
   2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Goulds Water Technology; a Xylem brand.
      b. Liberty Pumps.
      c. Little Giant Pump Co.
      d. Zoeller Company.
   3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.

4. Casing: Metal.
5. Impeller: Brass.
6. Pump Seal: Mechanical.
7. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection.
8. Power Cord: Three-conductor, waterproof cable 10 feet long, with grounding plug and cable-sealing assembly for connection at pump.
9. Pump Discharge Piping: Factory provided threaded outlet
10. Control: Motor-mounted float switch.
11. Basin: Plastic.

B. Capacities and Characteristics:
1. Capacity: 10 gpm.
2. Total Dynamic Head: 18 feet.
3. Discharge Pipe Size: 1-1/2” NPS.
4. Electrical Characteristics:
a. Motor Horsepower: 1/3 hp.
b. Volts: 120 V.
c. Phases: Single.
d. Hertz: 60.
5. Basin:
a. Capacity: 4.3 gal. minimum.
b. Inlet Connection: NPS 1-1/2 minimum.
c. Dimensions: 11.125” High x 13.75” diameter.

2.03 MOTORS

A. Motors for submersible pumps shall be hermetically sealed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.02 CONNECTIONS

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

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test, inspect, and adjust components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections:
1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Pumps and controls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.04 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.

3.05 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION

SECTION 223000
PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Tankless gas-fired water heaters.

B. Domestic hot water storage tanks.

C. Diaphragm-type compression tanks.

1.02 RELATED REQUIREMENTS

A. Section 221123 - Domestic Water Pumps.

1.03 REFERENCE STANDARDS

A. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks; 2020, with Addendum (2024).

B. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2023.

C. NSF 61 - Drinking Water System Components - Health Effects; 2023, with Errata.

1.04 SUBMITTALS

A. See Section 013000 - 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. Provide electrical characteristics and connection requirements.

C. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

D. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section.

B. Certifications:
   1. Water Heaters: NSF approved.
   2. Gas Water Heaters: ANSI Z21.10.1 and ANSI Z21.10.3.
   3. Pressure Vessels for Heat Exchangers: ASME labeled to ASME BPVC-VIII-1.
   4. Water Tanks: ASME labeled to ASME BPVC-VIII-1.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.07 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide 5-year manufacturer warranty for domestic water heaters and water storage tanks. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 WATER HEATERS

A. Manufacturers:
   1. A.O. Smith Water Products Co.
   2. Bradford White Corporation.
   3. Rheem Manufacturing Company.

4. Substitutions: See Section 016000 - Product Requirements.

B. Tankless Gas-Fired Water Heaters:
1. Minimum Efficiency Required: ASHRAE Std 90.1 I-P.
2. Water Inlet Pressure: From 30 psi to 150 psi.
3. Supply Gas Type: Natural gas.
4. Capacity: As scheduled on plans.
5. Heater Type: Self-contained, floor-mounted unit capable of handling listed capacity, air intake valve, condensate solenoid drain valve, water-inlet strainer, removable thermally-insulated front panel, blower access cover, and threaded water, gas, and condensate pipe-end connections.
6. Burner-Heat Exchanger: 316L stainless steel assembly with single flue passage, flue baffle, and draft hood; thermally insulated and encased in corrosion-resistant steel jacket; baked-on enamel finish.
7. Safeties: Provide internal safeties for vent side, water flow, flame detection, fan speed, electrical load, and thermal load.
8. Controls: Color touchscreen interface for internal controls and built-in gas pressure regulator; temperature range adjustable from 100 to 185 degrees F using safety pilot and thermocouple.
9. BAS, SCADA, or other Integrated Automation Link: ASHRAE Std 135 BACnet MS/TP.
10. Accessories: Provide cold water inlet expansion tank, hot water recirculation pump, inlet ball valve, outlet ball valve, outlet ASME-ratred temperature-pressure relief valve, and pipe-mounted thermometers.
11. Electrical Load: 120 VAC, single phase.
12. Additional System Accessories: Concentric vent kit and acid neutralizers.

2.02 DOMESTIC HOT WATER STORAGE TANKS

A. Manufacturers:
1. A.O. Smith Water Products Co.
2. Bradford White Corporation; Jacketed Storage Tank.
3. Rheem Manufacturing company.
4. Substitutions: See Section 016000 - Product Requirements.

B. Storage Capacity: As scheduled on plans.

C. Tank: Welded steel, ASME labeled for working pressure of 125 psig, steel support saddles, tappings for accessories, threaded connections of stainless steel, access manhole.

D. Insulation: 2 inch thick, non-cfc foam on respective top and tank sides.

E. Lining: Corrosion-resistant glass continued into screwed connections.

F. Openings: Up to 3 inches, copper-silicone threaded; over 4 inches, flanged; flanged collar for heat exchanger; manway fitting.

G. Openings and Connections:
1. Threaded top hot water outlet and front-side bottom cold water inlet, 2 inch.
2. Threaded openings for aquastat, drain, PT release valve, and pump circulation.
3. Threaded hand-hole cleanout access opening with cover.

H. Accessories: Provide aquastat, drain valve, pressure-temperature (PT) relief valve ASME rated for maximum working pressure, and thermometer with range of 40 to 200 degrees F.

2.03 DIAPHRAGM-TYPE COMPRESSION TANKS

A. Manufacturers:
1. Amtrol Inc.
2. Bell & Gossett, a brand of Xylem, Inc.
3. Taco, Inc.
4. Thrush Manufacturing.
5. Substitutions: See Section 016000 - Product Requirements.

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

C. Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 12 psig.

D. Size: As scheduled on plans.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions required for applicable certifications.

B. Provide housekeeping pad for all floor mounted equipment.

C. Coordinate system, equipment, and piping work with applicable electrical, gas, and drain support interconnections as included or provided by other trades.

D. Domestic Water Storage Tanks:
   1. Provide steel pipe support, independent of building structural framing members.
   2. Clean and flush prior to delivery to site. Seal until pipe connections are made.

3.02 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s).

END OF SECTION

SECTION 224000
PLUMBING FIXTURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Flush valve water closets.

B. Wall hung urinals.

C. Lavatories.

D. Sinks.

E. Under-lavatory pipe supply covers.

F. Bi-level, electric water coolers.

1.02 RELATED REQUIREMENTS

A. Section 221005 - Plumbing Piping.

B. Section 221006 - Plumbing Piping Specialties.

C. Section 223000 - Plumbing Equipment.

1.03 REFERENCE STANDARDS

A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.

B. ASHRAE Std 18 - Methods of Testing for Rating Drinking-Water Coolers with Self-Contained Mechanical Refrigeration; 2008 (Reaffirmed 2013).

C. ASME A112.6.1M - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use; 1997 (Reaffirmed 2017).

D. ASME A112.18.1 - Plumbing Supply Fittings; 2018, with Errata.

E. ASME A112.18.9 - Protectors/Insulators for Exposed Waste and Supplies on Accessible Fixtures; 2011 (Reaffirmed 2022).

F. ASME A112.19.2 - Ceramic Plumbing Fixtures; 2018, with Errata.

G. ASME A112.19.5 - Flush Valves and Spuds for Water Closets, Urinals, and Tanks; 2022.

H. ASSE 1070 - Performance Requirements for Water Temperature Limiting Devices; 2020.

I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023c.

J. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).

K. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

L. NSF 61 - Drinking Water System Components - Health Effects; 2023, with Errata.

M. NSF 372 - Drinking Water System Components - Lead Content; 2022.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Manufacturer's Instructions: Indicate installation methods and procedures.

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 016000 - Product Requirements for additional provisions.
   2. Extra Faucet Washers: One set of each type and size.
   3. Extra Toilet Seats: One of each type and size.

4. Flush Valve Service Kits: One for each type and size.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section.

B. Plumbing Code of New York State.

C. State Education Department Planning Standards.

1.06 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.

1.07 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturer warranty for electric water cooler.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

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

B. Water Efficiency: EPA WaterSense label is required for all water closets, urinals, lavatory faucets, and showerheads.

C. Maximum Fixture or Faucet Supply Pressure: 60 psi unless stated otherwise.

2.02 FLUSH VALVE WATER CLOSETS

A. Water Closets:
   1. Vitreous china, ASME A112.19.2, wall hung, siphon jet flush action, china bolt caps.
   2. Bowl: ASME A112.19.2; 16.5 inches high with elongated rim.
   3. Flush Valve: Exposed (top spud).
   4. Flush Operation: Sensor operated.
   5. Handle Height: 44 inches or less.
   6. Inlet Size: 1-1/2 inches.
   7. Trapway Outlet: 4 inch.
   8. Color: White.
   9. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. American Standard, Inc.
      b. Zurn Industries, LLC.
      c. Sloan Company.
      d. Substitutions: See Section 016000 - Product Requirements.

B. Flush Valves:
   1. Valve Supply Size: 1 inch.
   2. Valve Outlet Size: 1-1/2 inches.
   3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Delany Products.
      b. Sloan Valve Company.
      c. Zurn Industries, LLC.
   4. Sensor-Operated:

a. Type: ASME A112.19.5; chloramine-resistant clog-resistant dual-seat diaphragm valve complete with vacuum breaker, stops and accessories.
b. Mechanism: Solenoid-operated piston or electronic motor-actuated operator with low-voltage powered infrared sensor, and mechanical override button.
c. Supplied Volume Capacity: 1.2 gal per flush.

C. Toilet Seats:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Bemis Manufacturing Company.
b. Church Seat Company.
c. Olsonite.
d. Substitutions: See Section 016000 - Product Requirements.
2. Type: commercial, extra heavy duty.
3. Plastic: Solid, white finish, enlongated shape, open front, slow-closing hinged seat cover, extended back complete with self-sustaining hinges, and brass bolts with covers.

D. Water Closet Carriers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Jay R. Smith Manufacturing.
b. JOSAM Company.
c. Zurn Industries, LLC.
d. Watts Drainage Products.
e. Substitutions: See Section 016000 - Product Requirements.
2. ASME A112.6.1M; adjustable cast iron frame, integral drain hub and vent, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers.

2.03 WALL HUNG URINALS

A. Manufacturers:
1. American Standard, Inc.
2. Sloan Company
3. Zurn Industries, LLC.
4. Substitutions: See Section 016000 - Product Requirements.

B. Vitreous china, ASME A112.19.2, wall hung with side shields and concealed carrier.
1. Consumption Volume: 0.5 gal per flush, maximum.
2. Flush Style: Washout.
3. Flush Valve: Exposed (top spud).
4. Flush Operation: Sensor operated.
5. Trapway Outlet: Integral.
6. Removable stainless steel strainer.
7. Supply Size: 3/4 inch.
8. Outlet Size and Location: 2 inches, bottom side.

C. Flush Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Delany Products; _____: www.delanyproducts.com/#sle.
b. Sloan Valve Company; _____: www.sloanvalve.com/#sle.
c. Zurn Industries, LLC; ZEMS Series: www.zurn.com/#sle.
2. Sensor-Operated:

a. Type: ASME A112.19.5; chloramine-resistant, clog-resistant dual-seat diaphragm valve with vacuum breaker, stops and accessories.
b. Mechanism: Solenoid-operated piston or electronic motor-actuated operator with low-voltage powered infrared sensor, and mechanical override button.
c. Supplied Volume Capacity: 0.5 gallons per flush.

D. Urinal Carriers:
1. Manufacturers:
a. Jay R. Smith Manufacturing Company.
b. JOSAM Company.
c. Zurn Industries, LLC.
d. Watts Drainage Products.
e. Substitutions: See Section 016000 - Product Requirements.
2. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs.

2.04 LAVATORIES

A. Manufacturers:
1. American Standard, Inc.
2. Sloan Company.
3. Zurn Industries, LLC.
4. Substitutions: See Section 016000 - Product Requirements.

B. Wall-Hung Basin:
1. Vitreous China: ASME A112.19.2; white, rectangular basin with splash lip, front overflow, soap depression, and hanger. Size as indicated on drawings with 4-inch centerset spacing.
2. Carrier:
a. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded studs for fixture hanger, bearing plate and studs.
b. Manufacturers:
1) Jay R. Smith MFG. Co.
2) JOSAM Company.
3) Zurn Industries, LLC.
4) Watts Drainage Products.
5) Substitutions: See Section 016000 - Product Requirements.

C. Supply Faucet:
1. Deck Mounted Faucet Manufacturers:
a. Chicago Faucets.
b. T&S Brass.
c. Sloan Company..
d. Zurn Industries, LLC.

D. Sensor Operated Faucet:
1. Cast brass, chrome plated, deck mounted with sensor located on neck of spout.
2. Spout Style: Swivel gooseneck.
3. Power Supply:
a. Wired: 6 VDC, field-wired into dedicated or common power supply.
4. Mixing Valve: External lever operated.
5. Water Supply: 3/8 inch compression connections.
6. Aerator: Vandal resistant, 0.5 gpm, laminar flow device.
7. Automatic Shut-off: 30 seconds.
8. Sensor Range: Factory set at 3 inch adjustable up to 24 inch.
9. Finish: Polished chrome.
10. Accessory: 4 inch deck plate.

11. Lead Content: Extra low; maximum 0.25 percent by weighed average.
12. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    a. Chicago Faucet Company.
    b. Sloan Valve Company.
    c. Zurn Industries, LLC.

E. Thermostatic Mixing Valve:
1. ASSE 1070 listed with combination stop, strainer, and check valves, and flexible stainless steel connectors.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    a. Acorn Controls.
    b. Watts Technologies.
    c. Leonard Valve comopany
    d. Substitutions: See Section 016000 - Product Requirements.
3. Chrome plated 17 gauge, 0.0538 inch brass P-trap with clean-out plug and arm with escutcheon.

F. Lavatory Carrier:
1. Manufacturers:
    a. Jay R. Smith Manufacturing Company.
    b. JOSAM Company.
    c. Zurn Industries, LLC.
    d. Watts Drainage Products.
    e. Substitutions: See Section 016000 - Product Requirements.
2. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded studs for fixture hanger, bearing plate and studs.

G. Accessories:
1. Offset waste with perforated open strainer.
2. Loose key angle stops.
3. Rigid supplies.

2.05 SINKS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Acorn Engineering Company.
2. Just Manufacturing.
3. Elkay.
4. Substitutions: See Section 016000 - Product Requirements.

B. Single Compartment Bowl
1. ASME A112.19.3; 31 by 22 by 6.0 inch outside dimensions, 18 gauge, 0.050 inch thick, type 304 stainless steel, self-rimming and undercoated, with ledge back drilled for trim.
2. Drain Location: Center rear of bowl.
3. Drain: 3-1/2 inch crumb cup and offset tailpiece.

C. Double Compartment Bowl:
1. ASME A112.19.3; 37.25 by 17 by 5.5 inch outside dimensions, 18 gauge, 0.050 inch thick, type 304 stainless steel, self- rimming and undercoated, with ledge back drilled for trim.
2. Drain: 1-1/2 inch chromed brass grids strainer for bubbler bowl
3. Drain: 3-1/2 inch crumb cup and offset tailpiece.

D. Faucets:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Chicago Faucets.
   b. T&S Brass.
   c. Moen.
2. Two-Handle Faucet:
   a. Type: Deck-mount,wrist blade operated swivel gooseneck spout faucet with mounting plate.
   b. Spray Type: Full stream spray at 1.75 gpm, maximum.
   c. ASME A112.18.1, ADA Standards, and NSF 61 compliant assembly.
   d. Materials: Brass body with polished chrome finish.

2.06 UNDER-LAVATORY PIPE SUPPLY COVERS

A. Manufacturers:
   1. Plumberex Specialty Products, Inc.
   2. Sloan
   3. Treubro

B. General:
   1. Construction: 1/8 inch PVC with antimicrobial, antifungal and UV resistant properties.
      a. Provide one piece injected molded design with internal bridge at top of J-bend to prevent separating.
      b. Comply with ASTM E84 for flame and smoke development.
      c. Comply with ASTM C1822 Type III for covers on accessible lavatory piping.
      d. Comply with ASME A112.18.9 for covers on accessible lavatory piping.
      e. Comply with ICC A117.1.
      f. Microbial and Fungal Resistance for Interior and Exterior: Comply with ASTM G21.
   2. Color: High gloss white.
   3. Fasteners: Reusable, snap-locking fasteners with no sharp or abrasive external surfaces. No cable ties allowed.

2.07 BI-LEVEL, ELECTRIC WATER COOLERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Elkay Manufacturing Company.
   2. Haws Corporation.
   3. Oasis International.

B. Water Cooler: Bi-level, electric, mechanically refrigerated; surface mounted, ADA compliant; stainless steel top, vinyl on steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push bar bubbler operation, sensor operated bottle filler, mounting bracket; integral air cooled condenser and stainless steel grille.
   1. Capacity: 8 gph 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.
   2. Electrical: 115 VAC, 60 Hertz compressor, 6 foot cord and plug for connection to electric wiring system including grounding connector.

C. Bottle Filler: Materials to match fountain.

PART 3 EXECUTION

3.01 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.

C. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

3.02 PREPARATION

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

3.03 INSTALLATION

A. Provide chrome-plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.

B. Install components level and plumb.

C. Install and secure fixtures in place with wall supports and bolts.

D. Solidly attach water closets to floor with lag screws. Lead flashing is not intended to hold fixture in place.

3.04 INTERFACE WITH WORK OF OTHER SECTIONS

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

3.05 ADJUSTING

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

3.06 CLEANING

A. Clean plumbing fixtures and equipment.

3.07 PROTECTION

A. Protect installed products from damage due to subsequent construction operations.

B. Do not permit use of fixtures by construction personnel.

C. Repair or replace damaged products before Date of Substantial Completion.

END OF SECTION

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.
B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 104 deg F and at altitude of 3300 feet3300 feet above sea level.
B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.
B. Efficiency: Premium efficient, as defined in NEMA MG 1.
C. Service Factor: 1.15.
D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.
F. Rotor: Random-wound, squirrel cage.
G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
H. Temperature Rise: Match insulation rating.
I. Insulation: Class F.
J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

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

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
D. Motors 1/20 HP and Smaller: Shaded-pole type.
E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

SECTION 230514 – MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Adjustable speed drive motor controllers.
2. Nameplates

1.3 REFERENCES

A. AHRI 1210 – Performance Rating of Variable Frequency Drives
B. NEMA MC-1 - Motors and Generators.
C. NEMA ICS - General Standards for Industrial Control and Systems.
D. UL508 - Electric Industrial Control Equipment
E. IEEE 519 - Recommended Practices and Requirements for Harmonic Control in Electric Power Systems.

1.4 DIVISION OF WORK

A. Work Required Under Division 23:

1. Furnish adjustable speed drive (ASD) motor controllers required for HVAC equipment provided.
2. All temperature control wiring, external wiring of control circuits of magnetic starters, interlocking wiring, boiler wiring, and mounting of control devices.
    a. All external wiring shall be in conduit and comply with the specifications as described in Division 26.

1.5 ACTION SUBMITTALS

A. Product Data:

1. Motor Controllers: Rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   a. Identify each controller for use with corresponding motor.

B. Shop Drawings:

1. Include mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Complete diagrams for power, signal, and control wiring.
   a. Deliver (2) copies of approved wiring diagrams to the Electrical Contractor for installation of wiring.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For ASDs to include in operation and maintenance manuals.

1.7 WARRANTY

A. Provide full system warranty in accordance with Division 01 with a minimum of one (1) year from acceptance.

PART 2 - PRODUCTS

2.1 ADJUSTABLE SPEED DRIVE (ASD) MOTOR CONTROLLERS

A. Basis-of-Design: Subject to compliance with requirements, provide Square D; S-Flex 212 or comparable product by one of the following:

1. ABB Inc.
2. Eaton Corp.
3. Danfoss Inc.
4. Yaskawa Electric America, Inc.

B. Adjustable Speed Drive Description:

1. The ASD shall convert the input AC main power to an adjustable frequency and voltage.
2. The input power section shall utilize a full wave bridge design incorporating diode rectifiers. The diode rectifiers shall convert fixed voltage and frequency, AC line power to fixed DC voltage.
3. The output power section shall change fixed DC voltage to adjustable frequency AC voltage.
4. The adjustable frequency drive package shall consist of a through the door disconnecting means, 2 contactor bypass, 120V control transformer, control circuit terminal board for digital and analog field wiring.

5. The drive controller, shall be UL508C or UL 61800-5-1 listed and coordinated with NEMA ICS 7.1.

C. Enclosure:

1. The ASD power converter shall be enclosed in a UL rated Type 1, 12, or 3R enclosure. The enclosure shall provide dedicated user terminals for power and control device connection.
2. All enclosures shall be of steel construction and the drive shall be fully enclosed. Exposed plastic covers or back panel mounted power converters does not meet specification.

D. Application Data:

1. The ASD shall be sized to operate a variable torque load.
2. The speed range shall be from a minimum speed of 1.0 Hz to a maximum speed of 72 Hz.

E. Environmental Ratings:

1. The ASD shall meet IEC 60664-1 Annex A, NEMA ICS 1, and UL standards.
2. The ASD shall be designed to operate in an ambient temperature from 14 to 104 deg F.
3. The maximum relative humidity shall be 95%, non-condensing.
4. The ASD shall be rated to operate at altitudes less than or equal to 3300 ft.
5. The ASD shall meet the IEC 60721-3-3-3M3 operational vibration specification.

F. Ratings:

1. The ASD shall be designed to operate at 208 VAC (±) 10%, 230VAC (±) 10%, or 460VAC Hz (±) 10%.
2. The ASD shall operate from an input frequency range of 50 to 60 Hz (±) 5%.
3. The displacement power factor shall not be less than .96 lagging under any speed or load condition.
4. The efficiency of the ASD, including standard test motor, shall be published and certified to AHRI Standard 1210.
5. The variable torque rated ASD over current capacity shall be not less than 110% for 1 minute.

G. Protection

1. Upon power-up, the ASD shall automatically test for valid operation of memory, loss of analog reference input, loss of communication, DC-to-DC power supply, control power and pre-charge circuit.
2. The ASD shall be protected against short circuits, between output phases, and to ground.
3. The ASD shall have a solid-state UL 508C or UL 61800-5-1 listed overload protective device and meet IEC 60947
4. For a fault condition other than a ground fault, short circuit or internal fault, an auto restart function shall provide up to 10 programmable restart attempts after a detected fault has occurred.
5. Drive shall have programmable level of analog process follower reference signal; the ASD shall be programmable to display a fault below the selected level.
6. The output frequency shall be software enabled to fold back when the motor is overloaded.

H. Adjustments and Configurations

1. The ASD shall have the capability to be programmed using PC software and RS485 to USB adapter cable. All parameter settings for each ASD shall be retained in a digital configuration file on PC for record.
2. The ASD shall be factory programmed to operate all specified optional devices.
3. The acceleration and deceleration ramp times shall be adjustable from 0.1 to 3200 seconds.
4. The memory shall retain and record run status and fault type of the past four faults.
5. The output carrier frequency of the ASD shall be programmable from 6 to 16 kHz. In addition, the output carrier frequency shall be randomly modulated about the selected frequency.

I. Keypad Display Interface

1. The ASD shall include LED or LCD status indicators for power on, run, programming and monitoring mode.
2. A keypad display interface shall offer the modification of ASD adjustments through a keypad interface. Electrical values, configuration parameters, I/O assignments, application and activity function access, faults, local control, and adjustment storage, and diagnostics shall be accessible via the keypad.
3. The drive firmware shall have parameter lock capability that allows the drive to be locked out through the keypad menu from unauthorized personnel.
4. The keypad shall be capable of displaying I/O assignment and status.

J. Controls

1. The control power for the digital inputs and outputs shall be 24 Vdc.
2. The internal power supply shall incorporate automatic current fold-back that protects the internal power supply if incorrectly connected or shorted. The transistor logic outputs shall be current limited and shall not be damaged if shorted.
3. Two voltage-free relay output contacts shall be provided. One of the contacts shall indicate ASD trip status. The other contact shall indicate a drive run status.
4. The combination enclosure shall have the following dedicated operator controls when supplied with a 2 or 3 contactor bypass:
    a. Hand-Off-Auto selector switch
    b. ASD-Bypass selector switch
    c. Bypass Run Light
    d. Power on Light
5. The combination enclosure shall include terminal point connection for fire/freeze interlock, to prevent drive or bypass operation. The interlock must shut down the motor in the drive and bypass modes.

K. Serial Communication

1. The ASD shall have embedded serial communications capability for BACnet communications.

L. Drive and Bypass Contactors

1. The ASD shall include electrically interlocked bypass contactors complete with a Class 10 thermal overload relay, main circuit breaker disconnect, control circuit transformer and ASD-Bypass switch.
2. The operator shall have full control of the bypass starter by operation of the ASD-Bypass selector switch.

M. Harmonic Mitigation

1. Each drive shall include reduced harmonics technology for harmonic mitigation of <48% THDi according to IEC/EN 61000-3-12 at 80-100% load
2. Drives shall have certified THDI levels per AHRI Standard 1210 published and provided at time of submittal. AHRI VFD product directory shall provide the certified harmonic ratings.

2.2 NAMEPLATES

A. General: Precision engrave letters and numbers with uniform margins, character size minimum 3/16 inch high.

1. Phenolic: Two color laminated engraver's stock, 1/16 inch minimum thickness, machine engraved to expose inner core color (white).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install the Work of this Section in accordance with the manufacturer's installation instructions, NFPA-70, National Electrical Safety Code, state codes, local codes, and requirements of authority having jurisdiction.
B. All electrical work required in the Mechanical Contract shall conform to the applicable requirements of Division 26 of these Specifications.
C. Equipment shall be connected in a neat and skillful manner. Equipment delivered with terminal boxes that are inadequate shall be equipped with special boxes that suit the conditions by the Mechanical Contractor furnishing the equipment.
D. Rigid conduit or tubing shall be used unless equipment requires movement or would transmit vibration to conduit. Such equipment shall be wired with flexible, steel conduit not more than 18-inches long.
E. Control Wiring:

1. Provide control wiring and connections.
2. Where control circuit interlocking is required between individually mounted motor controllers, provide a single pole on off switch in a threaded type box mounted adjacent to motor safety switches which are remote from the control transformer to enable interlock circuit to be opened when the motor safety switch is opened.

F. Nameplates: Identify each remote control station, indicating the motor controlled. Identify each interlock switch, indicating purpose of switch:

1. NEMA 1 Enclosures: Rivet or bolt nameplate to the cover.
2. NEMA 3R: Attach nameplates to the cover using adhesive specifically designed for the purpose, or mount nameplate on wall or other conspicuous location adjacent to switch. Do not penetrate enclosure with fasteners.

3.2 FIELD QUALITY CONTROL

A. Adjustable Speed Drives: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Tests and Inspections for ASDs:

1. Test insulation resistance for each ASD element, component, connecting motor supply, feeder, and control circuit.
2. Test continuity of each circuit.
3. Verify that voltages at ASD locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager before starting the motor(s).
4. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
5. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Motor controllers will be considered defective if they do not pass test and inspections.

3.3 STARTUP SERVICE

A. Adjustable Speed Drives: Engage a factory-authorized representative to perform startup service. Complete installation and startup checks according to manufacturer’s written instructions.

3.4 ADJUSTING

A. For Adjustable Speed Drives:

1. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
2. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
3. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or

11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager before increasing settings.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain ASDs.

3.6 MOTOR CONTROLLER SCHEDULE

A. Types of Motor Controllers Required For Variable Speed Applications:

1. Three Phase Premises Wiring System:
   a. Three Phase Motors 1 to 800 hp: Adjustable speed drive as specified.

END OF SECTION 230514

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sleeves
2. Stack-sleeve fittings
3. Sleeve-seal systems
4. Grout

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 STACK-SLEEVE FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Jay R. Smith Mfg. Co; a division of Morris Group International
2. Zurn Industries, LLC

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide product by one of the following:

1. Presealed Systems.

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
B. Characteristics: Nonshrink; recommended for interior and exterior applications.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

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

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
C. Secure nailing flanges to concrete forms.
D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Concrete Slabs-on-Grade:

   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs above Grade:

   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
   b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

3. Interior Partitions:

   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.

   b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 230517

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished, chrome-plated finish and spring-clip fasteners.
B. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
C. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

2.2 FLOOR PLATES

A. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
   b. Insulated Piping: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
   c. Bare Piping in Unfinished Service Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
   d. Bare Piping in Equipment Rooms: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping : Split floor plate.

3.2 FIELD QUALITY CONTROL

A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 230518

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Liquid-in-glass thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.
5. Test plugs.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Flo Fab Inc.
   b. Tel-Tru Manufacturing Company.
   c. Weiss Instruments, Inc.
2. Standard: ASME B40.200.

3. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.
   a. Design for Air-Duct Installation: With ventilated shroud.
   b. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 DIAL-TYPE PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Flo Fab Inc.
   b. Tel-Tru Manufacturing Company.
   c. Weiss Instruments, Inc.
2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 6-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.

8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston -type surge-dampening device. Include extension for use on insulated piping.
B. Siphons: Loop-shaped section of stainless-steel pipe with NPS 1/4 or NPS 1/2 pipe threads.
C. Valves: Brass or stainless-steel needle, with NPS 1/4 NPS 1/2, ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

A. Description: Test-station fitting made for insertion in piping tee fitting.
B. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
C. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
D. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
E. Core Inserts: Chlorosulfonated polyethylene synthetic self-sealing rubber.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
C. Install thermowells with extension on insulated piping.
D. Fill thermowells with heat-transfer medium.
E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
G. Install valve and snubber in piping for each pressure gage for fluids (except steam).

H. Install test plugs in piping tees.
I. Install flow indicators in piping systems in accessible positions for easy viewing.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow space for service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.
B. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 230519

SECTION 230523.12 - BALL VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

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

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
3. ASME B16.18 for solder-joint connections.
4. ASME B31.1 for power piping valves.
5. ASME B31.9 for building services piping valves.

C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
D. Refer to HVAC valve schedule articles for applications of valves.
E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
F. Valve Sizes: Same as upstream piping unless otherwise indicated.
G. Valve Actuator Types:

1. Handlever: For quarter-turn valves smaller than NPS 4.

H. Valves in Insulated Piping:

1. Include 2-inch stem extensions.
2. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

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

2.2 BRASS BALL VALVES

A. Brass Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim, Threaded Ends:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Crane; a Crane brand.
   b. Hammond Valve.
   c. Milwaukee Valve Company.
2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.3 BRONZE BALL VALVES

A. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   b. Crane; a Crane brand.
   c. Milwaukee Valve Company.
2. Description:
   a. Standard: MSS SP-110.
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE.
   h. Stem: Stainless steel.
   i. Ball: Stainless steel, vented.
   j. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
C. Examine threads on valve and mating pipe for form and cleanliness.
D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
B. Locate valves for easy access and provide separate support where necessary.
C. Install valves in horizontal piping with stem at or above center of pipe.
D. Install valves in position to allow full stem movement.
E. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.
B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.4 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: Brass or bronze ball valves, two piece with trim, full port, solder -joint ends.

END OF SECTION 230523.12

SECTION 230523.13 - BUTTERFLY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. High-performance butterfly valves.
2. Chainwheels.

1.3 DEFINITIONS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set butterfly valves closed or slightly open.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

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

1. ASME B16.1 for flanges on iron valves.
2. ASME B16.5 for pipe flanges and flanged fittings, NPS 1/2 through NPS 24.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B31.1 for power piping valves.
5. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
E. Valve Sizes: Same as upstream piping unless otherwise indicated.
F. Valve Actuator Types:

1. Gear Actuator: For valves NPS 8 and larger.
2. Handlever: For valves NPS 6 and smaller.
3. Chainwheel: Device for attachment to gear, stem, or other actuator of size and with chain for mounting height, according to "Valve Installation" Article.

G. Valves in Insulated Piping: With 2-inch stem extensions with extended necks.

2.2 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Single-Flange, High-Performance Butterfly Valves, Class 150:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   b. Hammond Valve.
   c. Milwaukee Valve Company.
2. Description:
   a. Standard: MSS SP-68.
   b. CWP Rating: 285 psig at 100 deg F.

c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
e. Seat: Reinforced PTFE or metal.
f. Stem: Stainless steel; offset from seat plane.
g. Disc: Carbon steel.
h. Service: Bidirectional.

2.3 CHAINWHEELS

A. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to hand wheels.

1. Sprocket Rim with Chain Guides: Ductile or cast iron, of type and size required for valve.
2. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
C. Examine mating flange faces for damage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
D. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
B. Locate valves for easy access and provide separate support where necessary.
C. Install valves in horizontal piping with stem at or above center of pipe.
D. Install valves in position to allow full stem movement.
E. Install chainwheels on operators for butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:

1. High-Performance Butterfly Valves: Single flange, Class 150.

END OF SECTION 230523.13

SECTION 230523.14 - CHECK VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Bronze swing check valves.
2. Iron swing check valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

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

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder joint.

C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
E. Valve Sizes: Same as upstream piping unless otherwise indicated.
F. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves with Bronze Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   b. Milwaukee Valve Company.
   c. NIBCO INC.
2. Description:
   a. Standard: MSS SP-80, Type 3.
   b. CWP Rating: 200 psig.
   c. Body Design: Horizontal flow.
   d. Body Material: ASTM B 62, bronze.
   e. Ends: Threaded.
   f. Disc: Bronze.

2.3 IRON SWING CHECK VALVES

A. Iron Swing Check Valves with Nonmetallic-to-Metal Seats, Class 125:

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

a. APCO DeZurik Valve Co.
b. Crane Valves; a Crane Co. brand.
c. KITZ Corporation.

2. Description:
   a. Standard: MSS SP-71, Type I.
   b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
   c. NPS 14 to NPS 24, CWP Rating: 150 psig.
   d. Body Design: Clear or full waterway.
   e. Body Material: ASTM A 126, gray iron with bolted bonnet.
   f. Ends: Flanged.
   g. Trim: Composition.
   h. Seat Ring: Bronze.
   i. Disc Holder: Bronze.
   j. Disc: PTFE.
   k. Gasket: Asbestos free.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
C. Examine threads on valve and mating pipe for form and cleanliness.
D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
B. Locate valves for easy access and provide separate support where necessary.
C. Install valves in horizontal piping with stem at or above center of pipe.
D. Install valves in position to allow full stem movement.

E. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

F. Install valve tags. Comply with requirements for valve tags and schedules in Section 230553 "Identification for HVAC Piping and Equipment."

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.
B. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze swing check valves with bronze disc, Class 125.

B. Pipe NPS 2-1/2 and Larger:

1. NPS 2-1/2 to NPS 4: Iron valves may be provided with threaded ends instead of flanged ends.
2. Iron swing check valves with nonmetallic-to-metal seats, Class 125.

END OF SECTION 230523.14

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Equipment stands.
6. Equipment supports.

B. Related Requirements:

1. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
2. Section 230548.13 "Vibration Controls for HVAC" for vibration isolation devices.
3. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Equipment supports.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-plated steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psi minimum compressive strength and vapor barrier.
B. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psi minimum compressive strength.
C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Indoor Applications: Zinc-coated or stainless steel.
2. Outdoor Applications: Stainless steel.

2.6 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.7 MATERIALS

A. Aluminum: ASTM B221.
B. Carbon Steel: ASTM A1011/A1011M.
C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.
D. Stainless Steel: ASTM A240/A240M.
E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.
F. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

    1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
    2. Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems.
D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
E. Fastener System Installation:

    1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
I. Install lateral bracing with pipe hangers and supports to prevent swaying.
J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
M. Insulated Piping:

    1. Attach clamps and spacers to piping.
        a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

    1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Section 099113 "Exterior Painting" Section 099123 "Interior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and attachments for general service applications.
F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
G. Use padded hangers for piping that is subject to scratching.
H. Use thermal-hanger shield inserts for insulated piping and tubing.
I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

    1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.

2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
3. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
4. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
5. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
6. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
7. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
8. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is unnecessary.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 lb.
   b. Medium (MSS Type 32): 1500 lb.
   c. Heavy (MSS Type 33): 3000 lb.
8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

10. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

O. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230548.13 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Rubber-in-shear isolators.
2. Steel spring isolators
3. Integral structural steel or rail type bases.
4. Concrete inertia blocks.
5. Vibration isolation bases.
6. Combination rubber and spring isolators.
7. Pad type isolators.

1.3 DEFINITIONS

A. IBC: International Building Code.
B. Ground Floor: Floor or floor slab of building that rests directly on earth.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Catalog sheets, specifications, and installation instructions.
2. Vibration isolator schedule showing usage.

B. Shop Drawings:

1. Details of intermediate structural steel members and method of attachment required for installation of vibration isolating devices.
2. Design Calculations: Calculations for selection of vibration isolators, design of vibration isolation bases, and selection of seismic restraints.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints.
B. Welding certificates.
C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 RUBBER-IN-SHEAR ISOLATORS

A. Provide molded mound shaped rubber or neoprene elements designed to provide the required deflection under imposed load. Furnish isolators properly housed, with steel top plate and base plate completely imbedded in rubber or neoprene, for bolting to equipment and foundations, of type as follows:

1. Single Rubber-In-Shear: Single element designed for static deflection of 1/4 inch.
   a. Basis of design: Subject to compliance with requirements, provide Kinetics Noise Control, Inc., Model RD or comparable product.
2. Double Rubber-In-Shear: Two single elements assembled in series, to provide for a static deflection of 1/2 inch.
   a. Basis of design: Subject to compliance with requirements, provide Kinetics Noise Control, Inc., Model RD or comparable product.

2.2 STEEL SPRING ISOLATORS

A. Types:

1. Floor Free Standing Springs: Provide laterally stable units, without housing, with a minimum 1/4 inch thick rubber or neoprene sound deadening pad between spring and its support. Use for isolating equipment having a static deflection in excess of 1 inch, unless otherwise indicated.
   a. Basis of design: Subject to compliance with requirements, provide Kinetics Noise Control, Inc., Model FDS or comparable product.

2. Housed Springs: Provide units with telescoping cast iron or steel housings, containing one or more springs, complete with resilient alignment inserts and a minimum 1/4 inch thick rubber or neoprene sound deadening pad bonded to the base of housing.
   a. Basis of design: Subject to compliance with requirements, provide Kinetics Noise Control, Inc., Model FLS or comparable product.

B. Construction Features Required:

1. Provide limit stops for spring isolators with deflections of 2 inch or more so as to prevent undue motion during start and stop, but unrestrained movement during normal operation.
2. Hot dip galvanize all steel parts of isolators for outdoor use, with the exception of springs. Cadmium plate or neoprene coat springs.
3. Do not use isolator leveling bolts for jacking screws.

2.3 INTEGRAL STRUCTURAL STEEL OR RAIL TYPE BASES

A. Provide bases, factory fabricated from structural steel members of sufficient rigidity to maintain drive alignment and resist starting torque, without the use of restraining snubber devices. Provide bases complete with rubber-in-shear or spring type isolators, as specified for the particular equipment.

1. Basis of design: Subject to compliance with requirements, provide Kinetics Noise Control, Inc., Model SBB or SFB or comparable products.

2.4 CONCRETE INTERTIA BLOCKS

A. Type: Factory fabricated welded structural steel pouring frames with the following:

1. Basis of design: Subject to compliance with requirements, provide Kinetics Noise Control, Inc., Model CIB-L or CIB-H or comparable products.
2. Sheet metal casing a minimum of 6 inches deep.
3. Integral steel reinforcing rods on 9 inch centers in both directions, welded to steel frame;
4. Height saving mounting lugs with spring isolators designed to provide the required deflection and efficiency.

B. Configure bases to accommodate supported equipment.

1. Provide bases for isolating pumps of physical size and shape as required to accommodate base elbow supports. Provide mounting templates.

2.5 VIBRATION ISOLATION BASES

A. Type: Factory fabricated welded structural steel (ASTM A36) bases and rails with the following:

1. Support brackets to anchor base to vibration isolation.
2. Pre-located equipment anchor bolts.
3. Auxiliary motor slide bases or rails.
4. Steel angles welded to frame for outrigger isolation mountings.
5. Factory Finish: Corrosive resistant finish.

B. Design bases to result in lowest possible mounting height with not less than one inch clearance above housekeeping pad or floor.
C. Configure bases to accommodate supported equipment.

1. Provide bases for isolating pumps of physical size and shape as required to accommodate base elbow supports. Provide mounting templates.

2.6 COMBINATION RUBBER AND SPRING ISOLATORS

A. Type: Combination rubber and spring type designed for insertion in a split hanger rod for isolating equipment from the overhead construction.

1. Basis of design: Subject to compliance with requirements, provide Kinetics Noise Control, Inc., Model SRH or comparable product.

2.7 PAD TYPE ISOLATORS

A. Provide neoprene or rubber mountings, corrugated or waffle faced both sides, single or double layered or laminated, of size and thickness as required for the particular equipment.

1. Basis of design: Subject to compliance with requirements, provide Kinetics Noise Control, Inc., Model KNC or comparable product.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

A. Provide vibration isolators or vibration isolation bases for mechanical equipment and piping as specified.
B. Select isolation devices for uniform static deflection, in accordance with the distribution of weight and forces.

1. Whenever rotational speed is the cause of disturbing frequency, utilize the lowest operating speed of the equipment in determining the type of isolation required.
2. Selection shall result in uniform loading and deflection, even when equipment weight is not evenly distributed.

3. Select springs for a total deflection greater than the selected static deflection, to provide an adequate safety factor.

C. Isolate floor mounted fan units, air handling units and self-contained air conditioning units to obtain the following efficiencies:

RPM	MIN. DEFLECTION	EFFICIENCY
Up to 325	3.5	80
326 to 525	2.0	80-90
526 to 575	1.5	90
576 to 1000	1.25	90-95
1001 to 1200	.75	95
1201 and over	.50	95

3.3 VIBRATION ISOLATION SCHEDULE

A. Air Handling Units:

1. Air handling units, located above the ground floor and not ceiling mounted or suspended:
   a. Provide an integral structural steel base with a common steel member running the full length of the fan and motor, with built-in motor slide rails, so as to form a common support for fan unit and motor, with spring type isolators, unless otherwise indicated.
   b. Provide spring unit isolators, or steel rail type isolator bases with spring type isolators, for floor mounted units with motors mounted on the casings or frames.
2. Air handling units, located on the ground floor:
   a. Provide spring unit isolators or steel rail type isolator bases.
3. Air handling units, ceiling suspended: Provide combination rubber and spring type isolators, designed for insertion in a split hanger rod. Provide isolators with an efficiency as specified above, with no deflection greater than 1-1/2 inches required.

B. Pumps; In-line:

1. Provide housed type spring isolators designed for a minimum 3/4 static deflection.

C. Remote Installed Refrigerant Compressor Units:

1. Provide integral structural steel or rail type bases with built-in, metal housed, rubber-in-shear unit isolators, permanently fixed in place and provided with adjustable snubber devices. Provide rail bases on Ground Floor designed for 1/4 inch static deflection and above Ground Floor 1/2 inch static deflection.

D. Pipes:

1. Hot water piping connected to isolated equipment shall be isolated as follows:
   a. NPS 4 and smaller: First three points of support.
   b. NPS 5 to NPS 8: First four points of support.
2. Deflection shall be not less than that for the equipment to which the piping is connected.

3.4 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT

A. General:

1. Locations of all vibration isolation devices shall be selected for ease of inspection and adjustment and for proper operation.
2. Installation of vibration isolation equipment shall be in accordance with the manufacturer's installation instructions.

B. Isolators:

1. All vibration isolators shall be aligned squarely above or below mounting points of the supported equipment.
2. Isolators for equipment with bases shall be located on the sides of the bases which are parallel to the equipment shaft unless this is not possible because of physical constraints.
3. Locate isolators to provide stable support for equipment without excess rocking. Consideration shall be given to the location of the center of gravity of the system and the location and spacing of the isolators. If necessary, provide a base with suitable footprint to maintain stability of supported equipment.
4. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plates shall rest entirely on the pad.
5. Hanger rods for vibration-isolated support shall be connected to structural beams or joists, not the floor slab between beams and joists. Provide suitable intermediate support members as required.
6. Vibration isolation hanger elements shall be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360° about the rod axis without contacting any object.
7. When allowed per Section 230259, "Hangers and Supports for Piping and Equipment," parallel running pipes may be hung together on a trapeze that is isolated from the building. Isolator deflections must be the greatest required by the provisions for pipe isolation for any single pipe on the trapeze. Do not mix isolated and un-isolated pipes on the same trapeze.
8. Pipes, ducts and equipment shall not be supported from other pipes, ducts and equipment.
9. Resiliently isolated pipes, ducts and equipment shall not come in rigid contact with the building construction or rigidly supported equipment.
10. Adjust all leveling bolts and hanger rod bolts so that the isolated equipment is level and in proper alignment with connecting ducts or pipes.

C. Bases:

1. Equipment shall not bear directly on vibration isolators unless its own frame is suitably rigid to span between isolators and such direct support is approved by the equipment manufacturer. This provision shall apply whether or not a base frame is called for on the schedule. In the case that a base frame is required for the unit because of the equipment manufacturer's requirements, and is not specifically called for on the equipment schedule, a base frame recommended by the equipment manufacturer shall be provided at no additional expense.

2. Unless otherwise indicated, there is to be a minimum operating clearance of 1 in. between steel rails, steel frame base or inertia bases and the floor beneath the equipment. The isolator mounting brackets shall be positioned and the isolators adjusted so that the required clearance is maintained. The clearance space shall be checked by the Contractor to ensure that no construction debris has been left to short circuit or restrict the proper operation of the vibration isolation system.

3.5 ADJUSTING

A. Adjust isolators after system is at operating weight.
B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
B. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.

C. Remove and replace malfunctioning units and retest as specified above.
D. Prepare test and inspection reports.

END OF SECTION 230548.13

SECTION 230550 – WIND RESTRAINT FOR HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Support and brace roof mounted mechanical and electrical systems, to resist directional wind forces (lateral, longitudinal and vertical).

1.3 APPLICABLE CODES AND STANDARDS

A. Provide work in compliance with the following codes and standards:

1. 2020 Buildings Code of New York State (Section 1609).
2. 2020 Mechanical Code of New York State (Section 301, Item 301.15).
3. American Society of Civil Engineers (ASCE) Minimum Design Loads for Buildings and Other Structures with Supplement No. 1 – Standard ASCE/SEI 7-16.

1.4 QUALITY ASSURANCE

A. General:

1. The contractor shall provide Professional Engineer stamped and signed engineering calculations and details of wind restraint systems to meet total design later force requirements for support and restraint of mechanical systems.
2. The wind restraint engineering calculations shall provide the quantity of attachments and size/type of attachments for the mounting of an equipment curb or support rail to the building structure, and for attachment of the equipment or system to the equipment curb or support rail.
3. Systems requiring wind restraint:
    a. Condensing units.
    b. Exhaust fans.
    c. Louvered intake or relief penthouses.
    d. Intake or relief gravity ventilators.
    e. Refrigerant piping.
    f. Boiler flues.

1.5 SUBMITTALS

A. Submit wind force level (Fp) calculations from applicable building code. Submit pre-approved restraint selections, installation details, and plans indicating locations of restraints.
B. Calculations, plans, restraint selection, and installation details shall be stamped and signed by a professionally licensed engineer experienced in wind restraint design.
C. Submit manufacturer's product data.
D. For each piece of equipment that requires wind restraint as outlined in this section, include the following:

1. Dimensioned Outline Drawings of Equipment Unit: Identify the center of gravity and locate and describe mounting and anchoring provisions.
2. Anchorage: Provide detailed description of equipment anchorage devices on which the calculations are based and their installation requirements. Identify anchor bolts, studs and other mounting devices. Provide information on the size, type and spacing of mounting brackets, holes and other provisions.

PART 2 - PRODUCTS

2.1 CODE INFORMATION

A. This project is subject to the wind bracing requirements of the codes listed above. The following criteria are applicable to this project:

1. Basic Design Wind Speed (V): 117 mph
2. Risk Category: III
3. Exposure Category: B
4. Height and Exposure Adjustment Coefficient: N/A – Building height is less than 60 ft.

2.2 WIND BRACING AND SUPPORT OF SYSTEMS AND COMPONENTS

A. General:

1. Design analysis shall include calculated dead loads, wind loads, and capacity of materials utilized for the connection of the equipment or system to the structure.
2. Analysis shall detail anchoring methods, bolt diameter, and embedment depth.
3. All wind restraint devices shall be designed to accept without failure the forces calculated per the applicable building code and as summarized in Section 2.1.

B. Friction from gravity loads shall not be considered resistance to wind forces.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wind Restraint of Piping:

1. All restraint systems shall be installed in strict accordance with the wind restraint design submittal.
2. Installation of restraints shall not cause and change in position of equipment or piping, resulting in stresses or misalignment.

B. Wind Restraint of Ductwork and Equipment:

1. All restraint systems shall be installed in strict accordance with the wind restrain restraint design submittal.
2. The interaction between mechanical and electrical equipment and the supporting structures shall be designed into the restraint systems.
3. Installation of restraints shall not cause any change in position of equipment or ductwork, resulting in stresses or misalignment.
4. No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system specified.
5. Do not install any equipment or duct that makes rigid connections with the building unless isolation is not specified.
6. Prior to installation, bring to the Architect's/Engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.

END OF SECTION 230550

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Duct labels.
4. Valve tags.
5. Ceiling labels.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
C. Valve-numbering scheme.
D. Valve Schedules: Provide for each piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
2. Letter and Background Color: As indicated for specific application under Part 3.
3. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.
B. Letter and Background Color: As indicated for specific application under Part 3.
C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to circumference of pipe and to attach to pipe without fasteners or adhesive.
D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:

    1. Flow-Direction Arrows: Include flow-direction arrows on distribution piping. Arrows may be either integral with label or applied separately.
    2. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

2.3 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
B. Letter and Background Color: As indicated for specific application under Part 3.
C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
F. Fasteners: Stainless steel rivets or self-tapping screws.
G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
H. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings. Also include the following:

    1. Flow-Direction Arrows: Include flow-direction arrows on main distribution ducts. Arrows may be either integral with label or may be applied separately.
    2. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

2.4 VALVE TAGS

A. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.04-inch or minimum thickness, with predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass link chain or beaded chain or S-hook.

B. Letter and Background Color: As indicated for specific application under Part 3.

C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Include valve-tag schedule in operation and maintenance data.
2. Provide valve schedule in mechanical room. Valve schedule shall be printed on one or more 8-1/2- by-11-inch bond paper and framed in one or more metal frames with glass cover. Provide number of frames to accommodate all control valves as specified.

2.5 CEILING LABELS

A. Description: Machine printed self-adhesive labels on clear thermoplastic with black 1/4-inch high lettering and arrow pointing toward device location above ceiling.

B. Labels will be required for the following devices:
1. Fire Dampers and Fire/Smoke Dampers: Identify damper type (Fire or Fire/Smoke)

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on major mechanical equipment. This shall include at a minimum all air handling units, rooftop units, VAV Boxes, condensing units, boilers, and pumps.
B. Sign and Label Colors:

1. White letters on an ANSI Z535.1 safety-blue background.

C. Locate equipment labels where accessible and visible.

3.4 INSTALLATION OF PIPE LABELS

A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.
B. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.
D. Flow-Direction Arrows: Use arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
E. Pipe-Label Color Schedule:

1. Heating Water Piping: White letters on an ANSI Z535.1 safety-green background.
2. Refrigerant Piping: White letters on an ANSI Z535.1 safety-blue background.

3.5 INSTALLATION OF DUCT LABELS

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For cold-air supply ducts.
2. Yellow: For hot-air supply ducts.

3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

A. Locate label near each point where ducts enter into and exit from concealed spaces and at maximum intervals of 50 ft. where exposed or are concealed by removable ceiling system.

3.6 INSTALLATION OF VALVE TAGS

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below.

1. Valve-Tag Size and Shape:
   a. Hot Water: 2 inches, round.
2. Valve-Tag Colors:
   a. Black letters on natural brass background.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Testing, Adjusting, and Balancing of Air Systems:
   a. Constant-volume air systems.
   b. Variable-air-volume systems.
2. Testing, Adjusting, and Balancing of Hydronic Piping Systems:
   a. Variable-flow hydronic systems.
   b. Primary-secondary hydronic systems.
3. Testing, adjusting, and balancing of equipment.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.
B. NEBB: National Environmental Balancing Bureau.
C. TAB: Testing, adjusting, and balancing.
D. TABB: Testing, Adjusting, and Balancing Bureau.
E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
F. TDH: Total dynamic head.
G. UFAD: Underfloor air distribution.

1.4 PREINSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference at after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:
   a. The Contract Documents examination report.
   b. The TAB plan.

c. Needs for coordination and cooperation of trades and subcontractors.
d. Proposed procedures for documentation and communication flow.

1.5 INFORMATIONAL SUBMITTALS

A. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.
B. Certified TAB reports.
C. Sample report forms.
D. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.6 QUALITY ASSURANCE

A. TAB Specialists Qualifications, Certified by NEBB or TABB:

1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."
D. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.7 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
C. Examine the approved submittals for HVAC systems and equipment.
D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
E. Examine ceiling plenums and underfloor air plenums used for HVAC to verify that they are properly separated from adjacent areas and sealed.
F. Examine equipment performance data, including fan and pump curves.

    1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
    2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
H. Examine test reports specified in individual system and equipment Sections.
I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
K. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainer baskets are installed and clean.

L. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.
M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
N. Examine system pumps to ensure absence of entrained air in the suction piping.
O. Examine operating safety interlocks and controls on HVAC equipment.
P. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.
Q. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:
   a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
   b. Duct systems are complete with terminals installed.
   c. Volume, smoke, and fire dampers are open and functional.
   d. Clean filters are installed.
   e. Fans are operating, free of vibration, and rotating in correct direction.
   f. Variable-frequency controllers' startup is complete and safeties are verified.
   g. Automatic temperature-control systems are operational.
   h. Ceilings are installed.
   i. Windows and doors are installed.
   j. Suitable access to balancing devices and equipment is provided.
2. Hydronics:
   a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
   b. Piping is complete with terminals installed.
   c. Water treatment is complete.
   d. Systems are flushed, filled, and air purged.
   e. Strainers are pulled and cleaned.
   f. Control valves are functioning in accordance with the sequence of operation.
   g. Shutoff and balance valves have been verified to be 100 percent open.
   h. Pumps are started and proper rotation is verified.

i. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
j. Variable-frequency controllers' startup is complete and safeties are verified.
k. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance" ASHRAE 111 NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
B. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. Where holes for probes are required in piping or hydronic equipment, install pressure and temperature test plugs to seal systems.
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
D. Take and report testing and balancing measurements in units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
B. Prepare schematic diagrams of systems' Record drawings duct layouts.
C. For variable-air-volume systems, develop a plan to simulate diversity.
D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.
I. Check for airflow blockages.
J. Check condensate drains for proper connections and functioning.
K. Check for proper sealing of air-handling-unit components.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.
   a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
   b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
   c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
2. Measure fan static pressures as follows:
   a. Measure static pressure directly at the fan outlet or through the flexible connection.
   b. Measure static pressure directly at the fan inlet or through the flexible connection.
   c. Measure static pressure across each component that makes up the air-handling system.
   d. Report artificial loading of filters at the time static pressures are measured.
3. Review Contractor-prepared shop drawings and Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from Construction Manager for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.

2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
    a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
    b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
    c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
    d. Adjust controls so that terminal is calling for minimum airflow.
    e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
    f. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.

b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow, so that connected total matches fan selection and simulates actual load in the building.
c. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
d. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

6. Measure fan static pressures as follows:
   a. Measure static pressure directly at the fan outlet or through the flexible connection.
   b. Measure static pressure directly at the fan inlet or through the flexible connection.
   c. Measure static pressure across each component that makes up the air-handling system.
   d. Report any artificial loading of filters at the time static pressures are measured.
7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
   a. Balance the return-air ducts and inlets.
   b. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit, and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls Contractor.
9. Verify final system conditions as follows:
   a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
   b. Re-measure and confirm that total airflow is within design.
   c. Re-measure final fan operating data, speed, volts, amps, and static profile.
   d. Mark final settings.
   e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
   f. Verify tracking between supply and return fans.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and equipment flow rates with pump design flow rate.
B. Prepare schematic diagrams of systems' Record drawings piping layouts.
C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:

1. Check expansion tank for proper setting.
2. Check highest vent for adequate pressure.
3. Check flow-control valves for proper position.
4. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
5. Verify that motor controllers are equipped with properly sized thermal protection.
6. Check that air has been purged from the system.

D. Measure and record upstream and downstream pressure of each piece of equipment.

E. Measure and record upstream and downstream pressure of pressure-reducing valves.
F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

1. Check settings and operation of each safety valve. Record settings.

3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.
B. Adjust the variable-flow hydronic system as follows:

1. Verify that the pressure-differential sensor(s) is located as indicated.
2. Determine whether there is diversity in the system.

C. For systems with no flow diversity:

1. Adjust pumps to deliver total design flow.
    a. Measure total water flow.
        1) Position valves for full flow through coils.
        2) Measure flow by main flow meter, if installed.
        3) If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
    b. Measure pump TDH as follows:
        1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
        2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
        3) Convert pressure to head and correct for differences in gauge heights.
        4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
        5) With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.
    c. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
2. Adjust flow-measuring devices installed in mains and branches to design water flows.
    a. Measure flow in main and branch pipes.
    b. Adjust main and branch balance valves for design flow.
    c. Re-measure each main and branch after all have been adjusted.
3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
    a. Measure flow at terminals.
    b. Adjust each terminal to design flow.
    c. Re-measure each terminal after it is adjusted.

d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
e. Perform temperature tests after flows have been balanced.

4. For systems with pressure-independent valves at terminals:
   a. Measure differential pressure and verify that it is within manufacturer's specified range.
   b. Perform temperature tests after flows have been verified.
5. For systems without pressure-independent valves or flow-measuring devices at terminals:
   a. Measure and balance coils by either coil pressure drop or temperature method.
   b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
6. Prior to verifying final system conditions, determine the system pressure-differential set point(s).
7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion, open discharge valve 100 percent, and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
8. Mark final settings and verify that all memory stops have been set.
9. Verify final system conditions as follows:
   a. Re-measure and confirm that total flow is within design.
   b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
   c. Mark final settings.

D. For systems with flow diversity:

1. Determine diversity factor.
2. Simulate system diversity by closing required number of control valves, as approved by Architect.
3. Adjust pumps to deliver total design flow.
   a. Measure total water flow.
      1) Position valves for full flow through coils.
      2) Measure flow by main flow meter, if installed.
      3) If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
   b. Measure pump TDH as follows:
      1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
      2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
      3) Convert pressure to head and correct for differences in gauge heights.
      4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
      5) With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.
   c. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
4. Adjust flow-measuring devices installed in mains and branches to design water flows.

a. Measure flow in main and branch pipes.
b. Adjust main and branch balance valves for design flow.
c. Re-measure each main and branch after all have been adjusted.

5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
   a. Measure flow at terminals.
   b. Adjust each terminal to design flow.
   c. Re-measure each terminal after it is adjusted.
   d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
   e. Perform temperature tests after flows have been balanced.
6. For systems with pressure-independent valves at terminals:
   a. Measure differential pressure, and verify that it is within manufacturer's specified range.
   b. Perform temperature tests after flows have been verified.
7. For systems without pressure-independent valves or flow-measuring devices at terminals:
   a. Measure and balance coils by either coil pressure drop or temperature method.
   b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system pressure-differential set point(s).
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion, open discharge valve 100 percent, and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:
    a. Re-measure and confirm that total water flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
    c. Mark final settings.

3.9 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first.
B. Balance the secondary circuits after the primary circuits are complete.
C. Adjust pumps to deliver total design flow.

1. Measure total water flow.
   a. Position valves for full flow through coils.
   b. Measure flow by main flow meter, if installed.
   c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
2. Measure pump TDH as follows:
   a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.

b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
c. Convert pressure to head and correct for differences in gauge heights.
d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
e. With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.

3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

D. Adjust flow-measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

E. Adjust flow-measuring devices installed at terminals for each space to design water flows.

1. Measure flow at terminals.
2. Adjust each terminal to design flow.
3. Re-measure each terminal after it is adjusted.
4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
5. Perform temperature tests after flows have been balanced.

F. For systems with pressure-independent valves at terminals:

1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

G. For systems without pressure-independent valves or flow-measuring devices at terminals:

1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

H. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
3. Mark final settings.

I. Verify that memory stops have been set.

3.10 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.11 PROCEDURES FOR AIR-COOLED CONDENSING UNITS

A. Verify proper rotation of fan(s).
B. Measure and record entering- and leaving-air temperatures.
C. Measure and record entering and leaving refrigerant pressures.
D. Measure and record operating data of compressor(s), fan(s), and motors.

3.12 PROCEDURES FOR BOILERS

A. Hydronic Boilers:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Measure and record pressure drop.

B. Boilers with Flue Gas Economizers:

1. Measure and record entering- and leaving-water temperature.
2. Measure and record water flow rate.
3. Measure and record water pressure drop.
4. Heat Recovered: Calculate in Btu/h of waste heat recovered.

3.13 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each hydronic coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Air pressure drop.
5. Voltage and amperage input of each phase at full load.
6. Calculated kilowatt at full load.
7. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Entering and leaving refrigerant pressure and temperatures.

3.14 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Zero to plus 10 percent. If design value is less than 100 cfm, within 10 cfm.
2. Air Outlets and Inlets: Plus or minus 10 percent. If design value is less than 100 cfm, within 10 cfm.
3. Heating-Water Flow Rate: Plus or minus 10 percent. If design value is less than 10 gpm, within 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.15 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance-measuring and -balancing devices.

B. Status Reports: Prepare monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in

systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.16 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents, including the following:
    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans performance forms, including the following:
    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Heating coil, dry-bulb conditions.
    e. Face and bypass damper settings at coils.
    f. Fan drive settings, including settings and percentage of maximum pitch diameter.

g. Variable-frequency controller settings for variable-air-volume systems.
h. Settings for pressure controller(s).
i. Other system operating conditions that affect performance.

16. Test conditions for pump performance forms, including the following:
    a. Variable-frequency controller settings for variable-flow hydronic systems.
    b. Settings for pressure controller(s).
    c. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units, include the following:

1. Unit Data:
    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches, and bore.
    i. Center-to-center dimensions of sheave and amount of adjustments in inches.
    j. Number, make, and size of belts.
    k. Number, type, and size of filters.
2. Motor Data:
    a. Motor make, and frame type and size.
    b. Horsepower and speed.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Center-to-center dimensions of sheave and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan speed.
    d. Inlet and discharge static pressure in inches wg.
    e. For each filter bank, filter static-pressure differential in inches wg.
    f. Preheat-coil static-pressure differential in inches wg.
    g. Cooling-coil static-pressure differential in inches wg.
    h. Heating-coil static-pressure differential in inches wg.
    i. List for each internal component with pressure-drop, static-pressure differential in inches wg.

j. Outdoor airflow in cfm.
k. Return airflow in cfm.
l. Outdoor-air damper position.
m. Return-air damper position.
n. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:
   a. System identification.
   b. Location.
   c. Coil type.
   d. Number of rows.
   e. Fin spacing in fins per inch o.c.
   f. Make and model number.
   g. Face area in sq. ft.
   h. Tube size in NPS.
   i. Tube and fin materials.
   j. Circuiting arrangement.
2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Average face velocity in fpm.
   c. Air pressure drop in inches wg.
   d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
   e. Return-air, wet- and dry-bulb temperatures in deg F.
   f. Entering-air, wet- and dry-bulb temperatures in deg F.
   g. Leaving-air, wet- and dry-bulb temperatures in deg F.
   h. Water flow rate in gpm.
   i. Water pressure differential in feet of head or psig.
   j. Entering-water temperature in deg F.
   k. Leaving-water temperature in deg F.
   l. Refrigerant expansion valve and refrigerant types.
   m. Refrigerant suction pressure in psig.
   n. Refrigerant suction temperature in deg F.

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:
   a. System identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer's serial number.
   f. Fuel type in input data.
   g. Output capacity in Btu/h.
   h. Ignition type.
   i. Burner-control types.
   j. Motor horsepower and speed.
   k. Motor volts, phase, and hertz.
   l. Motor full-load amperage and service factor.

m. Sheave make, size in inches, and bore.
n. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Entering-air temperature in deg F.
   c. Leaving-air temperature in deg F.
   d. Air temperature differential in deg F.
   e. Entering-air static pressure in inches wg.
   f. Leaving-air static pressure in inches wg.
   g. Air static-pressure differential in inches wg.
   h. Low-fire fuel input in Btu/h.
   i. High-fire fuel input in Btu/h.
   j. Manifold pressure in psig.
   k. High-temperature-limit setting in deg F.
   l. Operating set point in Btu/h.
   m. Motor voltage at each connection.
   n. Motor amperage for each phase.
   o. Heating value of fuel in Btu/h.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:
   a. System identification.
   b. Location.
   c. Make and type.
   d. Model number and size.
   e. Manufacturer's serial number.
   f. Arrangement and class.
   g. Sheave make, size in inches, and bore.
   h. Center-to-center dimensions of sheave and amount of adjustments in inches.
2. Motor Data:
   a. Motor make, and frame type and size.
   b. Horsepower and speed.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Center-to-center dimensions of sheave and amount of adjustments in inches.
   g. Number, make, and size of belts.
3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan speed.
   d. Discharge static pressure in inches wg.
   e. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:
   a. System fan and air-handling-unit number.
   b. Location and zone.

c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft.
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:
   a. System and air-handling-unit identification.
   b. Location and zone.
   c. Room or riser served.
   d. Coil make and size.
   e. Flowmeter type.
2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Entering-water temperature in deg F.
   c. Leaving-water temperature in deg F.
   d. Water pressure drop in feet of head or psig.
   e. Entering-air temperature in deg F.
   f. Leaving-air temperature in deg F.

K. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Service.
   d. Make and size.
   e. Model number and serial number.
   f. Water flow rate in gpm.
   g. Water pressure differential in feet of head or psig.
   h. Required net positive suction head in feet of head or psig.
   i. Pump speed.
   j. Impeller diameter in inches.
   k. Motor make and frame size.
   l. Motor horsepower and rpm.
   m. Voltage at each connection.
   n. Amperage for each phase.
   o. Full-load amperage and service factor.
   p. Seal type.
2. Test Data (Indicated and Actual Values):
   a. Static head in feet of head or psig.
   b. Pump shutoff pressure in feet of head or psig.
   c. Actual impeller size in inches.
   d. Full-open flow rate in gpm.

e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

L. Instrument Calibration Reports:

1. Report Data:
   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
   e. Dates of calibration.

3.17 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Insulation Materials:
   a. Flexible elastomeric.
   b. Mineral fiber.
2. Insulating cements.
3. Adhesives.
4. Mastics.
5. Lagging adhesives.
6. Sealants.
7. Factory-applied jackets.
8. Field-applied jackets.
9. Tapes.
10. Securements.
11. Corner angles.

B. Related Sections:
1. Division 23 Section "Metal Ducts" for duct liners.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at pipe expansion joints for each type of insulation.
3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
4. Detail removable insulation at piping specialties, equipment connections, and access panels.
5. Detail application of field-applied jackets.
6. Detail application at linkages of control devices.

7. Detail field application for each equipment type.

C. Qualification Data: For qualified Installer.

D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

E. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
1. 'K' Value at 75 deg F mean temperature:
   a. 0.245 BTU-in/ft^2-hr-deg F (up to 1 in. wall thickness).
   b. 0.28 BTU-in/ft^2-hr-deg F (up to 1 in. wall thickness).

2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Aeroflex USA Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. 'K' Value at 75 deg F mean temperature: 0.27 BTU-in/ft^2-hr-deg F
2. Maximum Service Temperature: 250 degF

3. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. CertainTeed Corp.; Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Duct Wrap.
   d. Manson Insulation Inc.; Alley Wrap.
   e. Owens Corning; All-Service Duct Wrap.

H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide

insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. 'K' Value at 75 deg F mean temperature: 0.24 BTU-in/ft^2-hr-deg F

2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. CertainTeed Corp.; Commercial Board.
   b. Fibrex Insulations Inc.; FBX.
   c. Johns Manville; 800 Series Spin-Glas.
   d. Knauf Insulation; Insulation Board.
   e. Manson Insulation Inc.; AK Board.
   f. Owens Corning; Fiberglas 700 Series.

I. Mineral-Fiber, Preformed Pipe Insulation:

1. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   a. 'K' Value at 75 deg F mean temperature: 0.23 BTU-in/ft^2-hr-deg F

2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Fibrex Insulations Inc.; Coreplus 1200.
   b. Johns Manville; Micro-Lok.
   c. Knauf Insulation; 1000 Pipe Insulation.
   d. Manson Insulation Inc.; Alley-K.
   e. Owens Corning; Fiberglas Pipe Insulation.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Insulco, Division of MFS, Inc.; Triple I.
   b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

2.3 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. CertainTeed Corp.; FlameChek.
    b. Johns Manville; Firetemp Wrap.
    c. Nelson Fire Stop Products; Nelson FSB Flameshield Blanket.
    d. Thermal Ceramics; FireMaster Duct Wrap.
    e. 3M; Fire Barrier Wrap Products.
    f. Unifrax Corporation; FyreWrap.

2.4 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Aeroflex USA Inc.; Aeroseal.
    b. Armacell LCC; 520 Adhesive.
    c. Foster Products Corporation, H. B. Fuller Company; 85-75.
    d. RBX Corporation; Rubatex Contact Adhesive.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Products, Division of ITW; CP-82.
    b. Foster Products Corporation, H. B. Fuller Company; 85-20.
    c. ITW TACC, Division of Illinois Tool Works; S-90/80.
    d. Marathon Industries, Inc.; 225.
    e. Mon-Eco Industries, Inc.; 22-25.

D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Products, Division of ITW; CP-82.
    b. Foster Products Corporation, H. B. Fuller Company; 85-20.
    c. ITW TACC, Division of Illinois Tool Works; S-90/80.
    d. Marathon Industries, Inc.; 225.
    e. Mon-Eco Industries, Inc.; 22-25.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Dow Chemical Company (The); 739, Dow Silicone.
    b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
    c. P.I.C. Plastics, Inc.; Welding Adhesive.
    d. Speedline Corporation; Speedline Vinyl Adhesive.

2.5 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Products, Division of ITW; CP-35.
    b. Foster Products Corporation, H. B. Fuller Company; 30-90.
    c. ITW TACC, Division of Illinois Tool Works; CB-50.
    d. Marathon Industries, Inc.; 590.
    e. Mon-Eco Industries, Inc.; 55-40.
    f. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Products, Division of ITW; CP-10.
    b. Foster Products Corporation, H. B. Fuller Company; 35-00.
    c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
    d. Marathon Industries, Inc.; 550.
    e. Mon-Eco Industries, Inc.; 55-50.
    f. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 200 deg F.
4. Solids Content: 63 percent by volume and 73 percent by weight.
5. Color: White.

2.6 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

      a. Childers Products, Division of ITW; CP-52.
      b. Foster Products Corporation, H. B. Fuller Company; 81-42.
      c. Marathon Industries, Inc.; 130.
      d. Mon-Eco Industries, Inc.; 11-30.
      e. Vimasco Corporation; 136.

   2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
   3. Service Temperature Range: Minus 50 to plus 180 deg F.
   4. Color: White.

2.7 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

      a. Childers Products, Division of ITW; CP-76-8.
      b. Foster Products Corporation, H. B. Fuller Company; 95-44.
      c. Marathon Industries, Inc.; 405.
      d. Mon-Eco Industries, Inc.; 44-05.
      e. Vimasco Corporation; 750.

   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: Aluminum.
   6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

      a. Childers Products, Division of ITW; CP-76.

   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: White.

6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.8 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

      a. Johns Manville; Zeston.
      b. P.I.C. Plastics, Inc.; FG Series.
      c. Proto PVC Corporation; LoSmoke.
      d. Speedline Corporation; SmokeSafe.

   2. Adhesive: As recommended by jacket material manufacturer.
   3. Color: White.
   4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

   5. Factory-fabricated tank heads and tank side panels.

C. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with stucco-embossed aluminum-foil facing.

   1. Products:
      a. Polyguard; Alumaguard 60.
      b. Venture Tape Corp., Venture Clad

2.10 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
b. Compac Corp.; 104 and 105.
c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
b. Compac Corp.; 110 and 111.
c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.11 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Products; Bands.
b. PABCO Metals Corporation; Bands.
c. RPR Products, Inc.; Bands.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing or closed seal.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; CD.
      3) Midwest Fasteners, Inc.; CD.
      4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; Cupped Head Weld Pin.
      3) Midwest Fasteners, Inc.; Cupped Head.
      4) Nelson Stud Welding; CHP.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

      1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
      2) GEMCO; Perforated Base.
      3) Midwest Fasteners, Inc.; Spindle.

   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) AGM Industries, Inc.; RC-150.
        2) GEMCO; R-150.
        3) Midwest Fasteners, Inc.; WA-150.
        4) Nelson Stud Welding; Speed Clips.

    b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

2.12 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install in accordance with the Energy Conservation Code of New York State.
B. Install in accordance with the Mechanical Code of New York State.
C. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
D. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
E. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
F. Install insulation with longitudinal seams at top and bottom of horizontal runs.
G. Install multiple layers of insulation with longitudinal and end seams staggered.
H. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
I. Keep insulation materials dry during application and finishing.
J. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
K. Install insulation with least number of joints practical.
L. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

    1. Install insulation continuously through hangers and around anchor attachments.
    2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
    3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
    4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

M. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
N. Install insulation with factory-applied jackets as follows:

    1. Draw jacket tight and smooth.
    2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
    3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

O. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
P. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
Q. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
R. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Division 07 Section "Penetration Firestopping"irestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Pipe: Install insulation continuously through floor penetrations.
3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
    d. Do not overcompress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.

6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from aluminum, at least 0.060 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.6 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe

diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and

unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.7 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.10 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
B. Insulate duct access panels and doors to achieve same fire rating as duct.
C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

3.11 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of

threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.13 BOILER INSULATION SCHEDULE

A. Combustion Air Intake Insulation:
   1. Round combustion air intake ducts:
      a. Mineral-Fiber Board: 1 inches thick and 3-lb/cu. ft. nominal density.
   2. Combustion air intake plenum:
      a. Mineral-Fiber Board: 1 inches thick and 3-lb/cu. ft. nominal density.

3.14 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

   1. Indoor, concealed supply and outdoor air.
   2. Indoor, exposed supply and outdoor air.
   3. Indoor, concealed return located in nonconditioned spaces and above ceiling plenums.
   4. Indoor, exposed return located in nonconditioned space.
   5. Indoor, concealed exhaust between isolation damper and penetration of building exterior or 10’-0” of horizontal duct main from building envelope penetration whichever is greater.
   6. Indoor, exposed exhaust between isolation damper and penetration of building exterior or 10’-0” of horizontal duct main from building envelope penetration whichever is greater.

B. Items Not Insulated:

   1. Fibrous-glass ducts.
   2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
   3. Factory-insulated flexible ducts.
   4. Factory-insulated plenums and casings.
   5. Flexible connectors.
   6. Vibration-control devices.
   7. Factory-insulated access panels and doors.

3.15 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round, rectangular, and flat-oval, supply-air duct insulation shall be the following:
   1. Mineral-Fiber Blanket: 2 inches thick to achieve a minimum installed R-value of 6.

B. Concealed, round, rectangular, and flat-oval, return-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick to achieve a minimum installed R-value of 6.

C. Concealed, round, rectangular, and flat-oval, outdoor-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

D. Concealed, round, rectangular, and flat-oval, exhaust-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

E. Concealed, round, rectangular, and flat-oval, relief-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

F. Exposed, round, rectangular, and flat-oval, supply-air duct insulation shall be the following:
1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

G. Exposed, round, rectangular, and flat-oval, return-air duct insulation shall be the following:
1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

H. Exposed, round, rectangular, and flat-oval, outdoor-air duct insulation shall be the following:
1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

I. Exposed, round, rectangular, and flat-oval, exhaust-air duct insulation shall be the following:
1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

J. Exposed, outdoor-air plenum insulation shall be the following:
1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

K. Exposed, relief-air plenum insulation shall be the following:
1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

3.16 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Exposed, rectangular, supply-air duct insulation shall be the following:

1. Polyisocyanurate: Thickness as required to match duct flanges and stiffeners to provide a smooth exterior surface application or thickness required to achieve required R-value whichever is greater. The minimum R value required is R-12. Taper tops of ductwork to prevent ponding of water.

3.17 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
C. Heating-hot-water and glycol expansion/compression tank insulation shall be the following:
1. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
2. Mineral-Fiber Pipe and Tank: 1 inch thick.

D. Heating-hot-water and glycol air-separator insulation shall be the following:

1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
2. Mineral-Fiber Pipe and Tank: 2 inches thick.

3.18 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.19 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Heating-Hot-Water and glycol Supply and Return, 200 Deg F and below:

1. NPS 12” and Smaller: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe, Type I: 2 inch thick.

C. Refrigerant Suction, Liquid and Hot-Gas Piping:

1. Insulation shall be the following:

   a. Flexible Elastomeric: 1-1/2 inch thick.

3.20 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction, Liquid and Hot-Gas Piping:

1. Insulation shall be the following:
   a. Flexible Elastomeric: 2 inch thick.

3.21 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
B. Piping, Exposed, where noted on the drawings:

1. PVC: 20 mils thick.

3.22 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
B. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Aluminum, Stucco Embossed: 0.060 inch thick.

C. Piping, Exposed:

1. Aluminum, Corrugated with Z-Shaped Locking Seam: 0.024 inch thick.

END OF SECTION 230700

SECTION 230800 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes commissioning process requirements for HVAC systems, assemblies, and equipment.

1.3 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
B. Cx: Commissioning, as defined in Section 019113 “General Commissioning Requirements.”
C. CxA: Commissioning Authority, as defined in Section 019113 “General Commissioning Requirements.”
D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
E. TAB: Testing, adjusting, and balancing.

1.4 SUBMITTALS

A. Certificates of readiness.
B. Certificates of completion of installation, prestart, and startup activities.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CxA.
B. Attend construction phase controls coordination meeting.
C. Attend testing, adjusting, and balancing review and coordination meeting.
D. Participate in HVAC systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

E. Provide information requested by the CxA for final commissioning documentation.
F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.6 COMMISSIONG AUTHORITY'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
B. Direct commissioning testing.
C. Verify testing, adjusting, and balancing of Work are complete.
D. Provide test data, inspection reports, and certificates in Systems Manual.

1.7 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of readiness, signed by the Contractor, certifying that HVAC&R systems, assemblies, equipment, components, and associated controls are ready for testing.
5. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
6. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
7. Test and inspection reports and certificates.
8. Corrective action documents.
9. Verification of testing, adjusting, and balancing reports.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
B. Certify that HVAC instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
E. Inspect and verify the position of each device and interlock identified on checklists.
F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
B. Notify the CxAat least 10 days in advance of testing and balancing Work and provide access for the CxA to witness testing and balancing Work.
C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.

    1. The CxA will notify testing and balancing Subcontractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
    2. The testing and balancing Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
    3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.

4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.
C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
D. The CxA along with the HVAC Contractor, testing and balancing Subcontractor, and HVAC Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC systems, subsystems, and equipment.
E. Tests will be performed using design conditions whenever possible.
F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
G. The CxA may direct that set points be altered when simulating conditions is not practical.
H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
I. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Boiler Testing and Acceptance Procedures: Testing requirements are specified in HVAC boiler Sections. Provide submittals, test data, inspector record, and boiler certification to the CxA.
B. HVAC Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Section 230900 "Instrumentation and Control for HVAC". Assist the CxA with preparation of testing plans.

C. Pipe system cleaning, flushing, hydrostatic tests and chemical treatment requirements are specified in HVAC piping Sections. Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
2. Description of equipment for flushing operations.
3. Minimum flushing water velocity.
4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

D. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of hot-water systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

E. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

F. HVAC Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R air handling units, roof top units, exhaust fans, terminal equipment and unitary equipment.

END OF SECTION 230800

SECTION 230923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Direct digital control (DDC) system equipment and components for monitoring and controlling of HVAC, exclusive of instrumentation and control devices.

B. The **Hilton Central School District Board of Education** has passed a resolution to standardize on Schneider Electric products by Day Automations. No other manufacturers are acceptable unless prior approval is received from the Hilton CSD Board of Education.

1.2 QUALIFICATIONS OF BIDDER AND PRE-BID SUBMITTAL

A. All Temperature Control Equipment for the project shall be purchased by the Hilton Central School District via State Contract through Schneider Electric Building Management system by Day Automation and turned over to the Mechanical Contractor for installation.

B. The Mechanical Contractor shall be responsible to provide the professional services from Day Automation to develop the Direct Digital Temperature Controls system documentation, submittals, project management, programming, installation of the equipment, commissioning and warranty such that the project has a complete and workable Direct Digital Temperature Controls System compliant with the requirements of this section.

1.3 DEFINITIONS

A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

C. BACnet Specific Definitions:

1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data and services over a network.
2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.

D. Binary: Two-state signal where a high signal level represents "ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.

E. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: network controllers, programmable application controllers, and application-specific controllers.

F. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.

G. COV: Changes of value.

H. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.

I. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems to be capable of operating in a standalone mode using the last best available data.

J. E/P: Voltage to pneumatic.

K. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.

L. HLC: Heavy load conditions.

M. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI) and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.

N. I/P: Current to pneumatic.

O. LAN: Local area network.

P. LNS: LonWorks Network Services.

Q. LON Specific Definitions:

1. FTT-10: Echelon Transmitter-Free Topology Transceiver.
2. LonMark International: Association comprising suppliers and installers of LonTalk products. Association provides guidelines for implementing LonTalk protocol to ensure interoperability through a standard or consistent implementation.
3. LonTalk: An open standard protocol developed by Echelon Corporation that uses a "Neuron Chip" for communication. LonTalk is a register trademark of Echelon.
4. LonWorks: Network technology developed by Echelon.

5. Node: Device that communicates using CTA-709.1-D protocol and that is connected to a CTA-709.1-D network.
6. Node Address: The logical address of a node on the network, consisting of a Domain number, Subnet number, and Node number. "Node number" portion of an address is a number assigned to device during installation, is unique within a subnet, and is not a factory-set unique Node ID.
7. Node ID: A unique 48-bit identifier assigned at factory to each CTA-709.1-D device. Sometimes called a "Neuron ID."
8. Program ID: An identifier (number) stored in a device (usually, EEPROM) that identifies node manufacturer, functionality of device (application and sequence), transceiver used, and intended device usage.
9. Standard Configuration Property Type (SCPT): Pronounced "skip-it." A standard format type maintained by LonMark for configuration properties.
10. Standard Network Variable Type (SNVT): Pronounced "snivet." A standard format type maintained by LonMark used to define data information transmitted and received by individual nodes. "SNVT" is used in two ways. It is an acronym for "Standard Network Variable Type" and is often used to indicate a network variable itself (i.e., it can mean "a network variable of a standard network variable type").
11. ard network variable type").
12. Subnet: Consists of a logical grouping of up to 127 nodes, where logical grouping is defined by node addressing. Each subnet is assigned a number, which is unique within a Domain. See "Node Address."
13. TP/FT-10: Free Topology Twisted Pair network defined by CTA-709.3 and is most common media type for a CTA-709.1-D control network.
14. TP/XF-1250: High-speed, 1.25 Mbps, twisted-pair, doubly terminated bus network defined by "LonMark Interoperability Guidelines" and typically used only to connect multiple TP/FT-10 networks.
15. User-Defined Configuration Property Type (UCPT): Pronounced "u-keep-it." A Configuration Property format type that is defined by device manufacturer.
16. User-Defined Network Variable Type (UNVT): Network variable format defined by device manufacturer. UNVTs create non-standard communications that other vendors' devices may not correctly interpret and may negatively impact system operation. UNVTs are not allowed.

R. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

S. Mobile Device: A data-enabled phone or tablet computer capable of connecting to a cellular data network and running a native control application or accessing a web interface.

T. Modbus TCP/IP: An open protocol for exchange of process data.

U. MS/TP: Master-slave/token-passing, ISO/IEC/IEEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.

V. MTBF: Mean time between failures.

W. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.

X. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.

Y. Peer to Peer: Networking architecture that treats all network stations as equal partners.

Z. POT: Portable operator's terminal.

AA. RAM: Random access memory.

BB. RF: Radio frequency.

CC. Router: Device connecting two or more networks at network layer.

DD. Server: Computer used to maintain system configuration, historical and programming database.

EE. TCP/IP: Transport control protocol/Internet protocol.

FF. UPS: Uninterruptible power supply.

GG. USB: Universal Serial Bus.

HH. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.

II. VAV: Variable air volume.

JJ. WLED: White light emitting diode.

1.4 SCOPE OF WORK

A. The Mechanical Contractor shall furnish and install a complete building automation system including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification. Network level components of the system – workstations, servers, etc. shall communicate using the BACnet protocol, as defined by ASHRAE Standard 135-2004. No gateways shall be used for communication to controllers furnished under this section. At a minimum, provide controls for the following:

1. Air Handling Units
2. Boilers, including hot water pumps
3. Cabinet unit heater controls
4. Exhaust and Supply Fans
5. Finned tube radiation control
6. Hot Water Loop Pumps
7. Rooftop Units
8. Unit Heaters

B. Except as otherwise noted, the control system shall consist of all necessary Ethernet Network Controllers, Standalone Digital Control Units, Room Controllers, workstations, software, sensors, transducers, relays, valves, dampers, damper operators, control panels, and other

accessory equipment, along with a complete system of electrical interlocking wiring to fill the intent of the specification and provide for a complete and operable system. Except as otherwise specified, provide operators for equipment such as dampers if the equipment manufacturer does not provide these. Coordinate requirements with the various Contractors.

C. The BAS contractor shall review and study all HVAC drawings and the entire specification to familiarize themselves with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc. to be provided.

D. All interlocking wiring, wiring and installation of control devices associated with the equipment listed below shall be provided by the Mechanical Contractor. When the BAS system is fully installed and operational, the BAS Contractor and representatives of the Owner will review and check out the system – see System Acceptance and Testing section of this document. At that time, the BAS contractor shall demonstrate the operation of the system and prove that it complies with the intent of the drawings and specifications.

E. Provide services and manpower necessary for commissioning of the system in coordination with the Mechanical Contractor, Balancing Contractor and Owner's representative.

F. All work performed under this section of the specifications will comply with all governing codes, laws and governing bodies. If the drawings and/or specifications are in conflict with governing codes, the Contractor, with guidance from the engineer, shall submit a proposal with appropriate modifications to the project to meet code restrictions. If this specification and associated drawings exceed governing code requirements, the specification will govern. The Contractor shall obtain and pay for all necessary construction permits and licenses.

1.5 SYSTEM DESCRIPTION

A. In accordance with the scope of work, the system shall also provide a graphical, web-based, operator interface that allows for instant access to any system through a standard browser. The contractor must provide PC-based programming workstations, operator workstations and microcomputer controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions. For this project, the system shall consist of the following components:

1. Administration and Programming Workstation: The BAS Contractor shall include Operation software and architecture as described in Part 2 of the specification. These workstations must be running the standard workstation software developed and tested by the manufacturer of the network server controllers and the standalone controllers. No third-party front-end workstation software will be acceptable. Workstations must conform to the B-OWS BACnet device profile.
2. Web-Based Operator Workstations: The BAS Contractor shall furnish licenses for web connection to the BAS system. Web-based users shall have access to all system points and graphics, shall be able to receive and acknowledge alarms, and shall be able to control setpoints and other parameters. All engineering work, such as trends, reports, graphics, etc. that are accomplished from the WorkStation shall be available for viewing through the web browser interface without additional changes. The web-based interface must conform to the B-OWS BACnet device profile. There will be no need for any additional computer-based hardware to support the web-based user interface.

3. Ethernet-based Network Router and/or Network Server Controller: The BAS Contractor shall furnish needed quantity of Ethernet-based Network Server Controllers as described in Part 2 of the specification. These controllers will connect directly to the Operator Workstation over Ethernet at a minimum of 100mbps, and provide communication to the Standalone Digital Control Units and/or other Input/Output Modules. Network Server Controllers shall conform to BACnet device profile B-BC. Network controllers that utilize RS232 serial communications or ARCNET to communicate with the workstations will not be accepted. Network Controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Building Controllers (B-BC).
4. t device profile B-BC. Network controllers that utilize RS232 serial communications or ARCNET to communicate with the workstations will not be accepted. Network Controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Building Controllers (B-BC).
5. lize RS232 serial communications or ARCNET to communicate with the workstations will not be accepted. Network Controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Building Controllers (B-BC).
6. Standalone Digital Control Units (SDCUs): Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment. Each BACnet protocol SDCU shall conform to the BACnet device profile B-AAC. BACnet SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Advanced Application Controllers (B-AAC).
7. one, containing all of the I/O and programs to control its associated equipment. Each BACnet protocol SDCU shall conform to the BACnet device profile B-AAC. BACnet SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Advanced Application Controllers (B-AAC).
8. ry (BTL) as BACnet Advanced Application Controllers (B-AAC).

B. The Local Area Network (LAN) shall be either a 10 or 100 Mpbs Ethernet network supporting BACnet, Modbus, XML and HTTP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Server Controllers (NSCs), user workstations and a local host computer system.

C. The Enterprise Ethernet (IEEE 802.3) LAN shall utilize Carrier Sense Multiple/Access/Collision Detect (CSMA/CD), Address Resolution Protocol (ARP) and User Datagram Protocol (UDP) operating at 10 or 100 Mbps.

D. P) operating at 10 or 100 Mbps.

E. The system shall enable an open architecture that utilizes EIA standard 709.1, the LonTalk™ protocol and/or ANSI / ASHRAE™ Standard 135-2004, BACnet functionality to assure interoperability between all system components. Native support for the LonTalk™ protocol and the ANSI / ASHRAE™ Standard 135-2004, BACnet protocol are required to assure that the project is fully supported by the HVAC open protocols to reduce future building maintenance, upgrade, and expansion costs.

F. The system shall enable an architecture that utilizes a MS/TP selectable 9.6-76.8 KBaud protocol, as a common communication protocol between controllers and integral ANSI / ASHRAE™ Standard 135-2004, BACnet functionality to assure interoperability between all system components. The AAC shall be capable of communicating as a MS/TP device or as a

BACnet IP device communicating at 10/100 Mbps on a TCP/IP trunk. The ANSI / ASHRAE™ Standard 135-2004, BACnet protocol is required to assure that the project is fully supported by the leading HVAC open protocol to reduce future building maintenance, upgrade, and expansion costs.

G. ture that utilizes a MS/TP selectable 9.6-76.8 KBaud protocol, as a common communication protocol between controllers and integral ANSI / ASHRAE™ Standard 135-2004, BACnet functionality to assure interoperability between all system components. The AAC shall be capable of communicating as a MS/TP device or as a BACnet IP device communicating at 10/100 Mbps on a TCP/IP trunk. The ANSI / ASHRAE™ Standard 135-2004, BACnet protocol is required to assure that the project is fully supported by the leading HVAC open protocol to reduce future building maintenance, upgrade, and expansion costs.

H. ully supported by the leading HVAC open protocol to reduce future building maintenance, upgrade, and expansion costs.

I. open protocol to reduce future building maintenance, upgrade, and expansion costs.

J. The system shall provide support for Modbus TCP and RTU protocols natively, and not require the use of gateways.

K. Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation of Mechanical Equipment Room (MER) valves and dampers and electronic actuation of terminal equipment valves and actuators as specified herein. The BMS is intended to seamlessly connect devices throughout the building regardless of subsystem type, i.e. variable frequency drives, low voltage lighting systems, electrical circuit breakers, power metering and card access should easily coexist on the same network channel.

L. power metering and card access should easily coexist on the same network channel.

M. rk channel.

1. The supplied system must incorporate the ability to access all data using HTML5 enabled browsers without requiring proprietary operator interface and configuration programs. The system shall not require JAVA to be enabled in the browser.
2. Data shall reside on a supplier-installed server for all database access.
3. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer’s internal Intranet network.

N. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the approved manufacturer's local field office. Supervision, hardware and software engineering, calibration and checkout of the system shall be by the employees of the approved manufacturer's local field office and shall not be subcontracted. The control contractor shall have an in-place support facility within 50 miles of the site with factory certified technicians and engineers, spare parts inventory and all necessary test and diagnostic equipment for the installed system, and the control contractor shall have 24 hours/day, 7 days/week emergency service available.

1.6 WORK BY OTHERS

A. The BAS Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.

B. The BAS Contractor shall furnish all Airflow Stations, Control Dampers, Control Valves, Sensor Wells and other similar equipment for installation by the Mechanical Contractor and/or others.

C. The BAS Contractor shall provide field supervision to the designated contractor for the installation of the following:

1. Automatic control dampers
2. Temperature Well Sensors
3. Pressure taps
4. Hydronic Meters
5. Control Valves

1.7 SUBMITTALS

A. All shop drawings shall be prepared in AutoCAD software. In addition to the drawings, the Contractor shall furnish a CD containing the identical information. Drawings shall be B size or larger.

B. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typicals will be allowed where appropriate.

C. ropriate.

D. Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. Valve, damper and air flow station schedules shall indicate size, configuration, capacity and location of all equipment.

E. Submit (5) copies of submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. The Contractor, prior to submitting, shall check all documents for accuracy.

F. The Engineer will make corrections, if required, and return to the Contractor. The Contractor will then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved.

G. The following is a list of post construction submittals that shall be updated to reflect any changes during construction and re-submitted as "As-Built".

1. System architecture drawing.
2. Layout drawing for each control panel

3. Wiring diagram for individual components
4. System flow diagram for each controlled system
5. Instrumentation list for each controlled system
6. Sequence of control
7. Operation and Maintenance Manuals

H. Information common to the entire system shall be provided. This shall include but not be limited to the following.

1. Product manuals for the key software tasks.
2. Operating the system.
3. Administrating the system.
4. Engineering the operator workstation.
5. Application programming.
6. Engineering the network.
7. Setting up the web server.
8. Report creation.
9. Graphics creation.
10. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.

I. Information common to the systems in a single building shall be provided.

1. System architecture diagram for components within the building annotated with specific location information.
2. As-built drawing for each control panel.
3. As-built wiring design diagram for all components.
4. Installation design details for each I/O device.
5. Sequence of control for each system.
6. Product data sheet for each component.
7. Installation data sheet for each component.

1.8 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment from other divisions including "Intrusion Detection," "Lighting Controls," "Motor Control Centers," "Panel boards," and "Fire Alarm" to achieve compatibility with equipment that interfaces with those systems.

C. Coordinate supply of conditioned electrical circuits for control units and operator workstation.

D. Coordinate with the Owner's IT department on locations for NSC's, Ethernet communication cabling and TCP/IP addresses.

1.9 WARRANTY AND MAINTENANCE

A. All components, system software, and parts furnished and installed by the BMS contractor shall be guaranteed against defects in materials and workmanship for 1 year of substantial completion. Labor to repair, reprogram, or replace these components shall be furnished by the BMS contractor at no charge during normal working hours during the warranty period. Materials furnished but not installed by the BMS contractor shall be covered to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The Contractor shall respond to the owner's request for warranty service within 24 standard working hours.

B. bility of the trade contractor performing the installation. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The Contractor shall respond to the owner's request for warranty service within 24 standard working hours.

C. ility of the trade contractor performing the installation. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The Contractor shall respond to the owner's request for warranty service within 24 standard working hours.

1.10 TRAINING

A. On-site training shall consist of a minimum of (16) hours of hands-on instruction geared at the operation and maintenance of the systems. The curriculum shall include

1. System Overview
2. System Software and Operation
3. System access
4. Software features overview
5. Changing setpoints and other attributes
6. Scheduling
7. Editing programmed variables
8. Displaying color graphics
9. Running reports
10. Workstation maintenance
11. Viewing application programming
12. Operational sequences including start-up, shutdown, adjusting and balancing.
13. Equipment maintenance

B. Factory, classroom training will include a minimum of (6) training reservations for a 2-day course with material covering workstation operation tuition free with travel expense responsibility of the owner. The option for 2-3 weeks of system engineering and controller programming shall be possible if necessary and desired.

PART 2 - PRODUCTS

2.1 DDC SYSTEM DESCRIPTION

A. General

1. The Building Automation System (BAS) shall consist of Network Server/Controllers (NSCs), a family of Standalone Digital Control Units (SDCUs), Administration and Programming Workstations (APWs), and Web-based Operator Workstations (WOWs). The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable.
2. An Enterprise Level BAS shall consist of an Enterprise Server, which enables multiple NSCs (including all graphics, alarms, schedules, trends, programming, and configuration) to be accessible from a single Workstation simultaneously for operations and engineering tasks.
3. raphics, alarms, schedules, trends, programming, and configuration) to be accessible from a single Workstation simultaneously for operations and engineering tasks.
4. The Enterprise Level BAS shall be able to host up to 250 servers, or NSCs, beneath it.
5. For Enterprise reporting capability and robust reporting capability outside of the trend chart and listing ability of the Workstation, a Reports Server shall be installed on a Microsoft Windows SQL based computer. The Reports Server can be installed on the same computer as the Enterprise Server.
6. The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP, LonWorks IP, and/or Modbus TCP protocol.

B. Modbus RTU/ASCII (and J-bus), Modbus TCP, BACnet MS/TP, BACnet IP, LonTalk FTT-10A, and WebServices shall be native to the NSCs. There shall not be a need to provide multiple NSCs to support all the network protocols, nor should there be a need to supply additional software to allow all three protocols to be natively supported.

C. A sub-network of SDCUs using the BACnet IP protocol shall connect the local, stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers.

D. TCP/IP Level

1. The TCP/IP layer connects all of the buildings on a single Wide Area Network (WAN) isolated behind the campus firewall. Fixed IP addresses for connections to the campus WAN shall be used for each device that connects to the WAN.

E. Fieldbus Level with Standalone Digital Control Units (SDCUs)

1. The fieldbus layer shall support all of the following types of SDCUs:
   a. BACnet IP SDCU requirements: The system shall consist of one or more BACnet/IP field buses managed by the Network Server Controller. The field bus layer shall consist of up to 50 IP SDCUs in daisy chain topology, or 39 if using RSTP, per layer, with a max of 5 sub networks in daisy chain for a total of 250 SDCUs or 6 sub networks in RSTP for a total of 234 SDCUs. The field bus layer shall consist ONLY of BACnet IP SDCUs. No other protocols, including BACnet MS/TP, shall be acceptable.

F. BAS LAN Segmentation

1. The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN). Workstations can manage a single LAN (or building), and/or the entire system with all portions of that LAN maintaining its own, current database.

G. Standard Network Support

1. All NSCs, Workstation(s) and Servers shall be capable of residing directly on the owner's Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NSC's, Workstation(s), and Server(s) shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner's Information Systems Department as all devices utilize standard TCP/IP components.

2. ption of the maintenance of the LAN/WAN to be performed by the owner's Information Systems Department as all devices utilize standard TCP/IP components.

3. of the LAN/WAN to be performed by the owner's Information Systems Department as all devices utilize standard TCP/IP components.

H. System Expansion

1. The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same TCP/IP level and fieldbus level controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
2. Web-based operation shall be supported directly by the NSCs and require no additional software.
3. The system shall be capable of using graphical and/or line application programming language for the Network Server Controllers.

I. Support For Open Systems Protocols

1. All Network Server Controllers must natively support the BACnet IP, BACnet MS/TP, LonWorks FTT-10, Modbus TCP, Modbus RTU (RS-485 and RS-232), and Modbus ASCII protocols.

2.2 OPERATOR WORKSTATION REQUIREMENTS

A. General

1. The operator workstation portion of the BAS shall consist of one or more full-powered configuration and programming workstations, and one or more web-based operator workstations. For this project provide a minimum of 1 concurrent operator users and/or 1 concurrent engineering users within the enterprise server.

2. The programming and configuration workstation software shall allow any user with adequate permission to create and/or modify any or all parts of the NSC and/or Enterprise Server database.
3. Web-based workstations (webstations) shall have a minimum of 10 concurrent operator users.
4. All configuration workstations shall be personal computers operating under the Microsoft Windows operating system. The application software shall be capable of communication to all Network Server Controllers and shall feature high-resolution color graphics, alarming, trend charting. It shall be user configurable for all data collection and data presentation functions.
5. A minimum of 1 physical Workstation shall be allowed on the Ethernet network. In this client/server configuration, any changes or additions made from one workstation will automatically appear on all other workstations since the changes are accomplished to the databases within the NSC. Systems with a central database will not be acceptable.
6. ns made from one workstation will automatically appear on all other workstations since the changes are accomplished to the databases within the NSC. Systems with a central database will not be acceptable.

B. Administration/Programming Workstation, Enterprise Server, and Enterprise Central Requirements

1. The Enterprise Central shall consist of the following:
   a. Processor
      1) Minimum: Intel Core i5 @ 2.0 GHz or equivalent
      2) Recommended: Intel Core i5 @ 3.0 GHz or better
   b. Memory
      1) Minimum: 4GB
      2) Recommended: 8GB or higher
   c. Operating systems:
      1) Microsoft Windows 10 64-bit (Pro or Enterprise)
      2) Microsoft Windows Server 2012 R2 64-bit (Standard, Datacenter, Essentials, or Foundation)
      3) Microsoft Windows Server 2016 R2 64-bit (Standard, Datacenter, Essentials, or Foundation)
   d. 10/100MBPS Ethernet NIC
   e. 100 GB hard disk (minimum)
   f. Required additional software:
      1) Microsoft .Net 4.5
   g. License agreement for all applicable software

2. The workstation shall consist of the following:
   a. Processor
      1) Minimum: 2.0 GHz
      2) Recommended: 3.0 GHz or higher
   b. Memory
      1) Minimum: 4GB
      2) Recommended: 8GB or higher
   c. Operating systems:
      1) Microsoft Windows 10 64-bit (Pro or Enterprise)
      2) Microsoft Windows Server 2012 64-bit (Standard, Datacenter, Essentials, or Foundation)

3) Microsoft Windows Server 2012 R2 64-bit (Standard, Datacenter, Essentials, or Foundation)

d. Serial port, parallel port, USB port
e. 10/100MBPS Ethernet NIC
f. 20 GB hard disk
g. DVD drive
h. High resolution (minimum 1280 x 1024), 17" flat panel display
i. Optical mouse and full function keyboard
j. Audio sound card and speakers
k. Required additional software:
   1) Microsoft .Net 4.5
l. License agreement for all applicable software.

C. Web-Based Operator PC Requirements

1. Any user on the network can access the system, using the following software:
   a. Internet Explorer 11
   b. Mozilla Firefox
   c. Google Chrome

D. General Administration and Programming Workstation Software

1. System architecture shall be truly client server in that the Workstation shall operate as the client while the NSCs shall operate as the servers. The client is responsible for the data presentation and validation of inputs while the server is responsible for data gathering and delivery.
2. The workstation functions shall include monitoring and programming of all DDC controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.
3. ted control actions such as schedule and setpoint adjustments.
4. Programming of SDCUs shall be capable of being done either off-line or on-line from any operator workstation. All information will be available in graphic or text displays stored at the NSC. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through a mouse.

E. User Interface:

1. The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user when logging into any workstation. Additionally, it shall be possible to create customized workspaces that can be assigned to user groups. This interface shall support the creation of "hot-spots" that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user's "PC Desktop" – with all the links that a user needs to run other applications. This, along with the Windows user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software, but may also limit what a user can do on the PC and/or LAN/WAN. This might

be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shut down the active alarm viewer and/or unable to load software onto the PC.

2. System shall be able to automatically switch between displayed metric vs. imperial units based on the workstation/webstations localization.
3. Webstations shall have the capability to automatically re-direct to an HTTPS connection to ensure more secure communications.
4. Personalized layouts and panels within workstations shall be extended to webstations to ensure consistent user experiences between the two user interfaces.
5. Servers and clients shall have the ability to be located in different time zones, which are then synchronized via the NTP server.
6. Workstation shall indicate at all times the communication status between it and the server.

F. User Security

1. The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and editable only by, a system administrator. The sets of capabilities shall range from View only, Acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. The system must allow a minimum of 256 users to be configured per workstation. Additionally, the software shall enable the ability to add/remove users based upon Microsoft Windows Security Domains that enable the customer IT department to assist in user access.

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3. he system must allow a minimum of 256 users to be configured per workstation. Additionally, the software shall enable the ability to add/remove users based upon Microsoft Windows Security Domains that enable the customer IT department to assist in user access.
4. Additional requirements include mandatory change of passwords:
   a. At first logon with default credentials
   b. Of admin passwords before deploying
5. No general accounts, one account per user
6. Capability to integrate and use Windows Active Directory for user log on credentials
7. Include a timed auto log off feature
8. Use TLS 1.2 encryption or higher
9. Capability to use blacklisted and whitelisted IPs/MAC addresses to gate access
10. All devices and software that support HTTP shall allow disabling the HTTP access and require access via HTTPS.
11. All devices that have web portals for the configuration of IP addresses and other configuration attributes shall have the ability, through commands issued, to disable this service upon completion. A direct connection method with ASCII commands shall enable this service again if changes need to be applied. Loss of power or cycling the device shall not reverse this command. Disabling this web portal eliminates the security risk and the need for updating security patches.

12. All devices shall support SNMP V3 monitoring of network performance and stack statistics for the purpose of managing denial of service attacks
13. The Integrated Control Platform shall support the feature to alarm on a predetermined period of time until the default password for each device is changed from the default factory setting.
14. The Integrated Control Platform shall support encrypted password authentication for all web services whether serving or consuming.

G. Configuration Interface

1. The workstation software shall use a familiar Windows Explorer style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a "network map" of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions.
2. The configuration interface shall also include support for user defined object types. These object types shall be used as building blocks for the creation of the BAS database. They shall be created form the base object types within the system input, output, string variables, setpoints, etc., alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of user defined object types shall be able to be set up as a predefined aggregate of subsystems and systems. The configuration interface shall support copying/pasting and exporting/importing portions of the database for additional efficiency. The system shall also maintain a link to all "child" objects created. If a user wishes to make a change to a parent object, the software shall ask the user if he/she wants to update all of the child objects with the change.

H. Color Graphic Displays

1. The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.
2. Requirements of the color graphic subsystem include:
    a. At a minimum, the user shall have the ability to import .gif, .png, .bmp, .jpeg, .tif, and CAD generated picture files as background displays, and layering shall be possible.
    b. The system shall support HTML5 enabled graphics.
    c. It shall be possible for the user to use JavaScript to customize the behavior of each graphic.
    d. The editor shall use Scalable Vector Graphics (SVG) technology.
    e. A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, ad graphs which can be "dropped" on a graphic through the use of a software configuration "wizard". These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels.
    f. Support for high DPI icons shall be included and automatically chosen if viewing on a high definition display such as Retina or 4K displays.
    g. Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.

h. Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.
i. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.
j. It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable, customized libraries.
k. Graphics should rescale based on whatever monitor or viewing device is being used.
l. Be able to create graphics on varying layers that can be moved and repeated.
m. Be able to create graphics within varying window panes that can be moved and/or re-referenced. For example, creating the graphical menu within a pane and referencing it on every graphics page, therefore not rebuilding thus allowing for a single spot for updates that get pushed to all the pages that reference it.
n. The ability to create re-usable cascading menus.
o. The ability to have multiple instances of a graphic and edit one instance to change all.

3. Additionally, the Graphics Editor portion of the Engineering Software shall provide the following capabilities:
a. Create and save pages.
b. Group and ungroup symbols.
c. Modify an existing symbol.
d. Modify an existing graphic page.
e. Rotate and mirror a symbol.
f. Place a symbol on a page.
g. Place analog dynamic data in decimal format on a page.
h. Place binary dynamic data using state descriptors on a page.
i. Create motion through the use of animated .gif files or JavaScript.
j. Place test mode indication on a page.
k. Place manual mode indication on a page.
l. Place links using a fixed symbol or flyover on a page.
m. Links to other graphics.
n. Links to web sites.
o. Links to notes.
p. Links to time schedules.
q. Links to any .exe file on the operator work station.
r. Links to .doc files.
s. Assign a background color.
t. Assign a foreground color.
u. Place alarm indicators on a page.
v. Change symbol/text/value color as a function of an analog variable.
w. Change a symbol/text/value color as a function of a binary state.
x. Change symbol/text/value as a function of a binary state.
y. All symbols used by Schneider Electric EcoBuilding Business in the creation of graphic pages shall be saved to a library file for use by the owner.

I. Automatic monitoring

1. The software shall allow for the automatic collection of data and reporting from any controller or NSC. The frequency of data collection shall be user-configurable.

J. Alarm Management

1. The software shall be capable of accepting alarms directly from NSCs or controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.
2. Alarm management features shall include:
    a. A minimum of 1000 alarm notification levels at the NSC, workstation, and webstation levels. At the Enterprise level the minimum number of active and viewable alarms shall be 10,000. Each notification level will establish a unique set of parameters for controlling alarm display, distribution, acknowledgment, keyboard annunciation, and record keeping.
    b. Automatic logging in the database of the alarm message, point name, point value, source device, timestamp of alarm, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement).
    c. Playing an audible sound on alarm initiation or return to normal.
    d. Sending an email page to anyone specifically listed on the initial occurrence of an alarm. The ability to utilize email paging of alarms shall be a standard feature of the software using Simple Mail Transfer Protocol (SMTP) with support for secure email using Simple Mail Transfer Protocol Secure (SMTPS) No special software interfaces shall be required and no email client software must be running in order for email to be distributed. The email notification shall be able to be sent to an individual user or a user group.
    e. Individual alarms shall be able to be re-routed to a user at user-specified times and dates. For example, a critical high temp alarm can be configured to be routed to a Facilities Dept. workstation during normal working hours (7am-6pm, Mon-Fri) and to a Central Alarming workstation at all other times.
    f. ther times.
    g. An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes.
    h. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms.
    i. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of causes for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.
    j. The active alarm viewer can be configured such that an operator must confirm that all of the steps in a check list have been accomplished prior to acknowledging the alarm.
    k. The active alarm viewer shall, if filtered, show the quantity of visible and total number of alarms that are not equal to ‘normal’ and the quantity of disabled and hidden alarms.
    l. The alarm viewer can be configured to auto hide alarms when triggered.
    m. An operator shall have the capability to assign an alarm to another user of the system.
    n. Time schedules shall be able to be used to set control notifications to users.
    o. An operator shall have the capability to save and apply alarm favorites.
    p. Alarm notifications must support multiple distribution methods within one notification.

K. Scheduling

1. From the workstation or webstation, it shall be possible to configure and download schedules for any of the controllers on the network.
2. Time of day schedules shall be in a calendar style and viewable in both a graphical and tabular view.
3. Schedules shall be programmable for a minimum of one year in advance.
4. To change the schedule for a particular day, a user shall simply select the day and make the desired modifications.
5. Additionally, from the operator webstations, each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.
6. Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.
7. It shall be possible to assign a lead schedule such that shadow/local schedules are updated based upon changes in the Lead.
8. It shall be possible to assign a list(s) of exception event days, dates, date ranges to a schedule.
9. It shall be possible to view combined views showing the calendar and all prioritized exemptions on one screen.
10. It should accommodate a minimum of 16 priority levels.
11. Values should be able to be controlled directly from a schedule, without the need for special program logic.

L. Programmer's Environment

1. Programming in the NSC shall be either in graphical block format or line-programming format or both.
2. Programming of the NSC shall be available offline from system prior to deployment into the field. All engineering tasks shall be possible, except, of course, the viewing of live tasks or values.
3. The programmer's environment will include access to a superset of the same programming language supported in the SDCUs.
4. NSC devices will support both script programming language as well as the graphical function block programming language. For both languages, the programmer will be able to configure application software for custom program development, and write global control programs. Both languages will have debugging capabilities in their editors.
5. It shall be possible to save custom programs as libraries for reuse throughout the system. A wizard tool shall be available for loading programs from a library file in the program editor.
6. gram editor.
7. It shall be possible to view graphical programming live and real-time from the Workstation.
8. The system shall be capable of creating ‘binding templates’ allowing the user to bind multiple points to multiple objects all at once.
9. Key terms should appear when typing (IntelliType).
10. Applications should be able to be assigned different priorities and cycle times for a prioritized execution of different function.

11. The system shall be able to create objects that allow common objects such as power meters, VFD drives, etc. to be integrated into the system with simple import actions without the need of complicated programming or configuration setups.

M. Saving/Reloading

1. The workstation software shall have an application to save and restore NSC and field controller memory files.
2. For the NSC, this application shall not be limited to saving and reloading an entire controller – it must also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.

N. Audit Trail

1. The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.
2. It shall be possible to view a history of alarms, user actions, and commands for any system object individually or at least the last 5000 records of all events for the entire system from Workstation.
3. The Enterprise server shall be able to store up to 5 million events.
4. The event view shall support viewing of up to 100,000 events.
5. It shall be possible to save custom filtered views of event information that are viewable and configurable in Workstation.
6. It shall be capable to search and view all forced values within the system.

O. Fault Tolerant Enterprise Server Operation (Top level NSC)

1. A single component failure in the system shall not cause the entire system to fail. All system users shall be informed of any detectable component failure via an alarm event. System users shall not be logged off as a result of a system failure or switchover.

P. Web-based Operator Software

1. General:
   a. Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network.
   b. The system shall be able to be accessed on site via a mobile device environment with, at a minimum, access to overwrite and view system values.
2. Graphic Displays
   a. The browser-based interface must share the same graphical displays as the Administration and Programming Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser's graphics shall support commands to change setpoints, enable/disable equipment and start/stop equipment.
   b. Through the browser-based interface, operators must be able to navigate through the entire system, and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a record of the change stored in the system database.

3. Alarm Management
   a. Systems requiring additional client software to be installed on a PC for viewing the webstation from that PC will not be considered.
   b. Through the browser interface, a live alarm viewer identical to the alarm viewer on the Administration and Programming workstation shall be presented, if the user's password allows it. Users must be able to receive alarms, silence alarms, and acknowledge alarms through a browser. If desired, specific operator text must be able to be added to the alarm record before acknowledgement, attachments shall be viewable, and alarm checklists shall be available.

Q. Groups and Schedules

1. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.
2. Through the browser interface, operators must be able to change schedules – change start and stop times, add new times to a schedule, and modify calendars.

R. User Accounts and Audit Trail

1. The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.
2. All commands and user activity through the browser interface shall be recorded in the system's activity log, which can be later searched and retrieved by user, date, or both.

S. Web Services

1. The installed system shall be able to use web services to "consume" information within the Network Server/Controllers (NSCs) with other products and systems. Inability to perform web services within the NSCs will be unacceptable.
   a. Shall be able to "consume" data into the system via SOAP and REST web services

2.3 NETWORK SERVER CONTROLLERS (NSCS)

A. Network Router Controllers shall combine both network routing functions, control functions, and server functions into a single unit.

B. The BACnet NSC shall be classified as a "native" BACnet device, supporting the BACnet Network Server Controller (B-BC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. NSCs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Network Server Controllers (B-BC).

C. The Network Server Controller shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NRS.

D. nected to the NRS.

E. The NSCs shall be capable of whitelisting IPs to restrict access to a pre-defined list of hosts or devices.

F. Whitelisting of file extensions for documents shall be capable.

G. Encrypted and authenticated communication shall be configurable for non-open protocol communications using TLS 1.2

H. The NSCs shall support Simple Network Management Protocol version 3 (SNMPv3) for monitoring of the NSCs using a Network Management Tool.

I. The NSCs shall support remote system logging for used by System Information and Event Monitoring (SIEM) software.

J. They shall also be responsible for monitoring and controlling their own HVAC equipment such as an AHU or boiler.

K. They shall also contain graphics, trends, trend charts, alarm views, and other similar presentation objects that can be served to workstations or web-based interfaces. A sufficient number of NSCs shall be supplied to fully meet the requirements of this specification and the attached point list.

L. It shall be capable of executing application control programs to provide:

1. Calendar functions
2. Scheduling
3. Trending
4. Alarm monitoring and routing
5. Time synchronization by means of an Internet site including automatic synchronization
6. Native integration of LonWorks controller data and Modbus controller data or BACnet controller data and Modbus controller data

M. Hardware Specifications

1. Memory:
   a. The operating system of the controller, application programs, and all other portions of the configuration database, shall be stored in non-volatile, FLASH memory. Servers/Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.
2. Each NSC shall provide the following on-board hardware for communication:
   a. Two 10/100b Ethernet for communication to Workstations, other NRCs, IP field bus controllers, other SDCUs, and onto the internet.
      1) The two Ethernet ports shall support active switch and BACnet/IP communication protocols.
      2) Support IPv4 addressing
      3) Ethernet port 1 shall support static or DHCP client configuration for communication to Workstation or other NSCs
      4) Ethernet port 2 shall support switch mode or DHCP server to set addressing of DHCP client devices
      5) It shall be possible to disable Ethernet port 2
      6) In DHCP server mode, the Ethernet port 2 shall support 50 BACnet/IP field controllers in daisy chain configuration directly from the port
      7) Each NSC shall be able to support a total of 250 IP SDCUs in daisy chain configuration (5 sub networks via switch)

8) If using RSTP (Rapid Spanning Tree Protocol) with a managed switch (with IEEE 802.1W or IEEE 802.1Q-2014 support), Ethernet port 2 shall support up to 39 devices
9) Each NSC shall be able to support a total of 234 IP SDCUs in RSTP configuration (6 sub networks via managed switch)
10) Where a switch is needed, use a Cisco 9000 Catalyst or IE switch, EtherWAN EX63402-01B, or other equal and approved equivalent.

b. Two RS-485 ports for communication to BACnet MSTP bus or serial Modbus (software configurable)
c. One device USB port
d. One host USB port

3. The NSC shall conform to a small footprint no larger than 100W x 125H x 75D mm (3.94W x 4.92H x 2.95D in).

N. Modular Expandability:

1. The system shall employ a modular I/O design to allow expansion. Input and output capacity is to be provided through plug-in modules of various types. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.
2. One shall be able to "hot-change" (hot-swap) the I/O modules preserving the system on-line without any intervention on the software; addressing and configuration shall be automatic.
3. If for any reason the backplane of the modular I/O system were to fail, I/O module addresses will be protected.

O. Hardware Override Switches:

1. All digital outputs shall, optionally, include three position manual override switches to allow selection of the ON, OFF, or AUTO output state. These switches shall be built into the unit and shall provide feedback to the controller so that the position of the override switch can be obtained through software. In addition each analog output shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range, when the 3 position manual override switch is placed in the ON position.

P. Universal Input Temperatures

1. All universal inputs directly connected to the NSC via modular expansion shall be capable of using the following thermistors for use in the system without any external converters needed.
a. 10 kohm Type I (Continuum)
b. 10 kohm Type II (I/NET)
c. 10 kohm Type III (Satchwell)
d. 10 kohm Type IV (FD)
e. Linearized 10 kohm Type V (FD w/11k shunt)
f. Linearized 10 kohm (Satchwell)
g. 1.8 kohm (Xenta)
h. 1 kohm (Balco)
i. 20 kohm (Honeywell)
j. 2.2 kohm (Johnson)

2. In addition to the above, the system shall be capable of using the below RTD sensors, however it is not required that all universal inputs be compatible with them.
   a. PT100 (Siemens)
   b. PT1000 (Sauter)
   c. Ni1000 (Danfoss)

Q. Local Status Indicator Lamps:

1. The NSC shall provide as a minimum LED indication of CPU status, Ethernet LAN status, and field bus status.

R. Real Time Clock (RTC):

1. Each NSC shall include a real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. Each NSC will allow for its own UTC offset, depending upon the time zone. When the time zone is set, the NSC will also store the appropriate times for daylight savings time.
2. The RTC date and time shall also be accurate, up to 30 days, when the NSC is powerless.
3. No batteries may be used to for the backup of the RTC.

S. Power Supply:

1. The 24 VDC power supply for the NSCs shall provide 30 watts of available power for the NSC and associated IO modules. The system shall support the use of more than one power supply if heavily power consuming modules are required.
2. The power supply, NSC, and I/O modules shall connect power wise and communication wise via the separate terminal base allowing for ease of replacement and no separate or loose wiring.

T. Automatic Restart After Power Failure:

1. Upon restoration of power after an outage, the NSC shall automatically and without human intervention update all monitored functions, resume operation based on current, synchronize time and status, and implement special start-up strategies as required.

U. Data Retention:

1. During a power failure, the NSC shall retain all programs, configuration data, historical data, and all other data that is configured to be retained. There shall be no time restriction for this retention and it must not use batteries to achieve it.

V. Software Specifications

1. The operating system of the controller, application programs, and all other portions of the configuration database such as graphics, trends, alarms, views, etc., shall be stored in non-volatile, FLASH memory. There will be no restrictions placed on the type of application programs in the system. Each NSC shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user

communications including interrogation, program entry, printout of the program for storage, etc.

2. access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.

3. ities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
4. Each NSC shall have an available capacity of 4 GB of memory. This shall represent 2 GB for application and historical data and 2 GB dedicated for backup storage.

W. User Programming Language:

1. The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be either a script-based structured text or graphical function block based and fully programmable by the user. The language shall be structured to allow for the configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, and histories. Users shall be able to place comments anywhere in the body of either script or function block programs.

2. ers shall be able to place comments anywhere in the body of either script or function block programs.

3. omments anywhere in the body of either script or function block programs.
4. Network Server Controllers that use a “canned” program method will not be accepted.

X. Control Software:

1. The NSC shall have the ability to perform the following pre-tested control algorithms:
   a. Proportional, Integral plus Derivative Control (PID)
   b. Two Position Control
   c. Digital Filter
   d. Ratio Calculator
   e. Equipment Cycling Protection

Y. Mathematical Functions:

1. Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These must be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.

Z. NSCs shall have the ability to perform any or all of the following energy management routines:

AA. ollowing energy management routines:

1. Time of Day Scheduling
2. Calendar Based Scheduling
3. Holiday Scheduling
4. Temporary Schedule Overrides
5. Optimal Start
6. Optimal Stop
7. Night Setback Control
8. Enthalpy Switchover (Economizer)
9. Peak Demand Limiting
10. Temperature Compensated Duty Cycling
11. CFM Tracking
12. Heating/Cooling Interlock
13. Hot/Cold Deck Reset
14. Hot Water Reset
15. Chilled Water Reset
16. Condenser Water Reset
17. Chiller Sequencing

BB. History Logging:

1. Each NSC controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable either over user defined time intervals ranging from 1 second to 1440 minutes or based upon a user configurable change of value. A minimum of 1000 logs, with a minimum of 100,000 records, shall be stored. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to a higher level NSC long term archiving based upon user-defined time intervals, or manual command.

2. based upon user-defined time intervals, or manual command.

3. efined time intervals, or manual command.
4. For extended trend logging a minimum of 1500 trends shall be capable, with a minimum number of 600,000 records within.
5. Management of a power meter replacement to ensure meter log data is accurate shall be possible in the NSC.
6. Every hardware input and output point, hosted within the NSC and attached I/O modules, shall be trended automatically without the requirement for manual creation, and each of these logs shall log values based upon a change of value and store at least 500 trend samples before replacing the oldest sample with new data.
7. The presentation of logged data shall be built into the server capabilities of the NSC. Presentation can be in time stamped list formats or in a chart format with fully configurable pen colors, weights, scales and time spans.
8. weights, scales and time spans.
9. Tooltips shall be present, magnetic, and visible based on users preference.
10. Comments shall be visible whenever viewing the trend log list.
11. System shall give indication of memory usage and be able to alert the user if too many logs are allocated.

CC. Alarm Management:

1. For each system point, alarms can be created based on high/low limits or in comparison to other point values. All alarms will be tested each scan of the NSC and can result in the display of one or more alarm messages or reports.
2. There is no limit to the number of alarms that can be created for any point
3. Alarms can be configured to be generated based upon a single system condition or multiple system conditions.
4. Alarms will be generated based on an evaluation of the alarm conditions and can be presented to the user in a fully configurable order, by priority, by time, by category, etc. These configurable alarm views will be presented to a user upon logging into the system regardless of whether the log in takes place at a WorkStation or a Webstation.
5. The alarm management system shall support the ability to create and select cause and action notes to be selected and associated with an alarm event. Checklists shall also be possible in order to present to an operator a suggested mode of troubleshooting. When acknowledging an alarm, it shall be possible to assign it to a user of the system such that the user is notified of the assignment and is made responsible for the alarm resolution.
6. o be possible in order to present to an operator a suggested mode of troubleshooting. When acknowledging an alarm, it shall be possible to assign it to a user of the system such that the user is notified of the assignment and is made responsible for the alarm resolution.
7. Alarms must be capable of being routed to any BACnet workstation that conforms to the B-OWS device profile and uses the BACnet/IP protocol.

DD. Embedded Web Server

1. Each NSC must have the ability to serve out web pages containing the same information that is available from the WorkStation. The development of the screens to accomplish shall not require any additional engineering labor over that required to show them at the WorkStation itself.
2. The NSC shall be configurable to logging all Embedded Web Server access attempts
3. The NSC shall have the option to redirect HTTP based Embedded Web Server connections to secure, HTTPS connections.
4. The NSC shall authenticate and authorize all users connecting to the Embedded Web Server
5. The NSC shall provide to ability to configure an automatic logoff for Embedded Web Server users that have not had any activity for an adjustable time period.

2.4 BACNET IP FIELDBUS CONTROLLERS

A. Controllers – BACnet/IP Protocol

1. All BACnet/IP Fieldbus controllers shall be BACnet Testing Laboratory listed (v12 or later) as specified BACnet Advanced Application Controller (B-AAC)
2. All BACnet/IP Fieldbus controllers shall use the following communication specifications and achieve performance as specified herein:
   a. All controllers shall be able to communicate peer-to-peer without the need for a NSC
   b. Any BACnet/IP Fieldbus controllers on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.

B. The BACnet/IP Fieldbus controllers shall be equipped with 2x 10/100bT Ethernet communication ports with active switch and will support BACnet/IP communication protocols with the following configurations:

1. Supporting IPv4 addressing
2. Supporting Static IP setting, DHCP client and Auto-IP address acquision
3. It shall be possible to disable Ethernet port 2

C. Topologies

1. BACnet/IP Fieldbus controllers shall support daisy chain topology of up to 50 controllers. In case of any disruption to the communication, a system alarm shall notify the NSC/BMS of the point disruption has occurred.
2. BACnet/IP Fieldbus Controllers shall support RSTP loop whereby up to 39 controllers are supported.
3. In case of any disruption there shall be no communication interruption
4. In case of any disruption there shall be system alarms that will inform the operator of the disruption

D. Performance

1. Each BACnet/IP Fieldbus Controllers shall have a 32-bit microprocessor operating at 500 MHz and support a BACnet protocol stack in accordance with the ANSI/ASHRAE Standard 135-2008 and the BACnet Device Profile supported.
2. They shall be multi-tasking, real-time digital control processors consisting of communication controllers, controls processing, power supplies with built-in inputs and outputs.

E. Programmability

1. The BACnet/IP Fieldbus controllers shall support both script programming language and graphical that will be consistent with the NSC.
2. The control program will reside within the same enclosure as the input/output circuitry, that reads inputs and controls outputs
3. All control sequences programmed into the BACnet/IP Fieldbus Controllers shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
4. BACnet/IP Fieldbus controllers shall communicate with the Network Server Controller (NSC) via a BACnet/IP connection at a baud rate of not less than 100 Mbps
5. BACnet/IP Fieldbus controllers shall support a dedicated communications port for connecting and supplying power to a matching room temperature and/or humidity sensor and/or CO2 and/or presence detector that does not utilize any of the I/O points of the controller.
6. BACnet/IP Fieldbus controllers (Excluding VAV) shall support an add-on display to supply and provide access in real-time for monitoring inputs and overriding of outputs
7. The override functionality must be supported by a dedicated processor to assure reliable operation (overriding of output)
8. Each BACnet/IP Fieldbus controller shall have sufficient memory, to support its own operating system and databases, including:
    a. Control processes
    b. Energy management applications

c. Alarm management
d. Historical/trend data
e. Maintenance support applications
f. Custom processes
g. Manal override monitoring

9. Each BACnet/IP Fieldbus controller shall support local trend data up to 2x the built-in I/O and at a minimum be capable of holding 5 days @ 15 min intervals locally.
10. The BACnet/IP Fieldbus controller analog or universal input shall use a 16 bit A/D converter.
11. The BACnet/IP Fieldbus controller analog or universal output shall use a 10 bit D/A converter.
12. Built-in I/O: each BACnet/IP Fieldbus controllers shall support:
    a. At minimum 8 and up to 20 configurable IO channels to monitor and to control the following types of inputs and outputs without the addition of equipment inside or outside the DDC Controller cabinet.
        1) Universal Inputs – the following thermistors for use in the system without any external converters needed.
            a) 10 kohm Type I (Continuum)
            b) 10 kohm Type II (I/NET)
            c) 10 kohm Type III (Satchwell)
            d) 10 kohm Type IV (FD)
            e) Linearized 10 kohm Type V (FD w/11k shunt)
            f) Linearized 10 kohm (Satchwell)
            g) 1.8 kohm (Xenta)
            h) 1 kohm (Balco)
            i) 20 kohm (Honeywell)
            j) 2.2 kohm (Johnson)
            k) PT100 (Siemens)
            l) PT1000 (Sauter)
            m) Ni1000 (Danfoss)
        2) Analog inputs
            a) Current Input - 0-20 mA
            b) Voltage Input 0-10 Vdc
        3) Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
            a) Digital outputs
            b) Analog outputs of 4-20 mA and/or 0-10 Vdc

13. Real Time Clock (RTC):
    a. Each BACnet/IP Fieldbus controller shall include a real time clock, accurate to +/- 1 minute per month. The RTC shall provide the following: time of day, day, month, year, and day of week.
    b. The RTC date and time shall also be accurate, up to 7 days, when the BACnet/IP Fieldbus controller is powerless.
    c. No batteries may be used to for the backup of the RTC.
14. The BACnet/IP Fieldbus controller for Variable Air Volume (VAV) applications
    a. The BACnet/IP Fieldbus controller for VAV applications shall include a built-in ‘flow thru’ differential pressure transducer
    b. The VAV differential pressure transducer shall have a measurement range of 0 to 1 in. W.C. and measurement accuracy of ±5% at 0.001 to 1 in. W.C. and a minimum resolution of 0.001 in. W.C., insuring primary air flow conditions shall be

controlled and maintained to within ±5% of setpoint at the specified minimum and maximum air flow parameters

c. The BACnet/IP FieldBus controller for VAV applications shall support a dedicated commissioning tool for air flow balancing
d. The BACnet/IP Fieldbus controller for VAV applications shall require no programing for air balancing algorithm
e. All balancing parameters shall be synchronized in NSC

15. Each BACnet/IP Fieldbus controller shall have a minimum of 10% spare capacity for each point type represented on the controller for future point connection
16. Power Requirements.{BIP}{BIP}: 24VDC (21 to 33 VDC) and 24 VAC +/-20% with local transformer power

2.5 CONTROL DEVICES

A. General: Where indicated on the drawings, schedules or sequence of operations, provide equipment that conforms to the following specifications:

B. Temperature Sensors

1. All temperature devices shall use precision thermistors accurate to +/- 0.36°F over a range of –30 to 230°F.
2. Standard space sensors shall be provided in an off white enclosure for mounting on a standard electrical box.
3. Where manual override of unoccupied mode of control is indicated on the drawings or sequence of operation, provide a push button for selecting after hours operation.
4. Where manual adjustment to the setpoint is indicated on the drawings or sequence of operation, provide slider with +/- programmable scale
5. Where a local display is indicated on the drawings or sequence of operation, the sensor shall incorporate LCD display for viewing the space temperature.
6. Where digital setpoint adjustment and/or other operator selectable parameters are indicated on the drawings or sequence of operation, provide a sensor with built in buttons and digital display. The sensor shall be programmable to provide custom function as specified.
7. Duct temperature sensors shall incorporate a thermistor bead embedded at the tip of a stainless steel tube. Probe style duct sensors shall be used in air handling applications where the air stream temperature is consistent and is not stratified.
8. d.
9. Averaging sensors shall be employed in all mixing plenum applications and in any other application where the temperature might otherwise be stratified. The averaging sensor tube shall contain at least four thermistor sensors.
10. Immersion sensors shall be employed for measurement of temperature in all chilled water, hot water and glycol applications. Thermal wells shall be brass or stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications.

C. Humidity Sensors

1. Humidity sensors shall be polymer resistance type.
2. Space humidity sensors shall have a sensing range of 05 to 95% with accuracy of +/- 2% RH.

3. Duct sensors and Outdoor air humidity sensors shall have a sensing range of 05 to 95% RH with accuracy of +/- 3% RH. Sensors shall be suitable for ambient temperature conditions of -40 to 212°F.
4. Equipment shall be able to demonstrate that accuracy is NIST traceable calibration.

D. Carbon Dioxide Wall Transmitter:

1. Space or duct mounted carbon dioxide (CO2) sensor shall be a dual element thermally compensated Lithium Tantalate IR detector, and shall contain an on board relay with field adjustable trip point and adjustable time delay. The sensor shall monitor CO2 over a range of 0 – 3000 PPM, have an accuracy of +/-3% and operate within the range of 32-104°F and 0-95% RH. The sensor shall have a calibration accuracy of 0.5%, a repeatability of no more than +/-20 PPM and a drift of no more than +/-2%. The sensor shall have a green LED for normal operation, and a red LED for relay, and a reset button. Where required by the drawings or specifications, provide an LCD display for displaying PPM level and field adjustable settings. Greystone Product # CDD or equivalent.

2.
3. Wall mounted carbon monoxide (CO) sensor shall be microprocessor based (12 bit accuracy) and shall monitor CO over a range of 0-300 PPM (optional 200-500 PPM). The device shall have an accuracy of +/-3% (electrochemical type) or +/-5% (solid state type) and operate within the range of 32-122°F and 0-95% RH. The sensor shall have a calibration accuracy of 0.5%. Where required by the drawings or specifications, provide an LCD display for displaying PPM level and system configuration information and/or audible alarm with programmable trip point and disable jumper. Greystone Product # CMD or equivalent.

E. Pressure Transmitters.

1. Air pressure or differential air pressure measurements in the range of 0 to 10” water column shall be accurate to +/- 1% of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Acceptable manufacturer shall be Setra model C-264.
2. Liquid pressure or differential liquid pressure measurements shall be accurate to +/- 0.25% of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Unit shall be provided with isolation and bypass manifold for start-up and maintenance operations. An acceptable manufacturer shall be Setra model C-230.
3. Steam pressure measurements shall be accurate to +/- 0.13% of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Unit shall be provided with isolation and bypass manifold for start-up and maintenance operations. Acceptable manufacturer shall be Setra model C-207.
4. Transmitter shall be available with a certification of NIST calibration
5. [Transmitter shall be preinstalled on a bypass valve manifold]
6. Basis of Design: Veris PW

F. High Limit Thermostats

1. High limit thermostats shall be located as directed and shall be manual reset type set at 120°F in the return and 180°F in the discharge. Thermostats shall be double pole so as to provide input capability for alarm at the BAS.

G. Low Limit Thermostats

1. Safety low limit thermostats shall be vapor pressure type with a 20-foot minimum element. Element shall respond to the lowest temperature sensed by any one-foot section. Provide one thermostat for each 25 square foot of coil area.
2. Low limit thermostat shall be manual reset and shall be double pole so as to provide input capability for alarm at the BAS.

H. Current Sensors

1. Current status switches shall be used to monitor the run status of fans, pumps, motors and electrical loads. Acceptable manufacturer is Veris or approved equal.

I. Pneumatic Digital Transducers

1. Device shall provide a pneumatic output proportional to an analog output signal generated by the computer controller. Software algorithms shall compute the position of the actuator and the actuator shall be adjusted to that position. “Bleed Feed” Transducers that do not respond proportionally to a computed proportional output of the computer are not acceptable.
2. Device shall fail to Zero PSI on power or signal failure
3. Device shall use no air at steady state output position
4. Device shall be provided with Zero and Span adjustment and Manual override positioning capability.
5. Device shall be capable of generating a 0 to 10Vdc analog output proportional to pneumatic output

J. Control Valves

1. Control Valves: Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
2. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional (except as noted).
3. Hydronic system globe valves shall have the following characteristics:
   a. NPS 2 and Smaller: ANSI Class 250 bronze body, stainless steel stem, brass plug, bronze seat, and a TFE packing.
   b. NPS 2-1/2 and Larger: ANSI Class 250 cast iron body, stainless steel stem, bronze plug, bronze seat, and a TFE V-ring packing.
   c. Sizing:
      1) Two-Position: Line size or size using a pressure differential of 1 psi.
      2) Two-Way Modulating: 4 psig or twice the load pressure drop, whichever is more.
      3) Three-Way Modulating: Twice the load pressure drop, but not more than 4 psig.
4. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

5. Close-Off Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system head pressure for two-way valves and 150 percent of the design pressure differential across the three-way valves.
6. Two- and three-way globe valves shall be used only if characterized control valves do not fit the sizing criteria or application.
7. Electronic Valve Actuators:
    a. Size for torque required for valve close off at 150 percent of total system (head) pressure for two-way valves; and 100 percent of pressure differential across the valve or 100 percent of total system (pump) head differential pressure for three-way valves.
    b. Coupling: Directly couple end mount to stem, shaft, or ISO-style direct-coupled mounting pad.
    c. Mounting: Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
    d. Overload Protection: Electronic overload or digital rotation-sensing circuitry without the use of end switches to deactivate the actuator at the end of rotation.
    e. Fail-Safe Operation: Mechanical, spring-return mechanism.
    f. Power Requirements: Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
    g. Maximum 1 VA at 24-V ac or 1 W at 24-V dc.
    h. Temperature Rating: -22 to +122ºF -30 to +50ºC [-58 to +122ºF -50 to +50ºC].
    i. Housing: Minimum requirement NEMA type 2 / IP54 mounted in any orientation.
    j. Agency Listing: ISO 9001, cULus, and CSA C22.2 No. 24-93.
    k. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.

K. Dampers

1. Automatic dampers, furnished by the Building Automation Contractor shall be single or multiple blades as required. Dampers shall be installed by the Mechanical Contractor under the supervision of the BAS Contractor. All blank-off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the Sheet Metal Contractor.
2. Damper frames shall be hat shaped channel, 4” deep constructed of 16-gauge galvanized steel. Stainless steel side seals, and sintered bronze, oil-impregnated bearings shall also be provided.
3. Damper blades shall be 16-gauge galvanized steel and shall be 6” on center. Provide vinyl-grip seals on blades.
4. Provide damper linkage that consists of 0.50” diameter steel, cadmium plated and chromate treated pivots. Provide a ¼-20 set-screw with a locking-patch to lock the pivots to a 0.31 diameter aluminum rod. Pivots shall rotate in a Celcon bearing. Blade brackets shall be 12-gauge cadmium plated steel. Blades shall be individually factory adjusted for maximum shut off.
5. Provide axles that are steel, 0.350” diameter cadmium plated and driveshafts that are ½” diameter cadmium plated steel, extendable 6”.
6. For high performance applications, control dampers shall meet or exceed the UL Class I leakage rating.
7. Control dampers shall be Ruskin, Arrow or approved equal.
8. Unless otherwise noted, provide opposed blade dampers for modulating applications and parallel blade for two-position control.

L. Damper Actuators

1. Direct-coupled type non-hydraulic designed for minimum 100,000 full-stroke cycles at rated torque.
2. Direct-coupled damper actuators must have a five-year warrantee.
3. Size for torque required for damper seal at maximum design conditions and valve close-off pressure for system design.
4. Overload protected electronically throughout rotation except for selected Floating actuators the have a mechanical clutch.
5. Spring Return Actuators: Mechanical fail safe shall incorporate a spring-return mechanism.
6. Non-Spring Return Actuators shall stay in the position last commended by the controller with an external manual gear release to allow positioning when not powered.
7. Power Requirements: 24Vac/dc [120Vac] [230Vac]
8. Proportional Actuators controller input range from 0…10 Vdc, 2…10 Vdc or 4…20 mA models.
9. Housing: Minimum requirement NEMA type 2
10. Actuators with a microprocessor should not be able to be modified by an outside source (cracked or hacked).
11. Actuators of 133 and 270 lb.-in. of torque or more should be able to be tandem mount or "gang" mount.
12. Agency Listings: ISO 9001, cULus, CE and CSA
13. Basis of Design: Belimo.

M. Airflow Measuring Stations

1. Provide an array of airflow traverse probes where indicated, capable of continuously monitoring the fan or duct capacities (CFM) they serve. Each airflow traverse probe shall contain multiple total and static pressure sensors located along the exterior surface of the cylindrical probe and internally connected to their respective averaging manifolds. The flow sensors shall not protrude beyond the surface of the probe(s), and shall be the offset type for static pressure and the chamfered impact type for total pressure measurement. The airflow sensing probe's measurement accuracy shall not be affected by directional flow having pitch and/or yaw angles up to 30°. Each airflow traverse probe shall be of extruded aluminum construction and furnished with mounting plate(s), gasket and signal fittings suitable for HVAC duct installation.

2. l pressure measurement. The airflow sensing probe's measurement accuracy shall not be affected by directional flow having pitch and/or yaw angles up to 30°. Each airflow traverse probe shall be of extruded aluminum construction and furnished with mounting plate(s), gasket and signal fittings suitable for HVAC duct installation.

3. pressure measurement. The airflow sensing probe's measurement accuracy shall not be affected by directional flow having pitch and/or yaw angles up to 30°. Each airflow traverse probe shall be of extruded aluminum construction and furnished with mounting plate(s), gasket and signal fittings suitable for HVAC duct installation.
4. The airflow traverse probe shall not induce a pressure drop in excess of 0.03" w.c. at 2000 FPM, nor measurably contribute to sound levels within the duct. Total and static pressure sensors shall be located at the centers of equal areas (for rectangular duct) or at equal concentric area centers (for circular ducts) along the probe length. The airflow traverse probe shall be capable of producing steady, non-pulsating signals of total and static pressure without need for flow corrections or factors, with an accuracy of 2-3% of actual flow, over a velocity range of 400 to 4000 FPM.

5. ensors shall be located at the centers of equal areas (for rectangular duct) or at equal concentric area centers (for circular ducts) along the probe length. The airflow traverse probe shall be capable of producing steady, non-pulsating signals of total and static pressure without need for flow corrections or factors, with an accuracy of 2-3% of actual flow, over a velocity range of 400 to 4000 FPM.
6. ccuracy of 2-3% of actual flow, over a velocity range of 400 to 4000 FPM.
7. Provide the minimum number of probes indicated: Duct height 8 – 12", 1 probe; 13 – 30", 2 probes; 31 – 54", 3 probes; 55 – 84", 4 probes; 85 – 120", 5 probes; 121 – 180", 6 probes.
8. The airflow traverse probe shall be the VOLU-probe as manufactured by Air Monitor Corporation, or equivalent.

PART 3 - EXECUTION

3.1 CONTRACTOR RESPONSIBILITIES

A. General: Installation of the building automation system shall be performed by the Temperature Controls Contractor or a Subcontractor. However, all installation shall be under the personal supervision of the Temperature Controls Contractor. The Temperature Controls Contractor shall certify all work is proper and complete. The design, scheduling, coordination, programming, training, and warranty requirements for the project be performed by the Temperature Controls Contractor.

B. Demolition: Remove controls which do not remain as part of the building automation system, including all associated abandoned wiring, conduit, and pneumatic tubing. The Owner will inform the Contractor of any equipment that is to be removed that will remain the property of the Owner. This equipment shall be handled with care so as not to damage it. All other equipment that is removed shall be disposed of by the Contractor.

C. Cleanup: At the completion of the work, all equipment pertinent to this section shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this section. Clean the exposed surfaces of tubing, hangers, and other exposed metal of grease, plaster, or other foreign materials.

3.2 WIRING, CONDUIT AND CABLE

A. All wiring (high voltage, 50 volts and greater) and conduit is to be installed in accordance with local and national electrical codes and Division 26 (Electrical division) specification.

1. All temperature control cable less than 50 volts is to be considered low voltage.
2. All low voltage cable is to be run in conduit in any non-accessible concealed space and up to 10 ft. above floor level within mechanical rooms. Wiring above 10 ft or within accessible areas (ceilings, crawl spaces) may be run exposed with proper support with bridle rings. Wiring is to be run parallel and perpendicular to building lines in a neat and workmanlike manner and bundled with nylon tie wraps.
3. Conduit sleeves shall be run through any concrete or block walls for low voltage cable to be run through such walls.
4. ch walls.

5. All low voltage cable shall be run separate from high voltage cable. All microprocessor communications cable shall be run separate from any low or high voltage cable.
6. Any cable running in plenum rated areas shall be plenum rated cable.
7. Coaxial cable shall conform to RG62 or RG59 rating. Provide plenum rated coaxial cable when running in return air plenums.
8. Fiber optic cable shall include the following sizes: 50/125, 62.5/125 or 100/140.
9. Only glass fiber is acceptable, no plastic will be allowed.
10. Fiber optic cable shall only be installed and terminated by an experienced contractor.
11. Wires and tubing shall be installed a minimum of three (3) inches from hot water, steam, or condensate piping.
12. A true earth ground shall be available in the building. Ground shall be run from the source electrical panel ground to each temperature control panel or controller.
13. Metallic surface raceway may be used in finished areas on non-accessible masonry walls AS APPROVED BY OWNER AND/OR ARCHITECT/ENGINEER. All surface raceway in finished areas shall be color matched to the existing finish within the limitations of standard manufacturer's colors.

3.3 HARDWARE INSTALLATION

A. Installation Practices for Field Devices

1. Actuators shall be firmly mounted to give positive movement, and linkage shall be adjusted to give smooth continuous movement throughout 100 percent of the actuator stroke.
2. Actuators shall be stroked ~5%, tightened and returned to normal position to give a positive seal.
3. Relay outputs shall include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
4. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
5. For duct static pressure sensors, the high-pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low-pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.
6. For building static pressure sensors, the high-pressure port shall be inserted into the space via a metal tube. The low-pressure port shall be piped to the outside of the building.

B. Enclosures:

1. For all I/O requiring field interface devices, these devices where practical shall be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure that protects the device(s) from dust and moisture, and conceals integral wiring and moving parts.
2. FIPs shall contain power supplies for sensors, interface relays and contactors, safety circuits, and I/P transducers.
3. The FIP enclosure shall be of steel construction with baked enamel finish, NEMA 1 rated with a hinged door and keyed lock. All locks shall be keyed identically.
4. All outside mounted enclosures shall meet the NEMA-4 rating.

3.4 SOFTWARE INSTALLATION

A. General: The Contractor shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third-party software necessary for successful operation of the system.

B. Database Configuration: The Contractor shall provide all labor to configure those portions of the database that are required by the point list and sequence of operation.

C. Graphic user interface: Unless otherwise directed by the owner, the Contractor shall provide color graphic displays as depicted in the schematic drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for setpoint changes as required by the owner.

3.5 EXISTING CONTROL DEVICES

A. The bid for the control work shall be based on the premise that existing control devices (i.e. valves & damper operators) are operational and are not in need of repair or replacement, unless otherwise noted.

B. This contractor shall notify the Owner's Representative of existing control devices that need to be replaced or repaired that may be noticed in the process of installation of new work.

3.6 COMMISSIONING AND SYSTEM STARTUP

A. Point to Point Checkout: Each I/O device (both field mounted and those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager.

B. Controller and Workstation Checkout: A field checkout of all controllers and front-end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner's representative by the completion of the project.

C. System Acceptance Testing:

1. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended.
2. Perform an operational test of each third-party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

END OF SECTION 230923

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:

1. Copper tube and fittings.
2. Steel pipe and fittings.
3. Plastic pipe and fittings.
4. Joining materials.
5. Transition fittings.
6. Dielectric fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Pipe and tube.
2. Fittings.
3. Joining materials.
4. Transition and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Other building services.
3. Structural members.

B. Qualification Data: For Installer.
C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
C. DWV Copper Tubing: ASTM B 306, Type DWV.
D. Copper or Bronze Pressure-Seal Fittings:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Viega LLC.

2. Housing: Copper.
3. O-Rings and Pipe Stops: EPDM.
4. Tools: Manufacturer's special tools.
5. Minimum 200-psig working-pressure rating at 250 deg F.
6. Warranty: Pressure-seal fittings, when properly installed and under normal conditions of use, will be free of failure from manufacturing defect for a period of fifty (50) years from date of installation.

E. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.
B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.
C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.
D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.
E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.
F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.3 PLASTIC PIPE AND FITTINGS

A. PVC Plastic Pipe: ASTM D 1785, with wall thickness as indicated in "Piping Applications" Article.

1. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.

2.4 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.
D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
F. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
G. Solvent Cements for CPVC Piping: ASTM F 493.
H. Solvent Cements for PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.5 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings:

1. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.

B. Plastic-to-Metal Transition Unions:

1. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Description:

a. Standard: ASSE 1079.
b. Pressure Rating: 125 psig minimum at 180 deg F.
c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Description:

a. Standard: ASSE 1079.
b. Factory-fabricated, bolted, companion-flange assembly.
c. Pressure Rating: 125 psig minimum at 180 deg F 175 psig.
d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Description:

a. Standard: IAPMO PS 66.
b. Electroplated steel nipple, complying with ASTM F 1545.

c. Pressure Rating: 300 psig at 225 deg F.
d. End Connections: Male threaded or grooved.
e. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Hot-water heating piping, aboveground, NPS 3/4 to NPS 2, and in fully accessible areas such as above suspended ceilings or exposed in mechanical rooms, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Type L, drawn-temper copper tubing, wrought-copper fittings, and pressure-seal joints.

D. Hot-water heating piping, aboveground, NPS 2-1/2 to NPS 6, and in accessible areas such as above suspended ceilings or exposed in mechanical rooms, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Type L, drawn-temper copper tubing, wrought-copper fittings, and pressure-seal joints.
3. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

E. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints or Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.
F. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

G. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

3.2 PIPING INSTALLATION

A. Install copper pressure-seal fittings in fully accessible areas only. Pressure-seal fittings behind walls, in chases, or above gypsum boarded ceilings are not permitted.
B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
F. Install piping to permit valve servicing.
G. Install piping at indicated slopes.
H. Install piping free of sags and bends.
I. Install fittings for changes in direction and branch connections.
J. Install piping to allow application of insulation.
K. Select system components with pressure rating equal to or greater than system operating pressure.
L. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
M. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
N. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
O. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
P. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
Q. Install valves according to the following:

    1. Section 230523.12 "Ball Valves for HVAC Piping."
    2. Section 230523.13 "Butterfly Valves for HVAC Piping."
    3. Section 230523.14 "Check Valves for HVAC Piping."

R. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

S. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
T. Install shutoff valve immediately upstream of each dielectric fitting.
U. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.
V. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.
W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.3 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
C. Dielectric Fittings for: Use dielectric flange kits.
D. Dielectric Fittings for and Larger: Use dielectric flange kits.

3.4 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.
B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

C. Install hangers for copper tubing and steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
D. Install hangers for plastic piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
E. Install hangers for fiberglass piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
F. Support horizontal piping within 12 inches of each fitting and coupling.
G. Support vertical runs of copper tubing and steel piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
H. Support vertical runs of fiberglass piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.5 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

    1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
    2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
G. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
4. PVC Nonpressure Piping: Join according to ASTM D 2855.

H. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.6 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
B. Install control valves in accessible locations close to connected equipment.
C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
D. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

3.7 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom

of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Hydronic specialty valves.
2. Air-control devices.
3. Strainers.
4. Connectors.

B. Related Requirements:

1. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for expansion fittings and loops.
2. Section 230523.12 "Ball Valves for HVAC Piping" for specification and installation requirements for ball valves common to most piping systems.
3. Section 230523.13 "Butterfly Valves for HVAC Piping" for specification and installation requirements for butterfly valves common to most piping systems.
4. Section 230523.14 "Check Valves for HVAC Piping" for specification and installation requirements for check valves common to most piping systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product:

1. Include construction details and material descriptions for hydronic piping specialties.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
3. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For hydronic piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
B. Safety Valves and Pressure Vessels: Shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 HYDRONIC SPECIALTY VALVES

A. Bronze, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong Pumps, Inc.
   b. Bell & Gossett; a Xylem brand.
   c. TACO Comfort Solutions, Inc.
   d. WATTS.
2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig.
10. Maximum Operating Temperature: 250 deg F.

B. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong Pumps, Inc.
   b. Bell & Gossett; a Xylem brand.
   c. TACO Comfort Solutions, Inc.
   d. WATTS.
2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig.
11. Maximum Operating Temperature: 250 deg F.

C. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMTROL, Inc.
   b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   c. Armstrong Pumps, Inc.
   d. Bell & Gossett; a Xylem brand.
   e. WATTS.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: , removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

D. Diaphragm-Operated Safety Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMTROL, Inc.
   b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   c. Armstrong Pumps, Inc.
   d. Bell & Gossett; a Xylem brand.
   e. WATTS.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: Removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

E. Automatic Flow-Control Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. IMI Flow Design, Inc.
2. Body: Brass.
3. Flow Control Assembly, provide the following:
   a. Piston and Spring Assembly: Stainless steel, tamper proof, self-cleaning, and removable flow cartridge.

4. Combination Assemblies: Include integral bronze or brass-alloy ball valve.
5. Each valve shall have two pressure/temperature ports, arranged to provide a reading of the differential pressure across the flow limiting mechanism.
6. Identification Tag: Marked with zone identification, valve number, and flow rate.
7. Size: Same as pipe in which installed.
8. Performance: Maintain constant flow within plus or minus 10 percent, regardless of system pressure fluctuations.
9. Minimum CWP Rating: 175 psig.
10. Maximum Operating Temperature: 250 deg F.

2.2 AIR-CONTROL DEVICES

A. Manual Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMTROL, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett; a Xylem brand.
   d. TACO Comfort Solutions, Inc.
   e. WATTS.
2. Body: Bronze.
3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/8.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMTROL, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett; a Xylem brand.
   d. TACO Comfort Solutions, Inc.
   e. WATTS.
2. Body: Bronze or cast iron.
3. Internal Parts: Nonferrous.
4. Operator: Noncorrosive metal float.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/4.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 240 deg F.

C. Bladder-Type ASME Expansion Tanks:

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

a. AMTROL, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett; a Xylem brand.
d. TACO Comfort Solutions, Inc.

2. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

D. Coalescing-Type Combination Air Eliminator and Dirt Separators:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Spirotherm, Inc.; or comparable product by one of the following:
   a. Armstrong Pumps, Inc.
   b. Bell & Gossett; a Xylem brand.
2. Tank: Fabricated steel tank; ASME constructed and stamped for 12-psig working pressure and 270 deg F maximum operating temperature.
3. Internal Bundle: Copper core tube with continuous wound copper wire medium permanently attached and followed by a separate continuous wound copper wire permanently affixed. Bundle shall fill the entire vessel to suppress turbulence.
4. Performance:
   a. Air elimination: 100% efficiency for free and entrained air, 99.6% efficiency for dissolved air.
   b. Dirt separation: 80% efficiency for particles 30 micron and larger within 100 passes.
5. Air Venting: Separate venting chamber with integral full port float actuated brass venting mechanism at top.
6. Inline Inlet and Outlet Connections: Threaded for NPS 2 and smaller; Class 150 flanged connections for NPS 2-1/2 and larger.
7. Blowdown Connection: Threaded with integral ball valve.
8. Provide removable lower head for internal inspection.
9. Size: Match system flow capacity.

2.3 STRAINERS

A. Y-Pattern Strainers (1-1/2" and smaller):

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded..
3. Strainer Screen: Stainless-steel, 60-mesh strainer, or perforated stainless-steel basket.
4. CWP Rating: 125 psig.

B. Y-Patter Strainers (2" and larger):

1. Description: Low pressure drop design with the following CV values;
   a. 2" Pipe: 120
   b. 2-1/2" Pipe: 160
   c. 3" Pipe: 227
   d. 4" Pipe: 457

e. 6" Pipe: 976
f. 8" Pipe: 1,607
g. 10" Pipe: 2,574

2. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
3. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
4. Strainer Screen:
   a. Material: Type 304 Stainless-steel.
   b. Perforations:
      1) For liquid service for sizes 2" - 3" perforations shall be .045"
      2) For liquid service for sizes 4" - 12" perforation shall be .125"
   c. Strainer screens shall be removable via an access cover sealed with an O-ring.
5. Strainer shall be manufactured with 0.25" pressure differential ports, with one placed on each side of the screen.
6. CWP Rating: 125 psig.

2.4 CONNECTORS

A. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.
B. Install calibrated-orifice balancing valves at each branch connection to return main.
C. Install calibrated-orifice balancing valves in the return pipe of each heating or cooling terminal unless automatic flow-control valves are noted on drawings.
D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

A. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.
B. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
C. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.
D. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION 232116

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Close-coupled, in-line centrifugal pumps.
2. Separately coupled, base-mounted, end-suction centrifugal pumps.

1.3 DEFINITIONS

A. ECM: Electronically commutated motor.
B. EPDM: Ethylene propylene diene monomer.
C. HI: Hydraulic Institute.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of pump.

1. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated.
2. Indicate pump's operating point on curves.

B. Shop Drawings: For each pump.

1. Show pump layout and connections.
2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
3. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: One mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

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

1. Armstrong Pumps, Inc.
2. ITT Corporation.
3. Taco Comfort Solutions.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.

C. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gauge tappings at inlet and outlet and threaded companion-flange connections.
2. Impeller: Stainless steel.
3. Pump Shaft: Solid alloy steel, with bronze shaft sleeve.
4. Seal: Mechanical seal assembly with a stainless steel housing, Buna bellows and seat gasket, stainless steel spring, and of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.
5. Seal Flushing: Flush, cool, and lubricate pump seal by directing pump discharge water to flow over the seal.

D. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. NEMA Premium Efficient motors as defined in NEMA MG 1.
2. Variable-speed motor.

2.3 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

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

1. Armstrong Pumps, Inc.
2. ITT Corporation.
3. Taco Comfort Solutions.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump with flexible shaft coupling as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

C. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gauge tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and provide attached piping to allow removal and replacement of impeller without disconnecting piping or requiring realignment of pump and motor shaft.
2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps that are not frequency-drive controlled, trim impeller to match specified performance.
3. Impeller: Stainless steel.
4. Pump Shaft: Steel, with stainless steel shaft sleeve.
5. Seal: Internally-flushed mechanical seal assembly with Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.
6. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.

D. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor. Provide EPDM coupling sleeve for variable-speed applications.

E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A36/A36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

G. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. NEMA Premium Efficient motors as defined in NEMA MG 1.
2. Variable-speed motor.

2.4 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:

1. Angle pattern.
2. 175-psig pressure rating, cast -iron body and end cap, pump-inlet fitting.
3. Bronze 16-mesh wire startup and carbon steel or Type 304 stainless steel permanent strainers with 3/16-inch perforations.
4. Carbon steel or Type 304 stainless steel straightening vanes.
5. Drain plug.
6. Factory-fabricated support.

B. Triple-Duty Valve:

1. Angle or straight pattern.
2. 175-psig pressure rating, cast -iron body, pump-discharge fitting.
3. Valve with multi-turn stem and memory stop to allow valve to be returned to its original position after shutoff.
4. Brass valve disc with EPDM rubber seat.
5. Type 304 stainless steel valve stem.
6. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
7. Brass gauge ports with integral check valve and orifice for flow measurement.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.
B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
D. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.
E. Equipment Mounting:

1. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

F. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and spring hangers of size required to support weight of in-line pumps.

1. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

3.3 ALIGNMENT

A. Perform alignment service. When required by manufacturer to maintain warranty coverage, engage a factory-authorized service representative to perform it.
B. Comply with requirements in HI standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
C. Comply with pump and coupling manufacturers' written instructions.
D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 PIPING CONNECTIONS

A. Where installing piping adjacent to pump, allow space for service and maintenance.
B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
D. Install triple-duty valve on discharge side of pumps.
E. Install suction diffuser and shutoff valve on suction side of pumps.
F. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
G. Install pressure gauges on pump suction and discharge or at integral pressure-gauge tapping, or install single gauge with multiple-input selector valve.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.
B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping. Use startup strainer for initial startup.
4. Perform the following startup checks for each pump before starting:
    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c. Verify that pump is rotating in correct direction.
5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 232123

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Valves and specialties.
3. Refrigerants.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve, refrigerant piping, and piping specialty. Include pressure drop based on manufacturer's test data.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

1. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.7 PRODUCT STORAGE AND HANDLING

A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-454B or R-32:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Hot-Gas and Liquid Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR.
B. Wrought-Copper Fittings, Solder-Joint: ASME B16.22.
C. Wrought-Copper Fittings, Brazed-Joint: ASME B16.50.
D. Wrought-Copper Unions: ASME B16.22.
E. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
F. Brazing Filler Metals: AWS A5.8/A5.8M.
G. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
4. Working Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.3 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.

7. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24 -V ac coil.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.

F. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat: Polytetrafluoroethylene.

4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240 deg F.

G. Thermostatic Expansion Valves: Comply with AHRI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F.
6. Superheat: Adjustable.
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: 450 psig.

H. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

I. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

J. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in parts per million (ppm).
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

K. Replaceable-Core Filter Dryers: Comply with AHRI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated charcoal.
4. Designed for reverse flow (for heat-pump applications).

5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

L. Receivers: Comply with AHRI 495.

1. Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

2.4 REFRIGERANTS

A. ASHRAE 34, R-32 or R-454B:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Arkema Inc.
   b. DuPont Fluorochemicals Div.
   c. Genetron Refrigerants; Honeywell International Inc.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT

A. Suction Lines NPS 2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
B. Hot-Gas and Liquid Lines: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install packed-angle valves in suction and discharge lines of compressor.
B. Install service valves for gauge taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
D. Except as otherwise indicated, install packed-angle valves on inlet and outlet side of filter dryers.

E. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
F. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

G. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
H. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Compressor.

I. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.
J. Install receivers sized to accommodate pump-down charge.
K. Install flexible connectors at compressors.

3.3 INSTALLATION OF PIPING, GENERAL

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
B. Install refrigerant piping according to ASHRAE 15.
C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
F. Install piping adjacent to machines to allow service and maintenance.
G. Install piping free of sags and bends.
H. Install fittings for changes in direction and branch connections.
I. Select system components with pressure rating equal to or greater than system operating pressure.
J. Refer to Section 230900 "Instrumentation and Control for HVAC" for solenoid valve controllers, control wiring, and sequence of operation.
K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.
N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
O. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
R. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."
S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

F. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and to restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.
H. Welded Joints: Construct joints according to AWS D10.12M/D10.12.
I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic restraints in Section 230548 "Vibration and Seismic Controls for HVAC."
B. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.
C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

D. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
E. Support horizontal piping within 12 inches of each fitting.
F. Support vertical runs of copper tubing to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

B. Prepare test and inspection reports.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 232513 - WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes the following water treatment for closed-loop hydronic systems:

1. Manual chemical-feed equipment.
2. Chemicals.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:

1. Bypass feeders.
2. Chemical material safety data sheets.

1.4 INFORMATIONAL SUBMITTALS

A. Water-Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.
B. Field quality-control reports.
C. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.
D. Water Analysis: Illustrate water quality available at Project site.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider, capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

PART 2 - PRODUCTS

2.1 HVAC WATER-TREATMENT MANUFACTURERS

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

1. M.I.S. of America, Inc.

2.2 PERFORMANCE REQUIREMENTS

A. Provide all hardware, chemicals, and other material necessary to maintain HVAC water quality in all systems, as indicated in this Specification. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.
B. Base HVAC water treatment on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

2.3 CHEMICAL-FEED EQUIPMENT

A. Side-stream Filter System: Provide slipstream filtration device that incorporates a chemical shot feeder, magnetic filter, and cartridge filter. Device shall be all stainless-steel construction including all valves and fittings. Magnetic filtration shall consist of (4) rare earth magnets designed for easy removal and cleaning. The cartridge filtration range shall be 100 to 0.5 µ.

1. Dosing Capacity: 1.18 gal.
2. Maximum Working Pressure: 150 psig.
3. Flow Rate: Up to 6.3 gpm
4. Temperature Range: 32 to 200 deg F
5. Accessories:
    a. Wall mounting bracket
    b. Stainless steel isolation valves, drain valve, check valve, and funnel.
    c. Brass automatic air vent
6. Design Basis: Skidmore X-Pot Compact

2.4 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer, compatible with piping system components and connected equipment, and able to attain water quality specified in "Performance Requirements" Article.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical-application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate. Install all chemical application equipment within a spill-containment area without floor drain.
B. Bypass Feeders: Install in closed hydronic systems, including hot-water heating, and equip with the following:

1. Install bypass feeder in a bypass circuit around circulating pumps unless indicated otherwise on Drawings.
2. Install a full-port ball isolation valves on inlet, outlet, and drain below the feeder inlet.
3. Install a swing check on the inlet after the isolation valve.

3.3 PIPING CONNECTIONS

A. Piping installation requirement are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Where installing piping adjacent to equipment, allow space for service and maintenance.
C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Section 232113 "Hydronic Piping."
D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet.

3.4 SYSTEM CLEANING

A. A system cleaning shall be performed for the entire Quest Elementary School hot water loop under the supervision of the water-treatment supplier.
B. The loop cleaning chemical shall be MIS-6200NAC, or equal, inappropriate quantities based on total system volume. The cleaning compound shall be added after the loop is filled with water.

C. The loop water shall be circulated for at least (6) hours to remove all construction debris and installation fouling.
D. At the end of the procedure the loop shall be drained, flushed, and treated with the appropriate dosage of MIS of America formula CL-7100 or approved equal.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
B. Tests and Inspections:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials, and retest piping until no leaks exist.

C. Equipment will be considered defective if it does not pass tests and inspections.
D. Prepare test and inspection reports.

3.6 MAINTENANCE SERVICE

A. Scope of Maintenance Service (Quest Elementary School): Provide chemicals and service program to maintain water conditions required above, to inhibit corrosion and scale formation for hydronic piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:

1. Initial water analysis and HVAC water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.

5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

END OF SECTION 232513

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 DEFINITIONS

A. OSHPD: Office of Statewide Health Planning and Development (State of California).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top and bottom of ducts.
5. Dimensions of main duct runs from building grid lines.

6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
B. Welding certificates.
C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for duct joint and seam welding.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."
C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
D. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.

B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
3. Where specified for specific applications, all joints shall be welded.

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Where specified for specific applications, all joints shall be welded.

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in "Duct Schedule" Article.

E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

G. Tie Rods: Galvanized steel, 1/4-inch- minimum diameter for lengths 36 inches or less; 3/8-inch-minimum diameter for lengths longer than 36 inches.

2.5 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. CertainTeed Corporation; Saint-Gobain North America.
   b. Johns Manville; a Berkshire Hathaway company.
   c. Knauf Insulation.
2. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel ; with beveled edge sized as required to hold insulation securely in place, but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpmor greater.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
   a. Fan discharges.
   b. Intervals of lined duct preceding unlined duct.
9. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.6 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 4 inches .
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.7 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
F. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.
B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
C. Install ducts in maximum practical lengths with fewest possible joints.
D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

J. Install fire , combination fire/smoke, and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers and specific installation requirements of the damper UL listing.

K. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

M. Elbows: Use long-radius elbows wherever they fit.

1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.

N. Branch Connections: Use lateral or conical branch connections.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
3. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
4. Unconditioned Space, Exhaust Ducts: Seal Class C.
5. Unconditioned Space, Return-Air Ducts: Seal Class B.
6. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
7. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
8. Conditioned Space, Exhaust Ducts: Seal Class B.
9. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
D. Hangers Exposed to View: Threaded rod and angle or channel supports.
E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
B. Paint exterior of all exposed metal ducts installed in finished spaces.

3.7 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.
B. Use service openings for entry and inspection.

1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

3.8 STARTUP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.

B. Supply Ducts:

1. Pressure Class: Positive 3- inch wg.

C. Return Ducts:

1. Pressure Class: Positive or negative 3- inch wg.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
   a. Pressure Class: Negative 2- inch wg.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Pressure Class: Positive or negative 2- inch wg.

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel .
2. Stainless-Steel Ducts:
   a. Exposed to Airstream: Match duct material.
   b. Not Exposed to Airstream: Match duct material.
3. Aluminum Ducts: Aluminum .

G. Liner:

1. Supply-Air Ducts: Fibrous glass, Type I , 1-1/2 inch(es) thick.
2. Return-Air Ducts: Fibrous glass, Type I , 1-1/2 inch(es) thick.
3. Exhaust-Air Ducts: Fibrous glass, Type I , 1 inch(es) thick.
4. Transfer Ducts: Fibrous glass, Type I , 1 inch(es) thick.

H. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
   a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
   c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      1) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam .

I. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
   a. Rectangular Main to Rectangular Branch: 45-degree entry.
   b. Rectangular Main to Round Branch: Conical spin in.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
   a. Velocity 1000 fpm or Lower: 90-degree tap.
   b. Velocity 1000 to 1500 fpm: Conical tap.
   c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Manual volume dampers.
2. Fire dampers.
3. Combination fire and smoke dampers.
4. Flange connectors.
5. Turning vanes.
6. Duct-mounted access doors.
7. Flexible connectors.
8. Duct accessory hardware.

B. Related Requirements:

1. Section 233723 "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
2. Section 284621.11 "Addressable Fire-Alarm Systems" for duct-mounted fire and smoke detectors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop, dynamic insertion loss, and self-generated noise data. Include breakout noise calculations for high-transmission-loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Detail duct accessories' fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
   a. Special fittings.
   b. Manual volume damper installations.
   c. Control-damper installations.

d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Duct security bars.
f. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, or BIM model, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.
B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 90A and NFPA 90B.
B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Greenheck Fan Corporation.
b. Pottorff.

c. Ruskin Company.

2. Performance:
   a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. against 1-inch wg differential static pressure.
3. Construction:
   a. Linkage out of airstream.
   b. Suitable for horizontal or vertical airflow applications.
4. Frames:
   a. Hat-shaped, 18-gauge- thick stainless steel.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Stainless steel; 16 gauge thick.
6. Blade Axles: Stainless steel.
7. Bearings:
   a. Oil-impregnated stainless steel sleeve.
   b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.
8. Tie Bars and Brackets: Galvanized steel.
9. Locking device to hold damper blades in a fixed position without vibration.

B. Standard, Aluminum, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Pottorff.
   b. Ruskin Company.
   c. United Enertech.
2. Performance:
   a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. against 1-inch wg differential static pressure.
3. Construction:
   a. Linkage out of airstream.
   b. Suitable for horizontal or vertical airflow applications.
4. Frames:
   a. Hat-shaped, 0.10-inch- thick, aluminum sheet channels.
   b. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
   e. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
6. Blade Axles: Stainless steel.
7. Bearings:
   a. Stainless steel sleeve.

b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.

8. Tie Bars and Brackets: Aluminum.
9. Locking device to hold damper blades in a fixed position without vibration.

C. Jackshaft:

1. Size: 0.5-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

D. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle, made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.3 FIRE DAMPERS

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

1. Greenheck Fan Corporation.
2. Pottorff.
3. Ruskin Company.

B. Type: Static dynamic; rated and labeled in accordance with UL 555 by an NRTL.
C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000 fpm velocity.
D. Fire Rating: 1-1/2 hours.
E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed galvanized steel; with mitered and interlocking corners; gauge in accordance with UL listing.
F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel; gauge in accordance with UL listing.
G. Mounting Orientation: Vertical or horizontal as indicated.
H. Blades: Roll-formed galvanized sheet steel. Material gauge is to be in accordance with UL listing.
I. Horizontal Dampers: Include blade lock and stainless steel closure spring.
J. Heat-Responsive Device:

1. Replaceable, 165 deg F rated, fusible links.

2.4 COMBINATION FIRE AND SMOKE DAMPERS

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

1. Greenheck Fan Corporation.
2. Pottorff.
3. Ruskin Company.

B. General Requirements:

1. Label to indicate conformance to UL 555 and UL 555S by an NRTL.
2. Label to indicate conformance to NFPA 80 and NFPA 90A by an NRTL.
3. Unless otherwise indicated, use parallel-blade configuration.

C. Closing rating in ducts up to 6-inch wg static pressure class and minimum 2000 fpm velocity.
D. Fire Rating: 1-1/2 hours.
E. Performance:

1. Leakage:
   a. Class I: Leakage shall not exceed 8 cfm/sq. ft. against 4-inch wg differential static pressure.
2. Pressure Drop: 0.09 in. wg at 1500 fpm across a 24-by-24-inch damper when tested in accordance with AMCA 500-D, Figure 5.3.
3. Velocity: Up to 2000 fpm.
4. Temperature: Minus 25 to plus 180 deg F.
5. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

F. Construction:

1. Suitable for horizontal or vertical airflow applications.
   a. Where actuator access is provided only through face of grille provide out of plane style damper with thermal blanket that is UL qualified for mounting outside of the plane of the wall and has concealed actuator access.
2. Frame:
   a. Hat shaped.
   b. Galvanized sheet steel, with interlocking, gusseted corners and mounting flange.
   c. Gauge is to be in accordance with UL listing.
3. Blades:
   a. Roll-formed, horizontal, airfoil, galvanized sheet steel.
   b. Maximum width and gauge in accordance with UL listing.
4. Blade Edging Seals:
   a. Silicone rubber.
5. Blade Jamb Seal: Flexible stainless steel, compression type.

6. Blade Axles: 1/2-inch-diameter; plated steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings. Linkage mounted out of airstream.
7. Bearings:
   a. Stainless steel sleeve.

G. Mounting Sleeve:

1. Factory installed, galvanized sheet steel.
2. Length to suit wall or floor application.
3. Gauge in accordance with UL listing.

H. Heat-Responsive Device:

1. Electric resettable device and switch package, factory installed, 165 deg F rated.

I. Damper Actuator - Electric:

1. Electric - 120 V ac.
2. UL 873, plenum rated.
3. Designed to operate in smoke-control systems complying with UL 555S requirements.
4. Two position with fail-safe spring return.
   a. Sufficient motor torque and spring torque to drive damper fully open and fully closed with adequate force to achieve required damper seal.
   b. Maximum 15-second full-stroke closure.
   c. Minimum 90-degree drive rotation.
5. Clockwise or counterclockwise drive rotation as required for application.
6. Environmental Operating Range:
   a. Temperature: Minus 40 to plus 130 deg F.
   b. Humidity: 5 to 95 percent relative humidity noncondensing.
7. Environmental Enclosure: NEMA 2.
8. Actuator to be factory mounted and provided with single-point wiring connection.
   a. Actuator may be mounted external or internal to ductwork depending on application.

J. Accessories:

1. Test and reset switches, damper mounted.

2.5 FLANGE CONNECTORS

A. Description: roll-formed, factory fabricated, slide-on transverse flange connectors, gaskets, and components.
B. Material: Galvanized steel.
C. Gauge and Shape: Match connecting ductwork.

2.6 TURNING VANES

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

1. CL WARD & Family Inc.
2. Ductmate Industries, Inc.
3. Ward Industries; a brand of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Fabricate curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

D. Vane Construction:

1. Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.7 DUCT-MOUNTED ACCESS DOORS

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

1. CL WARD & Family Inc.
2. Ductmate Industries, Inc.
3. Ruskin Company.

B. Duct-Mounted Access Doors: Fabricate access panels in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 7-2 (7-2M), "Duct Access Doors and Panels," and Figure 7-3, "Access Doors - Round Duct."

1. Door:
   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. Vision panel.
   d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
   e. Fabricate doors airtight and suitable for duct pressure class.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
   a. 24-gauge- thick galvanized steel or 0.032-inch- thick aluminum frame.
3. Number of Hinges and Locks:
   a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
   c. Access Doors up to 24 by 48 Inches: Continuous and two compression latches.

d. Access Doors Larger Than 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.

2.8 FLEXIBLE CONNECTORS

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

1. CL WARD & Family Inc.
2. Ductmate Industries, Inc.
3. Ward Industries; a brand of Hart & Cooley, Inc.

B. Fire-Performance Characteristics: Adhesives, sealants, fabric materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Materials: Flame-retardant or noncombustible fabrics.

E. Coatings and Adhesives: Comply with UL 181, Class 1.

F. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

G. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd. .
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

2.9 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116 for fibrous-glass ducts.
B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.
C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
D. Where multiple damper sections are necessary to achieve required dimensions, provide reinforcement to fully support damper assembly when fully closed at full system design static pressure.
E. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

    1. Install steel volume dampers in steel ducts.
    2. Install aluminum volume dampers in aluminum ducts.

F. Set dampers to fully open position before testing, adjusting, and balancing.
G. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.
H. Install fire and smoke dampers in accordance with UL listing.
I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

    1. On both sides of duct coils.
    2. Upstream from duct filters.
    3. At outdoor-air intakes and mixed-air plenums.
    4. At drain pans and seals.
    5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
    6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
    7. At each change in direction and at maximum 50-ft. spacing.
    8. Upstream from turning vanes.
    9. Upstream or downstream from duct silencers.
    10. For grease ducts, install at locations and spacing as required by NFPA 96.

11. Control devices requiring inspection.
12. Elsewhere as indicated.

J. Install access doors with swing against duct static pressure.
K. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

L. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
M. Install flexible connectors to connect ducts to air handling unit intakes, discharges, and elsewhere indicated on Drawings.
N. For fans developing static pressures of 5 inches wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
O. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors, and verify that size and location of access doors are adequate to perform required operation.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation, and verify that vanes do not move or rattle.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Centrifugal ventilators - roof downblast.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
2. Rated capacities, operating characteristics, and furnished specialties and accessories.
3. Certified fan performance curves with system operating conditions indicated.
4. Certified fan sound-power ratings.
5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
6. Material thickness and finishes, including color charts.
7. Dampers, including housings, linkages, and operators.
8. Prefabricated roof curbs.
9. Fan speed controllers.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Design Calculations: Calculate requirements for selecting vibration isolators.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Product Certificates: Submit certificates that specified equipment will withstand required wind forces, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC power ventilators to include in normal and emergency operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.
C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.2 CENTRIFUGAL VENTILATORS - ROOF DOWNBLAST

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

1. Greenheck Fan Corporation.
2. Loren Cook Company.
3. PennBarry.

B. Housing: Downblast; removable spun-aluminum dome top and outlet baffle; square, one-piece aluminum base with venturi inlet cone. Each fan shall bear a permanently affixed, engraved metal nameplate containing the model number, individual serial number, and Drawing designation.
C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Motor: Provide electronically commutated motor with permanently lubricated ball bearings. Motor shall be speed controllable down to 20% of full speed. Speed shall be controlled by a potentiometer dial mounted at the motor.
E. Accessories:

1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.

F. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.
2. Overall Height: 24 inches.
3. Hinged sub-base to provide access to damper or as cleanout for grease applications.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.4 SOURCE QUALITY CONTROL

A. AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 311.
B. AMCA Certification for Fan Aerodynamic Performance Ratings: Test, rate, and label in accordance with AMCA 211.
C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install power ventilators level and plumb.
B. Equipment Mounting:

1. Secure roof-mounted fans to roof curbs with zinc-plated hardware. See Section 077200 "Roof Accessories" for installation of roof curbs.
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Install units with clearances for service and maintenance.
D. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

3.3 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.
B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.4 STARTUP SERVICE:

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
6. For belt-drive fans, disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
7. Adjust belt tension.
8. Adjust damper linkages for proper damper operation.
9. Verify lubrication for bearings and other moving parts.
10. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
11. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
12. Shut unit down and reconnect automatic temperature-control operators.

13. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

A. Adjust damper linkages for proper damper operation.
B. Adjust belt tension.
C. Lubricate bearings.
D. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.6 CLEANING

A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust.

3.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 233423

SECTION 233713.13 - AIR DIFFUSERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Rectangular and square ceiling diffusers.

B. Related Requirements:

1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers.
2. Section 233713.23 "Air Registers and Grilles" for adjustable-bar register and grilles, fixed-face registers and grilles, and linear bar grilles.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 ROUND CEILING DIFFUSERS

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

1. Nailor Industries Inc.
2. Price Industries.
3. Titus, a division of Air System Components; Johnson Controls, Inc.

B. Devices shall be specifically designed for variable-air-volume flows.
C. Material: Steel.
D. Finish: Baked enamel, white.
E. Face Style: Three cone.
F. Mounting: Duct connection.
G. Pattern: Two-position horizontal.

2.2 RECTANGULAR AND SQUARE CEILING DIFFUSERS

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

1. Nailor Industries Inc.
2. Price Industries.
3. Titus, a division of Air System Components; Johnson Controls, Inc.

B. Devices shall be specifically designed for variable-air-volume flows.
C. Material: Steel.
D. Finish: Baked enamel, white.
E. Face Size: As scheduled on drawings.
F. Face Style: Three cone Plaque.
G. Mounting: Surface or T-bar.
H. Pattern: Fixed.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers level and plumb.
B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.13

SECTION 233713.23 - REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Adjustable blade face registers and grilles.
2. Fixed face registers and grilles.

B. Related Requirements:

1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to registers and grilles.
2. Section 233713.13 "Air Diffusers" for various types of air diffusers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 REGISTERS

A. Adjustable Blade Face Register :

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Nailor Industries Inc.
   b. Price Industries.
   c. Titus, a division of Air System Components; Johnson Controls, Inc.
2. Material: Steel.
3. Finish: Baked enamel, white.
4. Frame: 1-1/4 inches wide.
5. Mounting: As scheduled on drawings.
6. Damper Type: Adjustable opposed blade.

B. Fixed Face Register :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Nailor Industries Inc.
   b. Price Industries.
   c. Titus, a division of Air System Components; Johnson Controls, Inc.
2. Material: Steel.
3. Finish: Baked enamel, white.
4. Frame: 1-1/4 inches wide.
5. Mounting: As scheduled on drawings.
6. Damper Type: Adjustable opposed blade.

2.2 GRILLES

A. Adjustable Blade Face Grille :

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Nailor Industries Inc.
   b. Price Industries.
   c. Titus, a division of Air System Components; Johnson Controls, Inc.
2. Material: Steel.
3. Finish: Baked enamel, white.
4. Frame: 1-1/4 inches wide.
5. Mounting: As scheduled on drawings.

B. Fixed Face Grille :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Nailor Industries Inc.
   b. Price Industries.
   c. Titus, a division of Air System Components; Johnson Controls, Inc.
2. Material: Steel.
3. Finish: Baked enamel, white.
4. Core Construction: Integral.
5. Frame: 1-1/4 inches wide.
6. Mounting: As scheduled on drawings..

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate registers and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where registers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install registers and grilles level and plumb.
B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.23

SECTION 233723 - HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Hooded ventilators.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product
B. Shop Drawings: For gravity ventilators.

1. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
2. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof-framing plans and other details, drawn to scale, and coordinated with each other, based on input from installers of the items involved:

1.5 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

B. ASHRAE 62.1 Compliance: Section 5, "Systems and Equipment" and Section 7, "Construction and System Start-up."
C. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

2.2 FABRICATION

A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.
B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.
D. Fabricate supports, anchorages, and accessories required for complete assembly.
E. Perform shop welding by AWS-certified procedures and personnel.

2.3 HOODED VENTILATORS.

A. Description: Rectangular or round roof hood for intake or relief air.
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Greenheck Fan Corporation.
2. Loren Cook Company.
3. PennBarry.

C. Construction:

1. Material, Aluminum: Thickness required to comply with structural performance requirements, but not less than 0.063-inch- thick base and 0.050-inch- thick hood; suitably reinforced.
2. Insect Screening: Aluminum, 18-by-16 mesh wire.
3. Motorized Damper: Motorized dampers and electronic damper actuators are to be furnished separately and field installed.
4. Insulation: None.

D. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch- thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.

2. Overall Height: Provide roof curb with sufficient height such that bottom of gravity ventilator hood is 30" minimum above the finished roof for intake applications and 24" for relief applications.

2.4 SOURCE QUALITY CONTROL

A. AMCA Certification for Hooded Ventilators: Test, rate, and label gravity ventilators in accordance with AMCA 511.

2.5 MATERIALS

A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5 or T-52.
B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005, with temper as required for forming or as otherwise recommended by metal producer for required finish.
C. Galvanized-Steel Sheet: ASTM A653/A653M, G90 zinc coating, mill phosphatized.
D. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.

1. Use types and sizes to suit unit installation conditions.
2. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.

E. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the loads imposed for concrete, or 6 times the load imposed for masonry, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.
F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.
B. Secure gravity ventilators to roof curbs with zinc-plated hardware. Use concealed anchorages where possible. Refer to Section 077200 "Roof Accessories."
C. Install gravity ventilators with clearances for service and maintenance.
D. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section 079200 "Joint Sealants" for sealants applied during installation.
F. Label gravity ventilators according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."
G. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
H. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes, so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

3.2 DUCT CONNECTIONS

A. Duct installation and connection requirements are specified in Section 233113 "Metal Ducts." Drawings indicate general arrangement of ducts and duct accessories.

3.3 ADJUSTING

A. Adjust damper linkages for proper damper operation.

END OF SECTION 233723

SECTION 235123 - FLUE GAS VENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Listed double-wall flue vents.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for product.
2. Prior to flue vent installation, engineered calculations and drawings must be submitted to Engineer to thoroughly demonstrate that size and configuration conform to recommended size, length and footprint for each submitted boiler.

B. Shop Drawings: For each flue gas venting system.

1. Submit a fully dimensioned and scaled shop drawing prepared by the flue vent manufacturer showing plan and elevation views of the entire flue gas venting system and its relationship to boiler(s), building structure, and other equipment. Indicate all section sizes and fittings to be installed. The drawing shall include all required vertical and horizontal supports.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.5 QUALITY ASSURANCE

A. Certified Sizing Calculations: Engage the services of the flue vent system manufacturer’s engineering department to design the system and all required vertical and horizontal supports.

1. Field verify all existing conditions.
2. Submit calculations of flue vent draft and sizing selection for approved appliances.

B. Prefabricated flue gas venting systems shall be designed and installed in accordance with the requirements of the NFPA, and all components shall be UL listed and labeled.
C. All flue gas carrying components of the vent system shall be obtained from a single manufacturer.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer shall warranty the flue gas vent system against defects in material and workmanship for a period of 15 years from the date of original installation. Any portion of the vent repaired or replaced under the warranty shall be warranted for the remainder of the original warranty period.

PART 2 - PRODUCTS

2.1 LISTED SPECIAL GAS VENTS

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

1. Security Chimneys International.

B. Description: Double-wall, factory-built metal vent designed for use in conjunction with Category I, II, III or IV condensing, gas-fired appliances. Vents shall be tested according to UL 1738 and rated for 550 deg F maximum flue gas temperature.
C. Vent shall be listed for a minimum positive pressure rating of 6 in. w.c.
D. The vent shall be constructed with an inner and outer tube, where the annular space between the tubes is 1-inch.

1. The inner tube (flue gas conduit) shall be constructed from AL29-4C stainless steel with a minimum wall thickness of 0.024-inches.
2. The outer tube (jacket) shall be constructed from 441 stainless steel with a minimum wall thickness of 0.024-inches.

E. The vent system shall be continuous from the appliance's flue outlet to the vent termination outside the building. The system shall be designed to eliminate on-site welding through the use of a slip fit, rigid connection with reinforcing ribs, built in mechanical locking clips, and a fluoroelastomer O-ring seal. The use of field-applied silicone gaskets or caulking at section joints is not permitted.
F. Accessories: Component parts, including but not limited to, tees, elbows, increasers, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly and provided by the vent manufacturer.

1. Termination: Exit cone with drain section incorporated into riser.

G. Provide flue gas condensate neutralizing kit for drain connection at base of stack.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF LISTED VENT SYSTEMS

A. Install prefabricated vent systems in accordance with the manufacturer's published installation instructions.
B. Comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading. Provide all necessary supports.
D. Install horizontal sections of the flue gas venting system at a slope of not less than 1/4-inch per foot, to allow for proper drainage of condensate back to the boiler(s).
E. Provide drain piping from flue vent drain section to condensate neutralizing tank and from neutralizing tank to nearest floor drain.

3.3 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

END OF SECTION 235123

SECTION 235216 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, firetube stainless steel ultra-high efficiency boilers, trim and accessories for generating hot water.
B. The **Hilton Central School District Board of Education** has passed a resolution to standardize on Fulton Heating Solutions, Inc. products. No other manufacturers are acceptable unless prior approval is received from the Hilton CSD Board of Education.

1.3 ACTION SUBMITTALS

A. Product Data: Include performance data, operating characteristics, technical product data, rated capacities of selected model, weights (shipping, installed and operating), installation and start-up instructions, and furnished accessory information.
B. Shop Drawings: For boilers, boiler trim, and accessories.

    1. Include plans, elevations, sections, and details.
    2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
    3. Include diagrams for power, signal, and control wiring.

C. Certificate of Product Rating: Submit AHRI Certificate indicating Thermal Efficiency, Combustion Efficiency, Materials of Construction, Input, and Gross Output conform to the design basis.
D. Thermal efficiency curves: Submit thermal efficiency curves for a minimum of 5 input rates between and including minimum and maximum rated capacities, for return water temperatures ranging from 80°F to 180°F.
E. Water side pressure drop curve.
F. Flue gas temperature curves: Submit flue gas temperature curves for minimum and maximum boiler capacity, for return water temperatures ranging from 80°F to 160°F.

1. If submitted flue gas temperatures, minimum or maximum inputs are different from that of the basis of design manufacturer and model, the manufacturer shall be responsible for draft calculations and reselection of the flue gas exhaust system.

G. Source quality-control test reports.
H. Field quality-control test reports: Start-up by a factory authorized service representative.
I. Operation and Maintenance Data: Data to be included in Installation and Operation Manual.
J. Warranty: Standard warranty specified in this Section.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.
B. Attic Stock
   1. Provide (2) block and scanner assembly for each type/size of boiler provided.
   2. Provide (2) O2 sensors for each type/size of boiler provided.
   3. Attic stock shall not be used for any in warranty service work. If it is used, the attic stock shall be replaced during the warranty period.

1.5 WARRANTY

A. Standard Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for the Pressure Vessel and Heat Exchanger: The boiler manufacturer shall warranty against failure due to:
      a. Flue gas condensate corrosion, and/or defective material or workmanship for a period of ten (10) years, non-prorated, from the date of shipment from the factory.
      b. Thermal shock for the lifetime of the boiler.
   2. Warranty Period for the Burner: The boiler manufacturer shall warranty the burner against defective material or workmanship for a period of five (5) years, non-prorated, from the date of shipment from the factory.
   3. Warranty Period for all other components: The boiler manufacturer shall repair or replace any part of the boiler that is found to be defective in workmanship or material within eighteen (18) months of shipment from the factory or twelve (12) months from start-up, whichever comes first.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label boilers to comply with 2010 ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N.

E. UL Compliance: Test boilers for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

2.2 MANUFACTURERS

A. Manufacturers: Provide products by the following:

1. Fulton Heating Solutions, Inc

2.3 FORCED-DRAFT, FIRE-TUBE CONDENSING BOILERS 2.5 MM BTUH AND LARGER

A. Description: Factory-fabricated, -assembled, and -pressure tested, duplex stainless steel firetube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including flue gas vent; combustion air intake connections, water supply, water return, condensate drain, and controls. The boiler, burner and controls shall be completely factory assembled as a self-contained unit. Each boiler shall be neatly finished, thoroughly tested, and properly packaged for shipping. The boiler shall be suitable for closed-loop water heating service only.

B. Heat Exchanger: The heat exchanger is defined as the surfaces of the pressure vessel where combustion gases transfer heat to the hydronic fluid.

1. The boiler shall be a single-pass firetube design, such that all combustion chamber components are within water-backed areas. Watertube boilers will not be accepted.
2. Furnace to tube connections shall be constructed with low weld intensity, a tube to tube minimum spacing of 2 tube diameters center to center, minimum 1 tube diameter tube to tube ligament, and shall not contain any overlapping welds.
3. Heat transfer capability shall be maximized via the use of corrugated firetubes. The corrugation process shall not remove any material from the tubes. Finned, twisted tape, or coil type tube inserts negatively impact ease of maintenance and will not be accepted.
4. The boiler shall compensate for heat exchanger thermal expansion using a stress relief deflection element external to the pressure vessel shell. The deflection element shall act to protect the boiler tubes and tubesheets from exposure to longitudinal thermal expansion stresses. The deflection element shall not be in contact with flue gases.
    a. Designs using the tubes, tubesheets, or furnace components to compensate for thermal expansion require cutting, welding, tube repair, or complete heat exchanger replacement in the event of deflection element failure and are not accepted.
    b. Designs which do not compensate for thermal expansion stresses are not accepted.
5. Tubesheet to tube weld stresses while the boiler is in operation shall never exceed 1.0 ksi.

6. Material: The heat exchanger furnace, tubesheets, and firetubes shall be constructed of duplex alloy stainless steel. Austenitic stainless steels, such as 316L or 304, and ferritic stainless steels, such as 439, are not accepted.
    a. For long term durability, heat exchanger material of construction must have a minimum Ultimate Tensile Strength of 101 ksi, and a minimum 0.2% Yield Strength of 77 ksi. Weaker materials of construction with reduced strength are not accepted. Boilers seeking an approval must provide documentation that supports this requirement or will be rejected.
    b. Heat exchangers constructed of cast aluminum, mild steel, cast iron or copper finned tube materials are not accepted.

C. Exhaust manifold shall be minimum 0.5" thick stainless steel, ASME designation SA-351 CF3M, and shall be a water-backed design to enhance heat transfer. Dry-back style flue gas condensate collection pan exhaust manifolds are not accepted.

D. Pressure Vessel: Design and construction shall be in accordance with Section IV of the ASME Code for heating boilers.
1. The shell shall be minimum 0.375" thick steel, SA-53B ERW.
2. The top head shall be a minimum 0.50" thick steel, SA-790 or SA-516 Grade 70.
3. The pressure vessel shall be a counter-flow design with internal water-baffling plates.
4. The boiler return and supply water connections shall be 4" 150# ANSI flanged. The water connections shall not be designed to support an external structural load from the piping system.
5. The water volume of the boiler shall not be less than 80 gallons.
6. The maximum water pressure drop across the boiler inlet and outlet connections shall not exceed 3.0 PSID at 235 GPM.

E. Fuel/Air Mixture Combustion System: Air and gas pre-mix on the suction side of the fan.
1. Closed-loop oxygen sensor feedback shall automatically adjust the fuel/air ratio. O2 monitoring-only systems that cannot adjust for operation variability shall not be accepted.
2. Combustion air flow shall be controlled by fan speed and a servo-motor actuated butterfly valve. Fuel flow shall be controlled by a servo-motor actuated butterfly valve. Zero governor or negative regulation systems offer less precision and are not capable of independent air and gas control, and are not accepted.

F. Burner: Standard natural gas, forced draft, woven fiber mesh design.
1. Turndown: Shall be no less than 12.5:1.
2. Excess Air: The burner shall operate at no greater than 8.0% excess O2 over the entire modulation range to maximize seasonal combustion and thermal efficiencies.
3. NOx Emissions: When operating on natural gas, the burner shall maintain a level of <20 ppm over the complete combustion range at a 3% O2 correction.

G. Blower: Variable speed centrifugal fan to operate during each burner firing sequence and to pre-purge and post-purge the combustion chamber.
1. Motor: Totally enclosed fan-cooled premium efficiency AC motor, Class H insulation, variable speed capable with sealed bearings.
2. Variable speed drive: IP20 housing, 0-400Hz frequency output capability, overload capacity of 150% for 60 seconds and 200% for 3 seconds, shall fully modulate fan speed according to burner input requirements

H. Main Fuel Train:

1. A factory mounted fuel train shall be supplied. The fuel train shall be fully assembled and enclosed within the boiler cabinet, complete with factory mounted and wired high and low gas pressure switches in compliance with CSD-1.

I. Ignition: Direct spark ignition with transformer. A UV scanner shall be utilized to ensure precise communication of flame status back to the flame programmer. Flame rods are not accepted.

J. Boiler Enclosure:

1. Cabinet: Jacketed steel enclosure with left hinged full height front access door, fully removable latching access panels, mounted on a steel skid with steel plate decking.
2. Control Enclosure: NEMA 250, Type 1.
3. Finish: Cabinet shall be powder coated, pressure vessel assembly shall be painted.
4. Combustion Air: Factory mounted air filter directly coupled to the blower inlet.

K. Rigging and Placement: The boiler shall include lifting eyes and fork hole accessibility for rigging.

L. Characteristics and Capacities:

1. Standard capacities shall be based on 100% water.
2. Minimum Design Water Pressure Rating: 160 psig.
3. Minimum Return Water Temperature: No minimum temperature requirements.
4. Maximum Allowable Water Temperature (ASME): 210°F.
5. Minimum Water Flow Rate: 25 gpm.
6. Maximum Delta-T: 100°F
7. Maximum Allowable Operating Setpoint: 200°F
8. Jacket Losses: External convection and radiation heat losses to the boiler room from the boiler shall comply with IAW ASHRAE 103-2007, and shall not exceed 0.2% of the rated boiler input at maximum capacity.

M. Flow switches, dedicated circulator pumps, or primary-secondary arrangements shall not be required to protect the boiler from thermal shock. Boilers requiring the use of flow switches or primary-secondary piping arrangements will not be accepted.

N. The dimensions of the boiler from where service clearances are measured shall not be more than (Height x Width x Depth) 80” x 30” x 73”.

O. The equipment shall be in strict compliance with the requirements of this specification and shall be the manufacturer’s standard commercial product unless specified otherwise. Additional equipment features, details, accessories, etc. which are not specifically identified but which are a part of the manufacturer’s standard commercial product, shall be included in the equipment being furnished.

2.4 TRIM

A. Safety Relief Valve: ASME rated 60 psig.

B. Pressure and Temperature Gauge: Minimum 3-1/2" diameter, combination pressure and - temperature gauge.
C. Flue Gas Condensate Drain Trap: A flue gas condensate drain trap shall be provided to prevent positive pressure exhaust gases from entering the boiler room.
D. Flue Gas Condensate Neutralization: pH neutralization shall be provided.

2.5 CONTROLS

A. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."
B. The boiler electrical control panel shall include the following devices and features:

1. 7" color touch screen control display factory mounted on the front cabinet panel door.
    a. The control display shall serve as a user interface for programming parameters, boiler control and monitoring; and shall feature a screen saver, screen disable for cleaning, contrast control, volume control for alarm features, boiler status, configuration, history and diagnostics.
2. Controls Transformers: 120VAC, 24 VDC, 12 VDC.
3. Flame safeguard control with 9 combustion fuel/air load profile points.
4. All controls shall be mounted and wired according to UL requirements.

C. Burner Operating Controls: To maintain safe operating conditions, factory mounted and wired burner safety controls limit burner operation:

1. O2 Compensation: Closed loop O2 trim shall be provided (units larger than 2.5 MM BtuH only)
2. High Limit: A single UL 353 temperature probe shall function as a dual-element outlet temperature sensor and shall comply with CSD-1 CW-400 requirements for 2 independent temperature control devices.
    a. High limit sensor shall be NTC resistive 10KOhm +/- 1% at 77°F. Sensor shall have brass material bulb with 1.181 +/- 0.015" insertion and 0.370 +/- 0.005" bulb diameter.
    b. Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
3. Low-Water Cut Off: Electronic probe type mounted in the pressure vessel shall prevent burner operation on low water alarm.
4. Provide a second Low-Water Cutt Off device in piping with manual reset.
5. Air Safety Switch: Prevent operation unless sufficient combustion air is proven.
6. High Condensate Probe: Prevent operation in the event of a blocked condensate drain.
7. Blocked Exhaust: Prevent operation in the event of a blocked flue gas exhaust stack.

D. Boiler Operating Controls and Features:
1. Inlet Water Temperature Monitoring.
2. Combustion Air Temperature Monitoring.
3. Flue Gas Exhaust Temperature Monitoring: Sensor probe shall be stainless steel.
4. Proportional Integral Derivative (PID) temperature load control capability for up to two loops, central heat and domestic hot water.

5. Operating temperature limit for automatic start and stop.
6. Flue gas exhaust temperature monitoring.
7. Return water temperature monitoring.
8. Time of day display.
9. Customizable boiler name display.
10. Alarm history for 15 most recent alarms including equipment status at time of lockout.
11. Password protection options.
12. Indirect domestic hot water priority.
13. Variable Speed System (Secondary) Pump Control:
    a. When installed in a variable primary flow configuration, the boiler controller shall provide the capability to control two variable speed hydronic heating pumps. One pump shall be duty, and one standby.
    b. The duty system pump shall be enabled upon the outdoor air temperature dropping below the warm weather shutdown temperature. Pumps shall be automatically rotated.
    c. Variable speed signal shall be provided to modulate pump speed according to hydronic heating loop Delta-T. A user selectable parameter allows for Delta-P in place of Delta-T.
14. Motorized isolation valve control:
    a. Upon heat demand for the boiler, the control shall provide an enable/open signal.
    b. After the burner is disabled and upon the heat exchanger delta-T dropping to a user programmable delta-T, the signal will be disabled.
        1) Boilers which utilize only a time delay close as the only means of valve actuation are unable to optimize for residual heat, and will not be accepted.
    c. In variable primary arrangements, the control shall hold the lead boiler isolation valve open at all times.

E. Sequencing Control of Modular Boiler Plants: Sequencing capabilities (lead/lag) shall be integral to the boiler controller for up to 8 boilers installed in the same hydronic loop and shall not require an external panel.

1. The boiler manufacturer shall provide a supply water header temperature sensor.
    a. The sensor shall be NTC resistive 10KOhm +/- 1% at 77°F, field installed in the common supply water piping, and field wired to the master boiler.
2. One (1) boiler in the system shall be field programmed as the master and subsequent boilers will be programmed as lag units.
3. Sequence of Operation:
    a. Upon call for heat and demand in the system, a boiler will be enabled at low fire and will modulate according to demand and PID settings up to the base load common value. The base load common shall be field adjustable with a default setting of 40%.
    b. If the heating load exceeds the output at the base load common firing rate, the next boiler in the sequence will be enabled at low fire. Modular boilers will modulate up and down in parallel as a cohesive unit with infinite modulation points to meet heating load requirements.
    c. This process continues until all available boilers are enabled, at which point they are released to modulate up to full fire if required.
    d. As the load decreases, the boilers will be sequentially disabled.
    e. Boiler sequence order shall be rotated on a programmable number of run hours.
    f. A boiler in lockout alarm shall be automatically removed from the sequence order.

g. Lag boilers shall default to local control if the master boiler is fully powered off or removed.
h. Each individual boiler shall enable and disable a water circulation control device. The enable of the device, for example a motorized isolation valve or boiler circulator, will be simultaneous with the heat demand for that boiler. The disable of each device will be based on a programmable time delay when the heat demand is no longer present. In variable primary arrangements, the control shall hold the lead boiler isolation valve open at all times.

F. Building Automation System Interface: Hardware and software to enable building automation system (BAS) to monitor, control, and display boiler status and alarms.

1. Hardwired Contacts:
   a. Monitoring: Boiler Status, Burner Demand, General Alarm, Firing Rate.
   b. Control with Factory Installed Jumper: Safety Interlock for External Device, Remote Boiler Enable, Remote Lead/Lag Enable, Emergency Stop (E-Stop)
   c. Remote Setpoint Signal: 4-20 mA.
2. Communication Protocol: A communication interface with BAS shall enable BAS operator to remotely enable and monitor the boiler plant from an operator workstation.
   a. The boilers will communicate with each other and the Building Automation System via a daisy chain addressed Modbus network. Field wiring between nodes shall be twisted pair low voltage with shielded ground.
   b. A BACnet MSTP and IP protocol communication gateway shall be provided. The BACnet gateway is field installed on the MASTER boiler. Lag boilers shall not require a dedicated BACnet gateway for the BAS to monitor status. The BAS shall only be required to communicate through the MASTER boiler. A communication point mapping list shall be provided.

2.6 ELECTRICAL POWER

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

1. Voltage: 460 V, 3 Phase (2 MM Btuh and Larger Boilers)
2. Frequency: 60 Hz

2.7 VENTING KITS

A. The boiler shall be capable of operating with a stack effect not exceeding -0.10” W.C. and a combined air intake and exhaust venting pressure drop not exceeding +1.50” W.C.
B. Combustion Air Intake: It shall be acceptable to either direct vent the boiler using sealed combustion by drawing combustion air in from the outdoors or by drawing air from the mechanical space itself.

1. Sealed Combustion: Schedule 40 PVC pipe or smooth-walled galvanized steel, vent termination with 1/2” x 1/2” mesh bird screen.

2. Mechanical Space: Adequate combustion air and ventilation shall be supplied to the boiler room in accordance with local codes.

C. Flue Gas Exhaust: The flue gas exhaust stack shall be AL 29-4C or 316L stainless steel, listed and labeled to UL-1738 / C-UL S636 for use with Category II/IV appliances, guaranteed appropriate for the application by the manufacturer and supplier of the venting.
D. Condensate drain piping must be galvanized, stainless steel, or Schedule 40 CPVC. Copper, carbon steel, or PVC pipe materials are not accepted.

2.8 SOURCE QUALITY CONTROL

A. Test and inspect factory-assembled boilers, before shipping, according to 2010 ASME Boiler and Pressure Vessel Code.
B. Each boiler shall be installed and operated in a functioning hydronic system, inclusive of venting, as part of the manufacturing process. A factory test fire report corresponding to the boiler configuration shall be included with each boiler.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance of the Work.

1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

A. Install boilers level on concrete base, minimum 6 inches high.
B. Install gas-fired boilers according to NFPA 54. Equipment and materials shall be installed in an approved manner and in accordance with the boiler manufacturer’s installation requirements.
C. Assemble and install boiler trim.
D. Install electrical devices furnished with the boiler but not specified to be factory mounted.
E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to boiler to allow service and maintenance.
C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 232116 "Hydronic Piping Specialties."
E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas-train connection. Provide a reducer if required.

F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

G. Install piping from safety relief valves to nearest floor drain.
H. Install piping from safety valves to drip-pan elbow and to nearest floor drain.
I. Boiler Venting:

    1. Install flue venting kit and combustion-air intake.
    2. Connect to boiler connections, flue size and type as recommended by the manufacturer.

J. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
K. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
B. Tests and Inspections:
    1. Perform installation and startup checks in accordance with manufacturer's written instructions.
    2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
    3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
    4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
        a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.

b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Boiler will be considered defective if it does not pass tests and inspections.
D. Prepare test and inspection reports.
E. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Section 017900 "Demonstration and Training."
   1. Instructor shall be factory trained and certified.
   2. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
   3. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
   4. Obtain Owner sign-off that training is complete.
   5. Owner training shall be held at Project site.

END OF SECTION 235216

SECTION 236200 - PACKAGED COMPRESSOR AND CONDENSER UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Compressor and condenser units, air cooled, 6 to 120 tons.

1.3 ACTION SUBMITTALS

A. Product Data: For each compressor and condenser unit.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.

B. Shop Drawings: For compressor and condenser units.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Startup service reports.
B. Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For compressor and condenser units to include in emergency, operation, and maintenance manuals.

1.6 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

B. Coordinate location of piping and electrical rough-ins.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of compressor and condenser units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Compressor failure.
   b. Condenser coil leak.
2. Warranty Period (Compressor Only): Five years from date of Substantial Completion.
3. Warranty Period (Components Other Than Compressor): One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fabricate and label refrigeration system in accordance with ASHRAE 15 and ASHRAE 34.
B. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6, "Heating, Ventilating, and Air-Conditioning."
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 COMPRESSOR AND CONDENSER UNITS, AIR COOLED, 6 TO 120 TONS

A. Manufacturers: Provide products by the following:

1. AAON.

B. Description: Factory assembled and tested, air cooled; consisting of casing, compressors, condenser coils, condenser fans and motors, and unit controls.
C. Compressor:

1. Hermetic scroll compressor designed for service with crankcase sight glass, crankcase heater, Schrader-type service fitting on both the high pressure and low pressure sides, and backseating service access valves on suction and discharge ports.
   a. Capacity Control (Primary/Elementary School): Two independently circuited R-454B scroll compressors with thermal overload protection. The lead compressor shall be a variable capacity scroll capable of modulation from 10-100% of its capacity.
   b. Capacity Control: Two tandem circuited R-454BA scroll compressors with thermal overload protection. The lead tandem set shall include a variable capacity scroll

compressor on the first compressor of the set which shall be capable of modulation from 10-100% of its capacity.

D. Hot-gas Reheat: The lead refrigeration circuit shall be provided with modulating hot gas reheat valve, electronic controller, liquid line receiver, supply air temperature sensor and a dehumidification control signal terminal.

E. Condenser Coil: Seamless copper-tube, aluminum-fin coil, including subcooling circuit and backseating liquid-line service access valve.

1. Factory pressure test coils, then dehydrate by drawing a vacuum and fill with a holding charge of nitrogen or refrigerant.

F. Condenser Fans: Propeller-type vertical discharge; directly driven. Include the following:

1. Permanently lubricated, ball-bearing, totally enclosed, air-over motors.
2. Separate motor for each fan.
   a. Primary School: Electrically commutated motor, condenser head pressure controller, and discharge pressure transducers for modulating head pressure control.
   b. Elementary/Middle School: Variable frequency drive controlled fans for head pressure control.
3. Dynamically and statically balanced fan assemblies.

G. Operating and safety controls include the following:

1. Manual-reset, high-pressure cutout switches.
2. Automatic-reset, low-pressure cutout switches.
3. Compressor-winding thermostat cutout switch.
4. Three-leg, compressor-overload protection.
5. Control transformer.
6. Magnetic contactors for compressor and condenser fan motors.
7. Timer to prevent excessive compressor cycling.

H. Accessories:

1. Non-fused disconnect switch, factory mounted and wired, for single external electrical power connection.
2. High density foam compressor sound suppression blanket.
3. 115 V ac convenience, ground-fault circuit interrupter receptacle in weatherproof enclosure.
4. Vibration isolation resilient mounts and spring vibration isolators (field installed).

I. Unit Casings: Designed for outdoor installation with weather protection for components and controls and with removable panels for required access to compressors, controls, condenser fans, motors, and drives. Additional features include the following:

1. Steel, galvanized or zinc coated, for exposed casing surfaces; treated and finished with manufacturer's standard paint coating.
   a. Corrosion Resistance: 2500 -hour salt spray test, in accordance with ASTM B117.
2. Perimeter base rail with forklift slots and lifting holes to facilitate rigging.

3. Gasketed control panel door.
4. Condenser coil hail guard.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of compressor and condenser units.
B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.
C. Examine walls, floors, and roofs for suitable conditions where compressor and condenser units will be installed.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units level and plumb, firmly anchored in locations indicated.
B. Equipment Mounting:

1. Install roof-mounted equipment on roof support rails.
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Maintain manufacturer's recommended clearances for service and maintenance.
D. Loose Components: Install piping specialties, electrical components, devices, and accessories that are not factory mounted.

3.3 PIPING CONNECTIONS

A. Where installing piping adjacent to equipment, allow space for service and maintenance.

B. Connect precharged refrigerant tubing to unit's quick-connect fittings. Install tubing so it does not interfere with access to unit. Install furnished accessories.
C. Connect refrigerant piping to air-cooled compressor and condenser units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Section 232300 "Refrigerant Piping."

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.
B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions and perform the following:
    a. Inspect for physical damage to unit casing.
    b. Verify that access doors move freely and are weathertight.
    c. Clean units and inspect for construction debris.
    d. Verify that all bolts and screws are tight.
    e. Adjust vibration isolation and flexible connections.
    f. Verify that controls are connected and operational.

B. Start unit in accordance with manufacturer's written instructions and complete manufacturer's startup checklist.
C. Measure and record airflow and air temperature rise over coils.
D. Verify operation of condenser capacity control device.
E. Verify that vibration isolation and flexible connections prevent vibration transmission to structure.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.

2. Leak Test: After installation, charge system with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor operation and unit operation, product capability, and compliance with requirements.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Verify manufacturer's required airflow over coils.

C. Verify that vibration isolation and flexible connections prevent vibration transmission to structure.
D. Compressor and condenser units will be considered defective if they do not pass tests and inspections.
E. Prepare test and inspection reports.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain compressor and condenser units.

END OF SECTION 236200

SECTION 237313.13 - INDOOR, BASIC AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes factory-assembled, indoor air-handling units, including the following components and accessories:

1. Casings.
2. Fans, drives, and motors.
3. Rotary heat exchanger.
4. Coils.
5. Air filtration.
6. Dampers.
7. Controls
8. Accessories.

B. The **Hilton Central School District Board of Education** has passed a resolution to standardize on AAON products. No other manufacturers are acceptable unless prior approval is received from the Hilton CSD Board of Education.

1.3 ACTION SUBMITTALS

A. Product Data: For each air-handling unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:
    a. Include certified fan-performance curves with system operating conditions indicated.
    b. Include certified fan-sound power ratings.
    c. Include fan construction and accessories.
    d. Include motor ratings, electrical characteristics, and motor accessories.
6. Include certified coil-performance ratings with system operating conditions indicated.
7. Include filters with performance characteristics.
8. Include dampers, including housings, linkages, and operators.

B. Shop Drawings: For each type and configuration of indoor, basic, air-handling unit.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of indoor, basic air-handling units, as well as procedures and diagrams.
4. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
B. Startup service reports.
C. Field quality-control reports.
D. Sample Warranty: For manufacturer's warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set(s) for each air-handling unit.

1.7 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of indoor, basic, air-handling units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Manufacturer's standard, but not less than one year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.2 MANUFACTURERS

A. Manufacturers: Provide products by the following:

1. AAON.

2.3 UNIT CASINGS

A. General Fabrication Requirements for Casings;

1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
2. Joints: Sheet metal screws or pop rivets.
3. Sealing: Seal all joints with water-resistant sealant. Hermetically seal at each corner and around entire perimeter.
4. Base Rail:
   a. Material: Galvanized steel.
   b. Height: 4 inches.

B. Double-Wall Construction:

1. Outside Casing Wall: G90 Galvanized steel, minimum 18 gauge thick, with manufacturer's standard finish. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
2. Inside Casing Wall: G90 galvanized steel, solid, minimum 18 gauge thick.
3. Floor Plate: G90 galvanized steel, minimum 18 gauge thick.
4. Casing Insulation:
   a. Materials: Injected polyurethane foam insulation.
   b. Casing Panel R-Value: Minimum 6.25.
   c. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.

C. Doors:

1. Fabrication: formed and reinforced with same materials and insulation thickness as casing.
2. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against airflow.
3. Gasket: Neoprene, applied around entire perimeters of frame.

D. Unit shall contain a mixing box with openings as indicated on drawings.
E. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
F. Condensate Drain Pans: Units with cooling coils shall include double-sloped, stainless steel drain pans. Cooling coil shall be mechanically supported above the drain pan my multiple supports that allow drain pan cleaning and coil removal.

2.4 FAN, DRIVE, AND MOTOR SECTION

A. Supply- and Exhaust-Air Fans: Direct drive, unhoused, backward curved, plenum supply fans.

1. Blowers and motors shall be dynamically balanced and utilize neoprene gasketing.
2. Motors shall be high efficiency, electronically commutated motors.
3. ECM driven fans include potentiometer within the control compartment. A factory provided terminal block shall allow for control from a 0-10 VDC control signal.

B. Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.5 ROTARY HEAT EXCHANGERS

A. Unit shall contain a factory mounted and tested total energy recovery wheel. The energy recovery wheel shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings. The frame shall slide out for service and removal from the cabinet. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor, and drive belt. Hinged service access doors shall allow access to the wheel.
B. Rotor - Aluminum or Polymer: Segmented wheel, strengthened with radial spokes, with nontoxic, noncorrosive, silica-gel desiccant coating.
C. Drive: Fractional horsepower motor and gear reducer. Permanently lubricated wheel bearings.

2.6 COIL SECTION

A. General Requirements for Coil Section:

1. Coils certified in accordance with AHRI 410 and hydrogen leak tested.
2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s). Access to coils shall be through hinged access door with lockable, quarter-turn handles.
3. Coil connections shall be labeled, extend beyond the unit casing, and be factory sealed on both the interior and exterior of the unit casing to minimize air leakage.

B. Hydronic Coils:

1. Headers shall be constructed of seamless copper tube with brazed joints or cast iron. Tubes shall be copper with aluminum fins mechanically bonded to the tubes and aluminum end casings.
2. Coil Working-Pressure Ratings: Minimum 200 psig, 325 deg F.

C. Supply-Air Refrigerant Coil:

1. Headers shall be constructed of seamless copper tube with brazed joints. Tubes shall be copper with aluminum fins mechanically bonded to the tubes and aluminum end casings.
2. Furnished with factory installed thermostatic expansion valves. Sensing bulbs field installed on the suction line immediately outside the cabinet.
3. Working Pressure: Minimum 300 psig.

D. Refrigeration System

1. Air handling unit and associated condensing unit shall be capable of operation as an R-454B split system air conditioner.
2. Each refrigeration circuit shall be equipped with thermostatic expansion valve refrigerant control.
3. Modulating hot gas reheat shall be provided on the lead refrigeration circuit. Unit shall be provided with hot gas reheat coil, a check valve on the liquid line, and a check valve on the hot gas reheat line.
4. The lag refrigerant circuit shall be provided with external hot gas bypass.

2.7 AIR FILTRATION SECTION

A. Panel Filters:

1. Description: Pleated factory-fabricated, self-supported, disposable air filters with holding frames.
   a. Pre-filter: 2-inch thick with an ASHRAE MERV rating of 8.
   b. Final filter: 4-inch thick with an ASHRAE MERV rating of 13.

B. The unit shall also include a 1-inch thick aluminum mesh pre-filter upstream of the outside air opening.

2.8 DAMPERS

A. Outdoor- and Return-Air Dampers: Unit shall be capable of 0-100% economizer using a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Damper blades shall be gear driven and be controlled by a spring return, fully modulating electronic damper actuator.
B. Exhaust-Air Dampers: Unit shall include on/off exhaust air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge and end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511.
C. Damper Actuators: Damper actuators to be furnished by others for field installation.

2.9 ACCESSORIES

A. Filter differential pressure switch.
B. Safeties:

1. Brownout protection.
2. Phase-loss reversal protection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine casing insulation materials and filter media before air-handling unit installation. Replace with new insulation materials and filter media that are wet, moisture damaged, or mold damaged.
C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Equipment Mounting:

1. Install air-handling units on cast-in-place concrete equipment bases. Coordinate sizes and locations of concrete bases with actual equipment provided. Comply with requirements

for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

B. Suspended Units: Suspend and brace units from structural-steel support frame using threaded steel rods and spring hangers. Coordinate sizes and locations of structural-steel support members with actual equipment provided. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

C. Arrange installation of units to provide access space around air-handling units for service and maintenance.

D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

E. Connect ducts to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to air-handling unit, allow for service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, ASTM B88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that outdoor- and return-air mixing dampers open and close and maintain minimum outdoor-air setting.
7. Comb coil fins for parallel orientation.
8. Verify that proper thermal-overload protection is installed for electric coils.
9. Install new, clean filters.
10. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.
B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.
C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing of air-handling unit and air-distribution systems, and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 237313.13

SECTION 237416.13 - PACKAGED, LARGE-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes packaged, large-capacity, rooftop air conditioning units (RTUs) with the following components:

1. Casings.
2. Fans, drives, and motors.
3. Rotary heat exchanger.
4. Air filtration.
5. Gas furnaces.
6. Dampers.
7. Electrical power connections.
8. Accessories.

B. The **Hilton Central School District Board of Education** has passed a resolution to standardize on AAON products. No other manufacturers are acceptable unless prior approval is received from the Hilton CSD Board of Education.

1.3 DEFINITIONS

A. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, large-capacity, rooftop air-conditioning units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

1.4 ACTION SUBMITTALS

A. Product Data: For each RTU.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:

a. Include certified fan-performance curves with system operating conditions indicated.
b. Include certified fan-sound power ratings.
c. Include fan construction and accessories.
d. Include motor ratings, electrical characteristics, and motor accessories.

6. Include certified coil-performance ratings with system operating conditions indicated.
7. Include filters with performance characteristics.
8. Include gas furnaces with performance characteristics.
9. Include dampers, including housings, linkages, and operators.

B. Shop Drawings: For each packaged, large-capacity, rooftop air-conditioning units.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set(s) of filters for each unit.
2. Fan Belts: One set(s) for each belt-driven unit fan.

1.7 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of outdoor, semi-custom, air-handling unit that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 1 year from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than 25 years from date of Substantial Completion
3. Warranty Period for Compressors: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of RTUs and components.
C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
D. ASHRAE 15 Compliance: For refrigeration system safety.
E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
F. UL Compliance: Comply with UL 1995.

2.2 MANUFACTURERS

A. Manufacturers: Provide products by the following:

1. AAON

2.3 UNIT CASINGS

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
B. Double-Wall Construction:

1. Outside Casing Wall: G-90-coated galvanized steel, minimum 18 gauge thick with manufacturer's standard finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
2. Inside Casing Wall: G90-coated galvanized steel, 0.028 inch thick.
3. Casing Insulation:
    a. Materials: Injected polyurethane foam insulation.
    b. Casing Panel R-Value: Minimum 13.
    c. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.

C. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

D. Condensate Drain Pans: Units with cooling coils shall include double-sloped stainless steel drain pans.

2.4 FANS, DRIVES, AND MOTORS

A. Supply-Air Fans: Direct drive, unhoused, backward curved, plenum supply fans.
   1. Blowers and motors shall be dynamically balanced and mounted on rubber isolators.
   2. Variable frequency drive shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.

B. Exhaust-Air Fans: Belt driven, unhoused, backward curved, plenum exhaust fan.

   1. Fans and motors shall be dynamically balanced.
   2. Variable frequency drive shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.
   3. Access to exhaust fans shall be through double wall, hinged access doors with quarter turn lockable handles.
   4. Exhaust dampers shall be sized for 100% relief.

C. Motors:

   1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   2. Enclosure Type: Open, dripproof.

2.5 ROTARY HEAT EXCHANGERS

A. Unit shall contain a factory mounted and tested energy recovery wheel. The energy recovery wheel shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings. The frame shall slide out for service and removal from the cabinet. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor, and drive belt. Hinged service access doors shall allow access to the wheel.

B. Rotor - Aluminum or Polymer: Segmented wheel, strengthened with radial spokes, with nontoxic, noncorrosive, silica-gel desiccant coating.

C. Drive: Fractional horsepower motor and gear reducer. Permanently lubricated wheel bearings.

2.6 AIR FILTRATION

A. Panel Filters:

   1. Description: Pleated factory-fabricated, self-supported, disposable air filters with holding frames.

a. Energy wheel outside air filter: 2-inch thick with an ASHRAE MERV rating of 8.
b. Energy wheel exhaust filter: 2-inch thick with an ASHRAE MERV rating of 8.
c. Final filter: 4-inch thick with an ASHRAE MERV rating of 13.

B. The unit shall also include a 1-inch thick aluminum mesh pre-filter upstream of the outside air opening.

2.7 GAS FURNACES

A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47/CSA 2.3 and NFPA 54.

1. Gas furnace shall be equipped with modulating gas valves, adjustable speed combustion blowers, stainless steel tubular heat exchangers, and electronic controller. Combustion blowers and gas valves shall be capable of modulation. Heat trace shall be included on the condensate drain

B. Burners: Stainless steel.

1. Rated Minimum Turndown Ratio: 4 to 1.
2. Fuel: Liquid Propane gas.
3. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
4. Gas Control Valve: Modulating.
5. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

C. Heat-Exchanger and Drain Pan: Stainless steel.
D. Venting: Gravity vented.
E. Safety Controls:

1. Gas Manifold: Safety switches and controls complying with ANSI standards.

2.8 DAMPERS

A. Outdoor- and Return-Air Dampers: Unit shall be capable of 0-100% economizer using a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Damper blades shall be gear driven and be controlled by a spring return, fully modulating electronic damper actuator.
B. Relief-Air Dampers: Barometric.

C. Damper Actuators: Damper actuators to be furnished and installed by HVAC Controls Contractor under Section 230900 "Instrumentation and Control for HVAC."

2.9 ELECTRICAL POWER CONNECTIONS

A. RTU shall have a single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.10 ACCESSORIES

A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Outlet shall be energized even if the unit main disconnect is open.

B. Outdoor Airflow Monitoring: Unit shall include outside airflow measuring station and airflow signal processor.

C. Filter differential pressure switch.
D. Coil guards of painted, galvanized-steel.
E. Outdoor air intake weather hood.
A. Safeties:

1. Brownout protection.
2. Phase-loss reversal protection.
3. Gas furnace airflow-proving switch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
C. Examine roofs for suitable conditions where RTUs will be installed.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.
B. Equipment Mounting:

1. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

3.3 PIPING CONNECTIONS

A. Connect condensate drain pans using NPS 1-1/4, ASTM B88, Type M copper tubing. Extend to nearest equipment or roof drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
B. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.

3.4 DUCT CONNECTIONS

A. Comply with duct installation requirements specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
4. Install return-air duct continuously through roof structure.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.
B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service according to manufacturer’s written instructions.
B. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust damper linkages for proper damper operation.
B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.8 CLEANING

A. After completing system installation and testing, adjusting, and balancing RTUs and air-distribution systems and after completing startup service, clean RTUs internally to remove

foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.9 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
B. RTU will be considered defective if it does not pass tests and inspections.
C. Prepare test and inspection reports.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs.

END OF SECTION 237416.13

SECTION 238113.11 - PACKAGED TERMINAL AIR-CONDITIONERS, THROUGH-WALL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes packaged, terminal, through-the-wall air conditioners.

1.2 ACTION SUBMITTALS

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

B. Shop Drawings: For packaged, terminal air conditioners.

1. Include plans, elevations, sections, details for wall penetrations and attachments to other work.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Color Samples: For unit cabinet, discharge grille, and exterior louver, and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of packaged, terminal air conditioners that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Sealed Refrigeration System: Manufacturer's standard, but not less than five years from date of Substantial Completion, including components and labor.
2. Warranty Period for Nonsealed System Parts: Manufacturer's standard, but not less than five years from date of Substantial Completion, including only components and excluding labor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Islandaire

2.2 MANUFACTURED UNITS

A. Description: Factory-assembled and -tested, self-contained, packaged, terminal air conditioner with room cabinet, electric refrigeration system, steam heating, and temperature controls; fully charged with refrigerant and filled with oil; with hardwired chassis.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."
D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

2.3 CHASSIS

A. Cabinet: 0.052-inch- thick powder-coated steel with removable front panel with concealed latches.

1. Mounting: Floor with subbase.
2. Top: Angled.
3. Discharge Grille: Extruded-aluminum discharge grille, tamperproof, and carrying a flame test rating in accordance with UL standard 494.
4. Louvers: Extruded aluminum with enamel finish.
5. Finish: Baked enamel.
6. Access Door: Hinged door in top of cabinet for access to controls.
7. Cabinet Extension: Matching cabinet in construction and finish, allowing diversion of airflow to adjoining room; with grille.
8. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
9. Subbase: Enameled steel with adjustable leveling feet and adjustable end plates, with two-row NPS 5/8 copper tube, aluminum-plate finned coil for use with hot water, normally open low-voltage electric valve for hot water and provision for mounting receptacle, with factory-installed and -wired, fused disconnect switch and receptacle sized for unit.
10. Wall Sleeves: Galvanized steel with powder-coated paint.

B. Refrigeration System: Direct-expansion indoor coil with capillary restrictor and hermetically sealed scroll compressor with vibration isolation and overload protection.
   1. Indoor and Outdoor Coils: Seamless copper tubes mechanically expanded into aluminum fins with capillary tube distributor on indoor coil.
   2. Accumulator.
   3. Constant-pressure expansion valve.
   4. Reversing valve.
   5. Charge: R-410A.

C. Indoor Fan: Forward curved, centrifugal; with two-speed motor and positive-pressure ventilation damper with electric operator.

D. Filters: Washable polyurethane in molded plastic frame.

E. Condensate Drain: Drain pan to direct condensate to outdoor coil for re-evaporation.

   1. Comply with ASHRAE 62.1 for drain pan construction and connections.

F. Outdoor Fan: Forward curved, centrifugal or propeller type driven by indoor fan motor.

   1. Indoor and Outdoor Fan Motors: Two speed; comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
      a. Fan Motors: Permanently lubricated split capacitor.
      b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
      c. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

2.4 HEATING

A. Hot-Water Heating Coil: Seamless copper tubes mechanically expanded into aluminum fins.

2.5 CONTROLS

A. Control Module: Unit-mounted digital panel with touchpad temperature control and with touchpad for heating, cooling, and fan operation. Include the following features:
   1. Low-Ambient Lockout Control: Prevents cooling-cycle operation below 40 deg F outdoor air temperature.
   2. Temperature-Limit Control: Prevents occupant from exceeding preset setback or setup temperature.
   3. Building Automation System Interface: Allows remote on-off control with setback temperature control.
   4. Reverse-Cycle Defrost: Solid-state sensor monitors frost buildup on outdoor coil and reverses unit to melt frost.

B. Outdoor Air: Motorized intake damper. Open intake when unit indoor-air fan runs.

2.6 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Factory test to comply with AHRI 300, "Sound Rating and Sound Transmission Loss of Packaged Terminal Equipment."

B. Unit Performance Ratings: Factory test to comply with AHRI 310/380/CSA C744, "Packaged Terminal Air-Conditioners and Heat Pumps."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb, maintaining manufacturer's recommended clearances and tolerances.

B. Install wall sleeves in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Section 079200 "Joint Sealants."

C. Install and anchor wall sleeves to withstand, without damage to equipment and structure, seismic forces required by building code.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. After installing packaged, terminal air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Packaged, terminal air conditioners will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 238113.11

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

1.6 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:
   a. For Compressor: Five year(s) from date of Substantial Completion.
   b. For Parts: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Daiken Applied.
2. Mitsubishi Electric & Electronics USA, Inc.
3. SANYO North America Corporation.

2.2 INDOOR UNITS (5 TONS OR LESS)

A. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
3. Fan: Direct drive, centrifugal.
4. Fan Motors:
   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
   c. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
   d. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
6. Condensate Drain Pans:

a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
   1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
   2) Depth: A minimum of 1 inch deep.
b. Single-wall, galvanized-steel sheet.
c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
   1) Minimum Connection Size: NPS 1.
d. Pan-Top Surface Coating: Asphaltic waterproofing compound.

7. Air Filtration Section:
   a. General Requirements for Air Filtration Section:
      1) Comply with NFPA 90A.
      2) Minimum MERV according to ASHRAE 52.2.
      3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
   b. Disposable Panel Filters:
      1) Factory-fabricated, viscous-coated, flat-panel type.
      2) Thickness: 1 inch.
      3) MERV according to ASHRAE 52.2: 5.
      4) Media: Interlaced glass fibers sprayed with nonflammable adhesive.
      5) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
   a. Compressor Type: Hermetic swing.
   b. Refrigerant: R-32.
   c. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
3. Fan: Aluminum-propeller type, directly connected to motor.
4. Motor: Permanently lubricated, with integral thermal-overload protection.
5. Low Ambient Kit: Permits operation down to -4 deg F.

2.4 ACCESSORIES

A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
D. Drain Hose: For condensate.
E. Manufacturer’s wall support mounting bracket for wall-mounted units.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.
B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
D. Equipment Mounting:

1. Install wall-mounted, compressor-condenser components on wall support bracket per manufacturer’s installation instructions..

E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.
D. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

SECTION 238232 - RADIANT HEATING CEILING PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Hydronic heating panels.

1.3 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits

1.4 SUBMITTALS

A. Product Data: Include rated capacities, specialties, and accessories for each product indicated.
B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Detail equipment assemblies and suspension and attachment. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

   1. Suspended ceiling components.
   2. Structural members to which heaters and suspension systems will be attached.
   3. Size and location of initial access modules for acoustical tile.
   4. Items penetrating finished ceiling, including the following:

      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.

   5. Perimeter moldings.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Field quality-control test reports.
F. Operation and Maintenance Data: For electric radiant heaters and panels to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

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

1.6 COORDINATION

A. Coordinate layout and installation of radiant heaters and panels and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 HYDRONIC HEATING PANELS

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

1. Zehnder Rittling.

B. Description: Linear sheet metal panel with serpentine water piping, suitable for lay-in installation flush with T-bar ceiling grid and recessed mounting in gypsum board ceiling.

1. Panels: Minimum 0.0725-inch thick, extruded aluminum planks with integral tube channels
2. Backing Insulation: Minimum 1-inch- thick, 1 lb density, mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB with factory-applied jacket.
3. Exposed-Side Panel Finish: Sheet metal with electrostatic epoxy powder coating.
   a. Provide standard color selection chart to architect for color selection.
4. Factory Piping: ASTM B 88, Type L copper tube with ASME B16.22 wrought-copper fittings and brazed joints. Provide a non-hardening heat paste between tubing and aluminum face plate to ensure even heat distribution to the active face.
   a. All interconnecting of radiant panels shall consist of 5/8-inch O.D. soft copper tubing. Piping connections to be soldered or brazed.

5. Surface-Mounting Trim: Sheet metal with baked-enamel finish in manufacturer's standard paint color as selected by Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive radiant heating units for compliance with requirements for installation tolerances and other conditions affecting performance.
B. Examine roughing-in for hydronic piping connections to verify actual locations before radiant heating and unit installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install radiant heating units level and plumb.
B. Suspend radiant heaters from structure.
C. Support for Radiant Heating in or on Grid-Type Suspended Ceilings: Do not use grid as a support element.

1. Install a minimum of four ceiling support system rods or wires for each panel. Locate not more than 6 inches from panel corners.
2. Support Clips: Fasten to panel and to ceiling grid members at or near each panel corner with clips designed for the application.
3. Panels of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support panels independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Unless otherwise indicated, install shutoff valve and union or flange at each connection.
C. Install piping adjacent to unit to allow service and maintenance.
D. All interconnecting of radiant panels shall consist of 5/8-inch O.D. soft copper tubing. Piping connections to be soldered or brazed.

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field tests and inspections and prepare test reports:
1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and units.

B. Remove and replace malfunctioning units and retest as specified above.

C. After installing panels, inspect unit cabinet for damage to finish. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain radiant heaters and panels. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION 238232

SECTION 238239.13 - CABINET UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes cabinet unit heaters with centrifugal fans and hot-water coils.

1.3 DEFINITIONS

A. CWP: Cold working pressure.
B. DDC: Direct digital control.
C. PTFE: Polytetrafluoroethylene plastic.
D. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include location and size of each field connection.
4. Include details of anchorages and attachments to structure and to supported equipment.
5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
6. Indicate location and arrangement of piping valves and specialties.
7. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which cabinet unit heaters will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.
6. Perimeter moldings for exposed for partially exposed cabinets.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cabinet Unit-Heater Filters: Furnish one spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Zehnder Rittling.

2.2 DESCRIPTION

A. Factory-assembled and -tested unit complying with AHRI 440.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 2021.

2.3 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.4 COIL SECTION INSULATION

A. Insulation Materials: ASTM C 1071; surfaces exposed to airstream shall have aluminum-foil facing to prevent erosion of glass fibers.

1. Thickness: 1/2 inch.
2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F mean temperature.
3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.5 CABINETS

A. Material: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.

1. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch- thick sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
2. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch- thick sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
3. Recessed Flanges: Steel, finished to match cabinet.
4. Control Access Door: Key operated.
5. Base: Minimum 0.0528-inch- thick steel, finished to match cabinet, 6 inches high with leveling bolts.
6. Extended Piping Compartment: 8-inch- wide piping end pocket.

2.6 FILTERS

A. Minimum Efficiency Reporting Value and Average Arrestance: According to ASHRAE 52.2.
B. Minimum Efficiency Reporting Value: According to ASHRAE 52.2.
C. Material: Glass fiber treated with adhesive, MERV 5.

2.7 COILS

A. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

2.8 CONTROLS

A. Fan and Motor Board: Removable.

1. Fan: Forward curved, double width, centrifugal, directly connected to motor; thermoplastic or painted-steel wheels and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

B. Control devices and operational sequences are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Electrical Connection: Factory-wired motors and controls for a single field connection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install cabinet unit heaters to comply with NFPA 90A.
B. Suspend cabinet unit heaters from structure with elastomeric hangers. Vibration isolators are specified in Section 230548.13 "Vibration Controls for HVAC."
C. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 232113 "Hydronic Piping," Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to machine to allow service and maintenance.
C. Comply with safety requirements in UL 1995.
D. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of cabinet unit heater. Hydronic specialties are specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.
C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

END OF SECTION 238239.13

SECTION 238239.16 - PROPELLER UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes propeller unit heaters with hot-water coils.

1.3 DEFINITIONS

A. CWP: Cold working pressure.
B. PTFE: Polytetrafluoroethylene plastic.
C. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include location and size of each field connection.
4. Include details of anchorages and attachments to structure and to supported equipment.
5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
6. Indicate location and arrangement of piping valves and specialties.
7. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Zehnder Rittling.

2.2 DESCRIPTION

A. Assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.4 HOUSINGS

A. Finish: Manufacturer's standard custom baked enamel applied to factory-assembled and -tested propeller unit heaters before shipping.
B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
C. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

2.5 COILS

A. General Coil Requirements: Test and rate hot-water propeller unit-heater coils according to ASHRAE 33.

B. Hot-Water Coil: Copper tube, minimum wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.

2.6 FAN AND MOTOR

A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
B. Motor: Permanently lubricated, multispeed. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install propeller unit heaters to comply with NFPA 90A.
B. Install propeller unit heaters level and plumb.
C. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers. Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Section 230548.13 "Vibration Controls for HVAC."

3.3 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Piping installation requirements are specified in the following Sections:

    1. Section 232113 "Hydronic Piping."
    2. Section 232116 "Hydronic Piping Specialties."

B. Install piping adjacent to machine to allow service and maintenance.
C. Comply with safety requirements in UL 1995.

D. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of propeller unit heater. Hydronic specialties are specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.
C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

END OF SECTION 238239.16

SECTION 260500 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

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

1.2 LICENSING

A. The Contractor shall hold a license to perform the work as issued by the authority having jurisdiction.

B. Plumbing contract work shall be performed by, or under, the direct supervision of a licensed master plumber.

C. Electrical contract work shall be performed by, or under, the direct supervision of a licensed electrician.

1.3 PERMITS

A. Apply for and obtain all required permits and inspections, pay all fees and charges including all service charges. Provide certificate of approval from the Authorities Having Jurisdiction prior to request for final payment.

B. Provide electrical inspection certificate of approval from Middle Department Inspection Agency, Commonwealth Inspection Agency, or an Engineer approved Inspection Agency prior to request for final payment.

1.4 CODE COMPLIANCE

A. Provide work in compliance with the following:

1. 2020 Building Code of New York State.
2. 2020 Existing Building Code of New York State.
3. 2020 Fire Code of New York State.
4. 2020 Plumbing Code of New York State.
5. 2020 Mechanical Code of New York State.
6. 2020 Fuel Gas Code of New York State.
7. 2022 New York State Education Department Manual of Planning Standards

8. 2020 Energy Conservation Code of New York State
9. Accessible and Usable Buildings and Facilities, ICC A117.1 (2009).
10. New York State Department of Labor Rules and Regulations.
11. New York State Department of Health.
12. National Electrical Code (NEC) (current edition in effect at project location).
13. Occupational Safety and Health Administration (OSHA).
14. Local Codes and Ordinances.
15. Life Safety Code, NFPA 101.
16. 2017 NFPA 72 National Fire Alarm and Signaling Code

1.5 GLOSSARY

ACI	American Concrete Institute
AGA	American Gas Association
AGCA	Associated General Contractors of America, Inc.
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AFBMA	Anti-Friction Bearing Manufacturer's Association
AMCA	Air Moving and Conditioning Association, Inc.
ANSI	American National Standards Institute
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASTM	American Society for Testing Materials
AWSC	American Welding Society Code
AWWA	American Water Works Association
FM	Factory Mutual Insurance Company
IBR	Institute of Boiler & Radiation Manufacturers
IEEE	Institute of Electrical and Electronics Engineers
IRI	Industrial Risk Insurers
NEC	National Electrical Code

NEMA	National Electrical Manufacturer's Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
NYS/DEC	New York State Department of Environmental Conservation
SBI	Steel Boiler Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
UFPO	Underground Facilities Protective Organization
UL	Underwriter's Laboratories, Inc.
OSHA	Occupational Safety and Health Administration
XL-GAP	XL Global Asset Protection Services

1.6 DEFINITIONS

Acceptance	Owner acceptance of the project from Contractor upon certification by Owner's Representative.
As Specified	Materials, equipment including the execution specified/shown in the contract documents.
Basis of Design	Equipment, materials, installation, etc. on which the design is based. (Refer to the article, Equipment Arrangements, and the article, Substitutions.)
Code Requirements	Minimum requirements.
Concealed	Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
Coordination Drawings	Show the relationship and integration of different construction elements and trades that require careful coordination during fabrication or installation, to fit in the space provided or to function as intended.
Delegated-Design Services	Performance and Design criteria for Contractor provided professional services. Where professional design services or certifications by a design professional are specifically required of a Contractor, by the Contract Documents. Provide products and systems with the specific design criteria indicated. If criteria indicated is insufficient to perform services or certification required, submit a written request for additional information to the Engineer. Submit wet signed and sealed certification by the licensed design professional for each product and system specifically assigned to the Contractor to be designed or certified by a design professional. Examples: structural maintenance ladders, stairs and platforms, pipe anchors, seismic compliant system, wind, structural supports for material equipment, sprinkler hydraulic calculations.

Equal, Equivalent, Equal To, Equivalent To, As Directed and As Required	Shall all be interpreted and should be taken to mean "to the satisfaction of the Engineer".
Exposed	Work not identified as concealed.
Extract	Carefully dismantle and store where directed by Owner's Representative and/or reinstall as indicated on drawings or as described in specifications.
Furnish	Purchase and deliver to job site, location as directed by the Owner's Representative.
Inspection	Visual observations by Owner's site Representative.
Install	Store at job site if required, proper placement within building construction including miscellaneous items needed to affect placement as required and protect during construction. Take responsibility to mount, connect, start-up and make fully functional.
Labeled	Refers to classification by a standards agency.
Manufacturers	Refer to the article, Equipment Arrangements, and the article, Substitutions.
Prime Professional	Architect or Engineer having a contract directly with the Owner for professional services.
Product Data	Illustrations, standard schedules, performance charts, instructions, brochures, wiring diagrams, finishes, or other information furnished by the Contractor to illustrate materials or equipment for some portion of the work.
Provide (Furnish and Install)	Contractor shall furnish all labor, materials, equipment and supplies necessary to install and place in operating condition, unless otherwise specifically stated.
Relocate	Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use.
Disconnect and remove	Dismantle and take away from premises without added cost to Owner, and dispose of in a legal manner.
Review and Reviewed	Should be taken to mean to be followed by "for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents".
Roughing	Pipe, duct, conduit, equipment layout and installation.
Samples	Physical full scale examples which illustrate materials, finishes, coatings, equipment or workmanship, and establishes standards by which work will be judged.
Satisfactory	As specified in contract documents.
Shop Drawings	Fabrication drawings, diagrams, schedules and other instruments, specifically prepared for the work by the Contractor or a Sub-contractor, manufacturer, supplier or distributor to illustrate some portion of the work.
Site Representative	Owner's Inspector or "Clerk of Works" at the work site.

Submittals Defined (Technical)

Any item required to be delivered to the Engineer for review as requirement of the Contract Documents.

The purpose of technical submittals is to demonstrate for those portions of the work for which a submittal is required, the manner in which the Contractor proposes to conform to the information given and design concepts expressed and required by the Contract Documents.

1.7 EXISTING CONDITIONS

A. Contractor shall review all available record documents of existing construction or other existing conditions and hazardous material information. Owner does not guarantee that existing conditions are the same as those indicated in these documents. Contractor shall record existing conditions via measured drawings and preconstruction photographs or video. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage, removal or construction operations.

B. Owner will occupy portions of the building immediately adjacent to the area(s) of removals. Conduct removals so Owner's operations are not disrupted. Contractor shall locate, identify, disconnect and seal or cap mechanical, plumbing, fire protection and/or electrical systems serving areas of removals, unless noted otherwise in the contract documents. Contractor shall arrange shut-down of systems with the Construction Manager. Piping and ductwork indicated to be removed shall be removed and capped or plugged with compatible materials. If services/systems are required to be removed, relocated or abandoned, provide temporary services/systems the bypass area(s) of removals to maintain continuity of services/systems to other parts of the building, as required.

1.8 SHOP ORAWINGS/PRODUCT DATA/SAMPLES

A. Provide submittals on all items of equipment and materials to be furnished and installed. Submittals shall be accompanied by a transmittal letter, stating name of project and contractor, name of vendor supplying equipment, number of drawings, titles, specification sections (name and number) and other pertinent data called for in individual sections. Submittals shall have individual cover sheets that shall be dated and contain: Name of project; name of prime professional; name of prime contractor; description or names of equipment, materials and items; and complete identification of locations at which materials or equipment are to be installed. Individual piecemeal or incomplete submittals will not be accepted. Similar items, (all types specified) shall be submitted at under one cover sheet per specification section (e.g. valves, plumbing fixtures, etc.). Number each submittal by trade. Indicate deviations from contract requirements on Letter of Transmittal. Submittals will be given a general review only. Corrections or comments made on the Submittals during the review do not relieve Contractor from compliance with requirements of the drawings and specifications. The Contractor is responsible for: confirming and correcting all quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner. If submitting hard copies, submit four (4) copies for review.

B. The Engineer will review up to two (2) submissions of any single submittal. The Contractor will be invoiced on an hourly rate basis for the time spent reviewing the same shop drawing in excess of twice.

C. If submittals are to be submitted electronically, all requirements in Item A apply. Submittals shall be emailed in PDF format to specific email address provided by the Construction Manager, General Contractor, Architect or Project Manager. Name of project shall be in subject line of email. Send emails to:_____

D. Refer to Division 01 for additional requirements.

1.9 PROTECTION OF PERSONS AND PROPERTY

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

1.10 EQUIPMENT ARRANGEMENTS

A. The contract documents are prepared using one manufacturer as the Basis of Design, even though other manufacturers' names are listed. If Contractor elects to use one of the listed manufacturers other than Basis of Design, submit detailed drawings, indicating proposed installation of equipment. Show maintenance clearances, service removal space required, and other pertinent revisions to the design arrangement. Make required changes in the work of other trades, at no increase in any contract. Provide larger motors, feeders, breakers, and equipment, additional control devices, valves, fittings and other miscellaneous equipment required for proper operation, and assume responsibility for proper location of roughing and connections by other trades. Remove and replace doorframes, access doors, walls, ceilings, or floors required to install other than Basis of Design. If revised arrangement submittal is rejected, revise and resubmit specified Basis of Design item which conforms to Contract Documents.

1.11 SUBSTITUTIONS

A. If Contractor desires to bid on any other kind, type, brand, or manufacture of material or equipment than those named in specifications, secure prior approval. To request such approval, Contractor shall submit complete information comparing (item-for-item) material or equipment offered with design material or equipment. Include sufficient information to permit quick and thorough comparison, and include performance curves on same basis, capacities, power requirements, controls, materials, metal gauges, finishes, dimensions, weights, etc., of major parts. If accepted, an addendum will be issued to this effect ahead of bid date. Unless such addendum is issued, substitution offered may not be used.

B. Refer to Division 01 for additional requirements.

1.12 CONTINUITY OF SERVICES

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

1.13 ROUGHING

A. The Contract Drawings have been prepared in order to convey design intent and are diagrammatic only. Drawings shall not be interpreted to be fully coordinated for construction.

B. Due to small scale of Drawings, it is not possible to indicate all offsets, fittings, changes in elevation, interferences, etc. Make necessary changes in contract work, equipment locations, etc., as part of a contract to accommodate work to avoid obstacles and interferences encountered. Before installing, verify exact location and elevations at work site. **DO NOT SCALE** plans. If field conditions, details, changes in equipment or shop drawing information require an important rearrangement, report same to Owner's Representative for review. Obtain written approval for all major changes before installing.

C. Install work so that items both existing and new are operable and serviceable. Eliminate interference with removal of coils, motors, filters, belt guards and/or operation of doors. Provide easy, safe, and code mandated clearances at controllers, motor starters, valve access, and other equipment requiring maintenance and operation. Provide new materials, including new piping and insulation for relocated work.

D. Coordinate work with other trades and determine exact route or location of each duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Obtain from Owner's Representative exact location of all equipment in finished areas, such as thermostat, fixture, and switch mounting heights, and equipment mounting heights. Coordinate all work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical and electrical drawings show design arrangement only for diffusers, grilles, registers, air terminals, lighting fixtures, sprinklers, speakers, and other items. Do not rough-in contract work without reflected ceiling location plans.

E. Before roughing for equipment furnished by Owner or in other Divisions, obtain from Owner and other Divisions, approved roughing drawings giving exact location for each piece of equipment. Do not "rough in" services without final layout drawings approved for construction. Cooperate with other trades to insure proper location and size of connections to insure proper functioning of all systems and equipment. For equipment and connections provided in this contract, prepare roughing drawing as follows:

1. Existing Equipment: Measure the existing equipment and prepare for installation in new location.

2. New Equipment: Obtain equipment roughing drawings and dimensions, then prepare roughing-in-drawings. If such information is not available in time, obtain an acknowledgement in writing, then make space arrangements as required with Owner's Representative.

1.14 COORDINATION OF DRAWINGS

A. Before construction work commences, Divisions for all trades shall submit coordination drawings in the form of CAD drawing files, drawn at not less than 1/4 in. scale. Such drawings will be required throughout all areas, for all Contracts. These drawings shall show resolutions of trade conflicts in congested areas. Mechanical Equipment Rooms shall be drawn early in coordination drawing process simultaneous with all other congested areas. Prepare Coordination Drawings as follows:

1. Division 23 shall prepare the base plan CAD coordination drawings showing all ductwork, all pertinent heating piping, and equipment. These drawings may be CAD files of the required Ductwork Shop Drawings. The drawings shall be coordinated with lighting fixtures, sprinklers, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Reposition proposed locations of work after coordination drawing review by the Owner's Representative. Provide adjustments to exact size, location, and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives. Provide these adjustments as part of contract. Minor revisions need not be redrawn.

2. Division 23shall provide CAD files and submit the base plan CAD Coordination Drawings to all Divisions.

3. Divisions 21 and 22 shall draw the location of piping and equipment on the base plan CAD Coordination Drawings, indicating areas of conflict and suggested resolutions.

4. Divisions 26, 27 and 28 shall draw the location of lighting fixtures, cable trays, and feeders over 1-1/2 in. on the base plan CAD Coordination Drawings, indicating areas of conflict and suggested resolution.

5. The General Construction Trade shall indicate areas of architectural/structural conflicts or obstacles on the CAD Coordination Drawings, and coordinate to suit the overall construction schedule.

6. The Construction Manager shall expedite all Coordination Drawing work and coordinate to suit the overall construction schedule. In the case of unresolved interferences, he shall notify the Owner's Representative. The Owner's Representative will then direct the various trades as to how to revise their drawings as required to eliminate installation interferences.

7. If a given trade proceeds prior to resolving conflicts, then if necessary, that trade shall change its work at no extra cost in order to permit others to proceed with a coordinated installation. Coordination approval will be given by areas after special site meetings involving all Divisions.

B. The purpose of the coordination drawing process is to identify and resolve potential conflicts between trades, and between trades and existing or new building construction, before they occur in construction. Coordination drawings are intended for the respective trade's use during construction and shall not replace any Shop Drawings, or record drawings required elsewhere in these contract documents.

1.15 REMOVAL WORK

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

B. For materials indicated to contain lead, that are being affected by demolition or construction, the contractor shall comply with all Federal, State and Local law requirements regarding worker exposure to lead disturbance and abatement procedures.

C. Refer to the Owner's Lead Paint Survey. The Survey identifies the surfaces within the buildings that were tested for lead by collecting paint samples and performing laboratory analysis. If any unidentified surfaces are to be impacted the lead content shall be tested by analytical determinations conducted by a qualified laboratory approved by the Owner. The contractor shall review the current owner's lead paint reports on file before starting any work which may disturb existing surfaces.

D. Refer to Division 02 for additional information regarding hazardous materials.

1.16 REFRIGERANT RECOVERY

A. Existing equipment to be removed, as shown on the plans may contain refrigerant and refrigerant oils. This refrigerant and refrigerant oil must be handled n accordance with Federal, State and Local law requirements.

B. Removal and recovery of refrigerant shall be in accordance with the current edition of Section 608 of the Clean Air Act of 1990, including all final regulations.

C. Refrigerant recovery must be performed by a technician, certified by an EPA-approved certification program, using refrigerant recovery and recycling equipment certified by an EPA-approved testing organization.

D. Owner "reserves the right of first refusal" on ownership of recovered refrigerant. Should Owner choose to maintain ownership of refrigerant, refrigerant shall be reclaimed, cleaned by this Contractor to ARI 700-1993 Standard of Purity, by an EPA certified refrigerant reclaimer. Refrigerant shall be turned over to the Owner in suitable marked containers to be stored on site, at a place of the Owner's choosing.

1.17 EQUIPMENT AND MATERIAL REQUIREMENTS

A. Provide materials that meet the following minimum requirements:

1. Materials shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less, in accordance with NFPA 255.

2. All equipment and material for which there is a listing service shall bear a UL label.

3. Potable water systems and equipment shall be built according to AWWA Standards.

4. Gas-fired equipment and system shall meet AGA Regulations and shall have AGA label.

5. All electrical equipment and systems, as a whole, shall be tested and listed by an OSHA approved Nationally Recognized Testing Laboratory (NRTL) for the intended use in accordance with the applicable standards and have a physical label indicating such.

6. Fire protection equipment shall be UL listed and FM approved.

B. Exterior and wet locations shall utilize materials, equipment supports, mounting, etc. suitable for the intended locations. Metals shall be stainless steel, galvanized or with baked enamel finish as a minimum. Finishes and coatings shall be continuous and any surface damaged or cut ends shall be field corrected in accordance with the manufacturer's recommendations. Hardware (screws, bolts, nuts, washers, supports, fasteners, etc.) shall be:

1. Stainless steel where the associated system or equipment material is stainless steel or aluminum.

2. Hot dipped galvanized or stainless steel where the associated system or equipment is steel, galvanized steel or other.

1.18 CUTTING AND PATCHING

A. Each trade shall include their required cutting and patching work unless shown as part of the General Construction Contract. Refer to·General Conditions of the Contract for Construction, for additional requirements. Cut and drill from both sides of walls and/or floors to eliminate splaying. Patch cut or abandoned holes left by removals of equipment or fixtures. Patch adjacent existing work disturbed by installation of new work including insulation, walls and wall covering, ceiling and floor covering, other finished surfaces.

Patch openings and damaged areas equal to existing surface finish. Cut openings in prefabricated construction units in accordance with manufacturer's instructions.

1.19 PAINTING

A. Paint all bare piping, pipe hangers and supports exposed to view in mechanical equipment rooms, penthouse, boiler rooms and similar spaces. Paint all bare piping, ductwork and supports exposed to the out-of-doors with rust inhibiting coatings. Paint all equipment that is not factory finish painted (i.e. expansion tanks, etc.).

B. All painting shall consist of one (1) prime coat and two (2) finish coats of non-lead oil base paint, unless otherwise indicated herein. Provide galvanized iron primer for all galvanized surfaces. All surfaces must be thoroughly cleaned before painting. Review system color coding prior to painting with the Owner's Representative or Architect.

C. **All** items installed after finished painting is completed and any damaged factory finish paint on equipment furnished under this contract must be touched up by the Contractor responsible for same.

D. Include painting for patchwork with color to match adjacent surfaces. Where color cannot be adequately matched, paint entire surface. Provide one (1) coat of primer and two (2) finish coats or as called for in the Specifications.

E. All primers and paint used in the interior of the building shall comply with the maximum Volatile Organic Compound (VOC) limits called for in the current version of U.S. Green Building Council LEED Credits EQ 4.1 and EQ 4.2.

F. Refer to Division 9 - Finishes, for additional information.

1.20 EXISTING CEILING REMOVAL AND RE-INSTALLATION

A. In a renovation project, any existing ceiling removal and re-installation work required for the completion of a Contractors or Subcontractors work, shall be removed and re-installed by that Contractor or Subcontractor. This applies in any areas not called for to have a new ceiling installed.

B. The ceiling removal and re-installation shall include lay-in ceiling tile and grid, to the extent necessary to accomplish the work. Removed ceiling tile and grid shall be safely stored during the course of the work, and it shall be re-installed to the original existing condition.

C. The ceiling removal and re-installation shall include gypsum board or plaster ceilings and the associated suspension systems. Removed ceiling areas shall be patched with materials to match the existing ceiling, and painted to match. If paint cannot be matched exactly, paint the entire ceiling a similar color.

1.21 CONCEALMENT

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

1.22 CHASES

A. New Construction:

I • Certain chases, recesses, openings, shafts, and wall pockets will be provided as part of General Construction Trade. Mechanical and Electrical trades shall provide all other openings required for their contract work.

2. Check Architectural and Structural Design and Shop Drawings to verify correct size and location for all openings, recesses and chases in general building construction work.

3. Assume responsibility for correct and final location and size of such openings.

4. Rectify improperly sized, improperly located or omitted chases or openings due to faulty or late information or failure to check final location.

5. Provide 18 gauge galvanized sleeves and inserts. Extend all sleeves 2 in. above finished floor. Set sleeves and inserts in place ahead of new construction, securely fastened during concrete pouring. Correct, by drilling, omitted or improperly located sleeves. Assume responsibility for all work and equipment damaged during course of drilling. Firestop all unused sleeves.

6. Provide angle iron frame where openings are required for contract work, unless provided by General Construction trade.

B. In Existing Buildings:

1. Drill holes for floor and/or roof slab openings.

2. Multiple pipes smaller than 1 in. properly spaced and supported may pass through one 6 in. or smaller diameter opening.

3. Seal voids in fire rated assemblies with a fire-stopping seal system to maintain the fire resistance of the assembly. Provide 18 gauge galvanized sleeves at fire rated assemblies. Extend sleeves 2 in. above floors.

4. In wall openings, drill or cut holes to suit. Provide 18 gauge galvanized sleeves at shafts and fire rated assemblies. Provide fire-stopping seal between sleeves and wall in drywall construction. Provide fire stopping similar to that for floor openings.

1.23 PENETRATION FIRESTOPPING

A. Fire-Stopping for Openings Through Fire and Smoke Rated Wall and Floor Assemblies:

I. Provide materials and products listed or classified by an approved independent testing laboratory for "Penetration Fire-Stop Systems". The system shall meet the requirements of "Fire Tests of Penetrations Fire-Stops" designated ASTM E814.

2. Provide fire-stop system seals at all locations where piping, tubing, conduit, electrical busways/cables/wires, ductwork and similar utilities pass through or penetrate fire rated wall or floor assembly. Provide fire-stop seal between sleeve and wall for drywall construction.

3. The minimum required fire resistance ratings of the wall or floor assembly shall be maintained by the fire-stop system. The installation shall provide an air and watertight seal.

4. The methods used shall incorporate qualities which permit the easy removal or addition of electrical conduits or cables without drilling or use of special tools. The product shall adhere to itself to allow repairs to be made with the same material and permit the vibration, expansion, and/or contraction of any items passing through the penetration without cracking, crumbling and resulting reduction in fire rating.

5. Plastic pipe/conduit materials shall be installed utilizing intumescent collars.

6. Provide a submittal including products intended for use, manufacturer's installation instructions, and the UL details for all applicable types of wall and floor penetrations.

7. Fire-stopping products shall not be used for sealing of penetrations of non-rated walls or floors.

B. Acceptable Manufacturers:

1. Dow Corning Fire-Stop System Foams and Sealants.

2. Nelson Electric Fire-Stop System Putty, CLK and WRP.

3. S-100 FS500/600, Thomas & Betts.

4. Carborundum Fyre Putty.

5. 3-M Fire Products.

6. Hilti Corporation.

1.24 NON-RATED WALL PENETRATIONS

A. Each trade shall be responsible for sealing wall penetrations related to their installed work, including but not limited to ductwork, piping, conduits, etc. See individual specification sections for requirements.

1.25 SUPPORTS

A. Provide required supports, beams, angles, hangers, rods, bases, braces, and other items to properly support contract work. Modify studs, add studs, add framing, or otherwise reinforce studs in metal stud walls and partitions as required to suit contract work. If necessary, in stud walls, provide special supports from floor to structure above.

B. For precast panels/planks and metal decks, support mechanical/electrical work as determined by manufacturer and the Engineer. Provide heavy gauge steel mounting plates for mounting contract work. Mounting plates shall span two or more studs. Size, gauge, and strength of mounting plates shall be sufficient for equipment size, weight, and desired rigidity.

C. For finished areas without a finished ceiling system such as classrooms, offices, conference rooms, etc., where decking and structure is exposed, and ductwork/piping/conduit is exposed: All mounting brackets, channel support systems and mounting hardware for ductwork, piping, lighting, etc. shall be concealed and approved by the Architect/Engineer prior to the installation. AirCraft cable style hanging for ductwork is required. It is recommended that room mockups be done and receive Architect/Engineer approval prior to proceeding with installation.

D. Equipment, piping, conduit, raceway, etc. supports shall be installed to minimize the generation and transmission of vibration.

E. Materials and equipment shall be solely supported by the building structure and connected framing. Gypboard, ceilings, other finishes, etc. shall not be used for support of materials and equipment.

1.26 APPLIED FIREPROOFING

A. Scope: Provide encapsulation of surfaces where applied fireproofing materials have been disturbed, removed, or left missing by the removal of hangers or upper attachments, or when new hangers or upper attachment are installed.

B. Fire Resistance Rating: Fireproofing shall meet the original hourly rating when applied to the construction assembly where materials have been removed or disturbed, or is missing.

C. Fire Hazard Classification: Fireproofing shall be listed in the Underwriters Laboratories Building Materials Directory with the following performance properties:

1. Flame Spread: 10 or less.

2. Smoke Developed: 5 or less.

D. Product Data: Provide manufacturer's product descriptions for each required fireproofing material. Include application instructions, including primer/adhesive requirements and recommended minimum thickness and density for each required hourly rating.

E. Fire Proofing Manufacturer:

1. Retro-Guard cementitious replacement fireproofing by Grace Construction Products, or equivalent Cafco Blaze Shield, and Cafco 300 by Isolatek.

2. Physical Properties:

a. Dry Field Density (ASTM E 605): 15 lb/cu ft minimum average.

b. Cohesion/Adhesion (Bond Strength) (ASTM E 736): 200 lb/sq ft minimum average.

c. Compressive Strength (ASTM E 761): 500 lb/sq ft minimum.

d. Impact (Bond Impact) Resistance (ASTM E 760): Shall not crack or delaminate.

e. Effect of Deflection (ASTM E 759): Shall not crack or delaminate.

f. Corrosion Resistance (ASTM E 937): No evidence of corrosion.

g. Air Erosion (ASTM E 859): Maximum 0.025 g/sq ft weight loss.

h. Provide primer or adhesive recommended by the fireproofing manufacturer to obtain required bond strength for the specific fireproofing and substrate.

F. Apply fireproofing prior to installation of ductwork, piping, conduits, and other suspended items. Hangers, clips and other supports for these items shall be installed before application of fireproofing.

G. Examine the substrate and conditions under which fireproofing is to be applied. Do not proceed with the fireproofing work until unsatisfactory conditions have been corrected. Verify that hangers, clips, sleeves, and other items that will penetrate the fireproofing are in place. Check paint on substrate for compatibility with primer/fireproofing and adequacy of bond strength in accordance with fireproofing manufacturer's instructions.

H. Surface Preparation: Remove dirt, dust, oil, grease, loose paint and rust, mill scale, and other foreign matter that may impair the bonding of the fireproofing to the substrate. Clean substrate free of contamination from chemicals and solvents. Apply primer/adhesive where necessary to obtain bond strength of fireproofing to steel shop paint and where recommended by the fireproofing manufacturer.

I. Apply the fireproofing in accordance with UL fire test report and the manufacturer's application instructions. Thickness and density of fireproofing shall be in accordance with the approved product data and as required to produce the hourly fire resistance rating required.

1.27 ACCESS PANELS

A. Provide access panels for required access to respective trade's work. Location and size shall be the responsibility of each trade. Access panels provided for equipment shall provide an opening not smaller than 22 in. by 22 in. Panels shall be capable of opening a minimum of 90 degrees. Bear cost of construction changes necessary due to improper information or failure to provide proper information in ample time. Access panels over 324 square inches shall have two cam locks. Provide proper frame and door type for various wall or ceiling finishes. Access panels shall be equal to "Milcor" as manufactured by Inland Steel Products Co., Milwaukee, Wisconsin. Provide General Construction trade with a set of architectural plans with size and locations of access panels.

1.28 CONCRETE BASES

A. Provide concrete bases for all floor mounted equipment. Provide 3,000 lb. concrete, chamfer edges, trowel finish, and securely bond to floor by roughening slab and coating with cement grout. Bases 4 in. high (unless otherwise indicated); shape and size to accommodate equipment. Provide anchor bolts in equipment bases for all equipment provided for the project, whether mounted on new concrete bases or existing concrete bases.

1.29 HVAC EQUIPMENT CONNECTIONS

A. Contractor is responsible for draining, filling, venting, chemically treating and restarting any systems which are affected by work shown on the Contract Documents unless specifically noted otherwise.

B. Provide final connections to all equipment as required by the equipment. Provide final connections, including domestic water piping, wiring, controls, and devices from equipment to outlets left by other trades. Provide equipment waste, drip, overflow and drain connections extended to floor drains.

C. Provide for Owner furnished and Contractor furnished equipment all valves, piping, piping accessories, traps, pressure reducing valves, gauges, relief valves, vents, drains, insulation, sheet metal work, controls, dampers, as required.

1.30 PLUMBING EQUIPMENT CONNECTIONS

A. Contractor is responsible for draining, filling, venting, chemically treating and restarting any systems which are affected by work shown on the Contract Documents unless specifically noted otherwise.

B. Provide roughing and final connections to all equipment. Provide loose key stops, sanitary "P" traps, tailpiece, adapters, gas or air cocks, and all necessary piping and fittings from roughing point to equipment. Provide installation of sinks, faucets, traps, tailpiece furnished by others. Provide cold water line with gate valve and backflow prevention device at locations called for. Provide continuation of piping and connection to equipment that is furnished by others. Provide relief valve discharge piping from equipment relief valves.

C. Provide valved water outlet adjacent to equipment requiring same. Provide equipment type floor drains, or drain hubs, adjacent to equipment.

D. Install controls and devices furnished by others.

E. Refer to Contract Documents for roughing schedules, and equipment and lists indicating scope of connections required.

F. Provide for Owner furnished and Contractor furnished equipment all valves, piping, piping accessories, traps, pressure reducing valves, gauges, relief valves, vents, drains, as required.

1.31 ELECTRICAL EQUIPMENT CONNECTIONS

A. Provide complete power connections to all electrical equipment. Provide control connections to equipment. Heavy duty NEC rated disconnect ahead of each piece of equipment. Ground all equipment in accordance with NEC.

B. Provide for Owner furnished and Contractor furnished equipment all power wiring, electric equipment, control wiring, switches, lights, receptacles, and connections as required.

1.32 STORAGE AND PROTECTION OF MATERIALS AND EQUIPMENT

A. Store Materials on dry base, at least 6 in. aboveground or floor. Store so as not to interfere with other work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.

B. Refer to Division O1 for additional information.

C. Division 23 shall provide airtight plastic covers over all supply and return air openings prior to the start of construction by any trade. The plastic shall be maintained airtight throughout the project construction and removed only with the approval of the Owner's Representative.

D. Ductwork shall be delivered to the site from the fabrication shop with air tight plastic covers over all ends of the ducts. The plastic covers shall be in place during transportation and shall be removed prior to installation.

1.33 FREEZING AND WATER DAMAGE

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

1.34 OWNER INSTRUCTIONS

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

1.35 OPERATION AND MAINTENANCE MANUALS

A. Submit by email (preferred) or digital media, thru the normal project submittal process. Include a copy of each final approved Shop Drawing, wiring diagrams, piping diagrams, spare parts lists, final testing and balancing report, as-built drawings and manufacturer's instructions. Include typewritten instructions, describing equipment, starting/operating procedures, emergency operating instructions, summer-winter changeover, freeze protection, precautions and recommended maintenance procedures. Include name, address, and telephone number of installing contractor and of supplier manufacturer Representative and service agency for all major equipment items. Provide a table of contents page and dividers based upon specification section numbers. Submit in a compiled and bookmarked PDF format as outlined below.

B. Provide content for Operation and Maintenance Manuals as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.

1. Engineer] will comment on whether content of operation and maintenance submittals is acceptable.

2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

C. Submit Operation and Maintenance Manuals in the following format:

1. Submit by uploading to web-based project software site, or by email to Architect, as a formal project submittal in conformance with the project specific submittal procedures. Enable reviewer comments on draft submittals.

2. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.

3. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in the table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

D. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing Owner training. Engineer will comment on whether general scope and content of manual are acceptable.

E. Final Manual Submittal: Submit O&M manual in final form prior to requesting inspection for Substantial Completion and at least 2 weeks before commencing Owner training. Engineer will return copy with review comments.

1. Correct or revise O&M manual to comply with Engineer'scomments. Submit copies of each corrected manual within 2 weeks of receipt of Engineer's comments.

F. Refer to Division 01 for additional requirements.

1.36 RECORD DRAWINGS

A. The Contractor shall obtain at his expense one (1) set of construction Contract Drawings, (including non-reproduction black and white prints or electronic files) for the purpose of recording as-built conditions.

B. The Contractor shall perform all survey work required for the location and construction of the work and to record information necessary for completion of the record drawings. Record drawings shall show the actual location of the constructed facilities in the same manner as was shown on the bid drawings. All elevations and dimensions shown on the drawings shall be verified or corrected so as to provide a complete and accurate record of the facilities as constructed.

C. It shall be the responsibility of the Contractor to mark **EACH** sheet of the contract documents in red and to record thereon in a legible manner, any and all approved field changes and conditions as they occur. A complete file of approved field sketches, diagrams, and other changes shall also be maintained. At completion of the work, the complete set of red marked contract documents, plus all approved field sketches and diagrams shall be submitted to the engineer and used in preparation of the record drawings.

D. A complete set of red marked contract drawings shall be submitted, at one time, as the "Record" set. If there are no changes to a specific drawing, the contractor shall indicate "NO CHANGES" on that drawing. ALL drawings shall be included in the "Record" set.

E. The complete set of red marked Contract Documents or electronic files shall be certified by the Contractor as reflecting record conditions and submitted to the engineer for review.

F. The Contractor shall have the marked up set scanned, if they are not already electronic files, and then submit them to the Engineer as the "Record Set".

G. Refer to Division 01 for additional requirements.

1.37 FINAL INSPECTION

A. Upon completion of all Engineering Site Observation list items, the Contractor shall provide a copy of the Engineering Site Observation Report back to the Engineer with each items noted as completed or the current status of the item. Upon receipt, the Engineer will schedule a final review.

1.38 COMMISSIONING

A. Refer to General Commissioning Requirements in Division 01 for additional requirements.

1.39 TEMPORARY HEATING AND COOLING

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

B. Systems and equipment installed as part of this project shall not be used for temporary heating or cooling.

1.40 MAINTENANCE OF HVAC SYSTEMS DURING TEMPORARY USE PERIODS

A. Provide each air handling system with a set of prefilters in addition to the permanent filters. Furnish four sets of prefilters for each system for use when system is operated for temporary heating or cooling. During such use, change prefilters as often as directed by Owner's Representative. Provide MERV-8 filters in all open ended ducts, return grilles and registers to keep dust out of ductwork. Change as often as necessary. Remove all such temporary filters upon completion. Use supply fans only. Do not operate return fans.

B. Blank-off outside air intake opening during temporary heating period. Install first set of permanent filters and prefilters.

C. Adjust dampers on supply system.

D. Set all heating coil control valves for manual operation.

E. Do not install any grilles or diffusers at room terminal ends of ducts until permission is given.

F. Assume responsibility for systems and equipment at all times, even though used for temporary heat or ventilating. Repair or replace all dented, scratched or damaged parts of systems prior to final acceptance.

G. Remove concrete, rust, paint spots, other blemishes, then clean.

H. Just prior to final acceptance, remove used final filter and install new set. Deliver all unused sets of prefilters to the Owner and obtain written receipt. Properly lubricate system bearings before and during temporary use. Maintain thermostats, freeze stats, overload devices, and all other safety controls in operating condition.

1.41 TEMPORARY FACILITIES

A. Refer to the Division I Sections, General Conditions and Supplemental General Conditions.

1.42 TEMPORARY LIGHT AND POWER

A. Refer to the Division 1 Sections, General Conditions and Supplemental General Conditions.

1.43 CLEANING

A. It is the Contractor's responsibility to keep clean all equipment and fixtures provided under this contract for the duration of the project. Each trade shall keep the premises free from an accumulation of waste material or rubbish caused by his operations. The facilities require an environment of extreme cleanliness, and it is the Contractor's responsibility to adhere to the strict regulations regarding procedures on the existing premises. After all tests are made and installations completed satisfactorily:

1. Thoroughly clean entire installation, both exposed surfaces and interiors.

2. Remove all debris caused by work.

3. Remove tools, surplus, materials, when work is finally accepted.

1.44 SYSTEM START-UP AND TESTING

A. All new heating and ventilating systems shall be started up and operated at normal operating temperature for a period of 24 hours to "bake-off" the equipment. The associated ventilation system shall run on 100% outside air during the bake-off for an additional eight hours to purge the building. This work shall be completed prior to occupancy or on a Saturday, with the Contractor responsible for being on site during the entire purge and bake-off operation.

B. Work of any contract which includes system "bake-off', system start-up, system cut-over or staff training shall not be done one week prior to and one week after the commencement of school except upon written approval by the Owner.

C. Prior to commencement of work, the Division(s) effecting such system shall survey all building mechanical, plumbing, fire protection and electrical systems and components and make written notice to the Owner's Representative regarding any damage, missing items and/or incomplete systems. Prior to the conclusion of this project, the Contractor shall verify with the Owner's Representative that all building systems have been returned to their original conditions.

D. Start-up and testing of HVAC systems shall occur while the building is not occupied by students and only after notice to the Owner's Representative is made at least 24 hours in advance. Division 23 shall be responsible for providing temporary filter media over all supply air registers and diffusers during the HVAC system start-up procedure.

Division 23 shall provide airtight plastic covers over all supply and return air openings prior to the start of construction by any contractor. The plastic shall be maintained airtight throughout the project construction and removed only with the approval of the Owner's Representative.

1.45 VIDEO RECORDING OF TRAINING SESSIONS

A. The contractor shall video record all training sessions required by their discipline. Video shall be in Windows Media Player video format saved on flash drives. Two (2) copies on flash drives are to be provided as a formal submittal. . Flash drives are to be tagged with project name, training session name(s), installing Contractor and date of training. The flash drive shall include a scanned version of the training session sign in list(s), including the presenter and the owner's participants.

1.46 ENERGY INCENTIVES

A. The Contractor, his Subcontractors and Suppliers shall provide to the Owner all paperwork necessary to support the Owners pursuit of incentives related to energy conservation as offered by the utility company or state sponsored incentive programs. This shall include at a minimum, receipts, and quantities and data sheets for energy efficient equipment such as: lighting, motors, variable frequency drives, etc.

END OF SECTION

SECTION 260501 - BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The drawings are diagrammatic, unless detailed dimensioned drawings are included, and show only approximate locations of equipment, fixtures, panelboards, conduits, and wiring devices. Exact locations are subject to the approval of the Owner's Representative. The general run of electrical feeders, branch circuits, and conduits, indicated on the drawings, is not intended to be the exact routing. Exact routings of conduit shall suit the job conditions. Not all items are applicable, refer to plans for quantities and all equipment required for this project.

B. Circuit designations, in the form of "Home Runs" on branches, indicate the designation of the branch circuit, the size and the quantity of branch circuit conductors, and the panel board or interconnection box from which the branch circuit is served.

C. Make measurements at the site and in the building during construction for all systems installed as the work progresses in such a manner that the equipment, piping, vents, ducts, conduit, and boxes will fit in the space available. Maintain headroom and if in unfinished areas, be as neatly installed, as obscure and "out-of-the-way" as physically possible. Where more than one trade is involved in an area, space or chase, all shall cooperate and install their own work to utilize the space equally between them in proportion to their individual requirements. In general, ductwork shall be given preference except where grading of piping becomes a problem, followed by piping then electrical wiring. If, after installation of any equipment, piping, ducts, conduit, and boxes, it is determined that ample maintenance and passage space has not been provided, rearrange work and /or furnish other equipment as required for ample maintenance space.

D. Any changes in the size or location of the material or equipment supplied, which may be necessary in order to meet field conditions or in order to avoid conflicts between trades, shall be brought to the immediate attention of the Owner's Representative and approval received before such alterations are made.

1.2 QUALITY ASSURANCE

A. Electric equipment shall be installed in a neat and workmanlike manner. All methods of construction, details of workmanship, that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative.

B. Equipment and materials shall be of the quality and manufacture indicated in their respective sections of the specifications. The equipment specified is based upon the acceptable manufacturers listed. Equipment types, device ratings, dimensions, etc., correspond to the nomenclature dictated by those manufacturers. Where "or equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.

1.3 SUBMITTALS

A. Submit the following equipment, materials and products, including all fittings and accessories:

1. Conduit
2. Surface Metal Raceway
3. Expansion Fittings
4. Power/Communication Poles
5. Wireway and Wire Trough
6. Channel Support Systems
7. Conductors
8. Cables
9. Cable Termination and Splice Kits
10. Poke-Through Service Fittings
11. Terminal and Equipment Cabinets
12. Flush Floor Boxes
13. Wiring Devices Including Dimmers
14. Telephone/Data Communication Outlets
15. Television Outlets
16. Rotary Time Switches
17. Release Delay Relay
18. Extension Cord Reels
19. Occupancy Sensors
20. Lighting Control Contactors
21. Emergency Shutdown Systems
22. Water Proofing Seals
23. Flashing, Sealing, Firestopping Materials
24. Hand Dryers
25. Salvageable Materials

1.4 SALVAGEABLE MATERIALS

A. Salvageable materials will be reviewed and identified by the Owner. Instruction shall be given to the Contractor whether the Owner will remove salvageable materials, or whether contractor is to remove and deliver salvageable materials to a designated site.

B. Items normally accepted as salvage by the Owner:

1. Non PCB contaminated transformers, oil filled or dry
2. All deadfront switchgear
3. All three phase circuit breaker panelboards and covers
4. Circuit breakers
5. Disconnects (100 AMP and up)
6. Bus duct and apparatus
7. Luminaires
8. Fire protection equipment
9. Motors above 1/2 HP and up
10. Environmental and automation control equipment
11. Telephones
12. Central clock system

13. Paging speakers and intercom components

PART 2 - PRODUCTS

2.1 MATERIALS

A. Conduit, Raceway and Tubing:

1. Rigid Metal Conduit shall be hot-dipped galvanized or electro-galvanized steel, U.L. listed “rigid metal conduit.”

a. Acceptable manufacturers:

1) Republic Steel
2) Triangle PWC
3) Allied Tube
4) Steel Duct

2. Electrical Metallic Tubing shall be electro-galvanized steel; U.L. listed “electrical metallic tubing.”

a. Acceptable manufacturers:

1) Republic Steel
2) Triangle PWC
3) Allied Tube
4) Steel Duct

3. Flexible Metal Conduit shall be constructed one continuous length of electro-galvanized, spirally wound steel strip with interlocking convolutions and interior surfaces free from burrs and sharp edges. Shall be U.L. listed “flexible metal conduit” or “liquidtight flexible metal conduit” as required.

a. Acceptable manufacturers:

1) Triangle PWC
2) American Flexible Conduit Company

4. Surface Metal Raceway shall be .040” steel U.L. listed “Surface Metal Raceway”. Use manufacturer’s standard fittings designed to be used with the specific raceway.

a. One-Piece Raceway:

1) Ivory finish
2) Acceptable manufacturers:

a) Wiremold “700” Series (Design Make)
b) Approved equivalent

b. Two-piece Prewired Raceways:

1) Ivory finish
2) Wiring Harness:

a) Single circuit NEMA 5-15R, 15 ampere, 125 volt, grounded receptacles spaced on 6 inch centers

3) Acceptable manufacturers:

a) Wiremold 2000
b) Approved equivalent

c. Two-Piece Raceways:

1) Ivory finish

2) Duplex or special receptacles as specified in wiring devices

3) Provide divider in raceways utilized for power and communications.

4) Acceptable manufacturers:

a) Wiremold V-4000
b) Approved equivalent

5. Electrical Non-Metallic Tubing (ENT), is designed to replace EMT, flexible metal conduit or other raceway or cable systems, for installation in accordance with Article 331 of the National Electrical Code, other applicable sections of the Code, and local codes.

a. Any ENT used shall meet the requirements of NEMA TC-13 and shall be listed by Underwriters laboratories, Inc., as suitable for its intended purpose.

b. ENT shall be recognized by a CABO National Evaluation Report for use in 1-hour and 2-hour rated construction.

c. Penetration of fire rated walls, floors or ceilings shall use classified Through-penetration Firestop Systems described in the current Underwriters Laboratories Building Materials Directory.

d. Fittings and outlet boxes shall be designed for use with ENT and listed by Underwriters Laboratories. All fittings, boxes, and accessories shall be from one manufacturer.

e. Only cement recommended specifically for use with the brand of ENT used shall be used.

f. Unless indicated differently on drawings, ENT systems shall be color coded: BLUE for branch and feeder circuit wiring, YELLOW for communications, and RED for fire alarm and emergency systems.

g. Acceptable manufacturers:

1) Carlon
2) Approved equal

B. Conduit Fittings:

1. Fittings for rigid metal conduit shall be fully threaded and shall be of the same material as the respective raceway system. Fittings for electrical metallic tubing shall be single screw indenter fittings for conduits up to 2 in. and double screw indenter fittings for conduits 2 in. and larger. Connectors shall also have insulated throat up to and including 1 in. size. For sizes 1-1/4 in. and larger, provide plastic insulating bushing. Die-cast, pressure cast fittings shall not be used. Fittings for rigid non-metallic conduit shall be solvent cemented in accordance with the manufacturer's instructions.

a. Acceptable manufacturers:

1) O.Z. Gedney
2) Steel City
3) Thomas & Betts
4) Crouse-Hinds
5) Carlon

2. Expansion Fittings shall be watertight, combination expansion and deflection type designed to compensate for movement in any direction. Fittings shall have flexible copper braid bonding jumpers, neoprene sleeve and stainless steel bands, Use aluminum body fittings for rigid aluminum conduit.

a. Acceptable manufacturers:

1) Crouse-Hinds, Type "DX"
2) O.Z./Gedney, Type "DX"
3) Or equivalent

C. Power/Communication Poles:

1. Poles shall contain a communication and power divider and be nominally 2-14 in. square by height required. Each pole shall be equipped with two (2), 20 ampere, 125 volt, grounded, duplex receptacles, and knockouts for telephone and computer/data connections. Constructed of a minimum of 0.050 in. thick, anodized aluminum extrusion, with removable trim plate and cover. Unit shall be furnished with top plate mounting assembly for easy installation to accessible ceiling.

Unit shall be prewired with wire leads at top of pole.

a. Acceptable manufacturers:

1) Wiremold AMDTP Series
2) Hubbell "PAX-5" Series

D. Wireway and Wire Trough:

1. Wireway and Wire Trough shall be hinged cover type wireway with provisions for full lay-in along the entire length of run. Wireway shall be steel, enclosed with gray enamel finish. Provide JIC sectional NEMA dust resistant, oil tight type where subjected to moisture, in Pump Rooms, Mechanical, Electric and Fan Rooms, exterior walls, Wood Shop, and Maintenance Shop, and similar locations. Size to meet NEC fill requirements or larger as noted on Contract Documents. Provide knockouts along runs. Recess in wall where required for flush mounted equipment. Provide all elbows, tees, pullboxes, fittings, hangers, reducers, supports, supports, etc., to meet installation requirements.

   a. Acceptable manufacturers

      1) Square D "Square Duct"
      2) General Electric
      3) Hoffman
      4) Meco

E. Channel Support Systems:

1. Channel Support Systems shall be provided for racking up conduit, trapeze suspensions, cable racks and panel racks**.** Provide necessary accessories such as bolts, screws, anchors, connection plates, and straps as required to perform the necessary functions.

   a. Acceptable manufacturers:

      1) Unistrut
      2) Globe
      3) Kindorf
      4) B-Line

F. Conductors and Cables:

1. Conductors shall be insulated for 600 volts, unless otherwise noted, and shall be standard AWG and kcmil sizes. Conductors shall be 98 percent copper, thermal plastic or cross-linked polymer insulated, heat and moisture resistant. Conductors shall be stranded, except for conductors used for fire alarm system wiring. Conductor sizes No. 18 AWG and smaller shall be a solid single strand; No. 16 AWG and larger shall be multiple stranded. Minimum conductor size shall be #12 AWG except smaller sizes may be used for communications and special systems. Conductor sizes shall be as called for.

   Conductors shall be labeled with U.L. seal and be marked with the manufacturer's name, wire size and insulation type. Insulation for all 600-volt conductors shall be Type THHN/THWN or Type XHHW, unless otherwise noted. Luminaire fixture wire shall conform to the latest Underwriters Laboratories requirements. Flexible cords and cables for general portable use shall be Type "SO" or "SJO." Cables for special use shall be of the type specified for the application.

a. Color Coding:

1) All circuits shall be color coded according to the following schedule.

	Three Phase 120/208V 240V	**Three Phase 277/480V**
Ground	Green	Green
Neutral	White	Gray
A or L1	Black	Brown
B or L2	Red	Orange
C or L3	Blue	Yellow

b. Acceptable manufacturers:

1) Cable
2) ITT Royal
3) Rome Cable
4) Pirelli
5) Brand Rex
6) Okonite

G. Terminal Lugs and Connectors:

1. The copper lug shall be capable of continuous operation at the current rating of the cable it is used on. The lug shall be UL listed per UL 486A, using industry standard crimping tools and dies. Terminal lugs shall be solderless, pressure type with UL label for "CU/AL" conductor terminations. The lug shall be a closed-end compression (crimp) type, constructed of seamless, tin-plated copper. The lug shall be made with a chamfered inside end, for ease of conductor insertion. Both one and two hole lugs shall be NEMA sized for standard stud sizes and spacing. The lug shall be designed for use at voltages up to 35 kV.

a. Acceptable Manufacturers:

1) 3M Scotchlok 30,000 and 31,000 Series
2) Burndy
3) O.Z./Gedney
4) Thomas and Betts

2. The copper conductor connection shall be capable of continuous operation at the current rating of the cables it is used on. The connection shall be UL listed per UL 486A, using industry standard crimping tools and ides. The connector shall be an inline compression (crimp) type, constructed of seamless, tin-plated copper. The connector shall be constructed with chamfered inside-ends and with center cable stops. The connector shall be designed for use at voltages up to 35 kV.

a. Acceptable Manufacturers:

1) 3M Scotchlok 10,000 and 11,000 Series
2) Burndy
3) O.Z./Gedney
4) Thomas and Betts

3. "Split-bolt" Connectors shall be solderless type.

a. Acceptable manufacturers:

1) Burndy
2) Kearney
3) O.Z./Gedney
4) Thomas and Betts
5) Anderson

4. "TWIST ON" Connectors shall be spiral steel spring type and insulated with vinyl cap and skirt.

a. Acceptable manufacturers:

1) 3-M Company "Scotch-Lock"
2) Ideal "Wing-Nuts"
3) Or equivalent

5. Ground Connectors shall be cast type.

a. Acceptable Manufacturers:

1) Thermoweld
2) Cadwell
3) Or equivalent

H. Boxes:

1. Outlet Boxes and covers shall be galvanized steel, not less than 1-1/2 in. deep, 4 in. square or octagonal, with knockouts. Outlet boxes exposed to moisture, exterior, wet or damp locations shall be cadmium cast alloy complete with threaded hubs and gasketed screw fastened covers. Minimum box size shall be as indicated in Article 370 of the National Electrical Code for the conductors and devices installed.

Boxes shall be approved for the environmental condition where they will be installed.

a. Acceptable manufacturers:

1) Steel City
2) Raco
3) Appleton

4) Crouse Hinds

2. Flush Floor Outlet Boxes shall provide flush service for power or communications/data as called for. Boxes shall be suitable for carpet or tile applications. Stamped steel, concrete tight, fully adjustable box with interior and exterior leveling screws, and with 1/2 in., 3/4 in. and 1 in. knockouts. Complete with expandable cap to prevent ingress of concrete during pour. Provide polished brass integrated carpet plate/duplex floor plate and duplex receptacle where called for. Provide polished brass integrated carpet plate/3/4 in. – 1 in. floor plate where utilized for communications/data. Make: Steel City 68-D with P60-CACP or P60-3/4-2-CACP as required, or approved equivalent.

3. Multiple Service Flush Floor Outlet Boxes shall provide flush service for power and telecommunications/data/video as called for. Boxes shall be suitable for carpet or tile applications. Multi-use, high capacity, flush, power and communications floor box (9 in. x 16 in.) with hinged top (8 in. x 8 in.) for carpet inset, in color as selected, and retractable wiring exit. Box shall have two (2) duplex receptacles (each on own circuit) on one side and minimum of four (4) tel/data/video outlets (as called for) on opposite side. Make: Steel City AFM Preset Inset with GAB-4 Box and AFM-4 Inset.

4. Pull and Junction Boxes shall be constructed of not less that 14-gauge galvanized steel with trim for flush or surface mounting in accordance with the location to be installed. Provide screw-on type covers. Boxes installed in damp or wet locations shall be of raintight construction with gasketed cover and threaded conduit hubs. In no case shall boxes be sized smaller than as indicated in Article 370 of the National Electrical Code for conduit and conductor sizes installed. Boxes shall be approved for the environmental condition of the location where they will be installed.

   a. Acceptable manufacturers:

      1) Hoffman
      2) Keystone
      3) Or equivalent

5. Flush floor junction boxes shall be recessed cover boxes designed for flush mounting in masonry. Provide checkered plate gasketed cover suitable for foot traffic. Make: O.Z. Gedney Type YR or approved equal.

6. Flush Poke-Through Service Fitting (Power/Communication). Provide flush poke-through suitable for installation in a 6 in. diameter opening. Shall be complete with Junction Box, conduit and conduit adapter for transition from the floor box to movable partitions or with flush devices as indicated on plans. The complete assembly shall be suitable for two hour fire rated floors and have brass cover, color as selected by the Architect. Provide duplex receptacle(s) in all poke-through. Also, provide telephone and computer data outlets, completely wired, where indicated.

a. Design Make: Wiremold Evolution 6AT Series with cover (color selected by Architect). Quantity of duplex receptacles and telecommunication drops per drawings.

1) Acceptable Manufacturers:

a) Hubbell
b) Steel City
c) Approved equal

I. Terminal and Equipment Cabinets:

1. Terminal and Equipment Cabinets shall be code gauge galvanized steel with removable endwalls. Fronts shall be of code gauge steel, flush or surface type (as indicated) with concealed trim clamps, concealed hinges, flush lock, and grey baked enamel finish. Boxes and front shall be U.L. listed and shall be minimum 35 in. H x 24 in. W x 6 in. D. Provide removable insulated plywood terminal board mounted on inside back wall of cabinet.

a. Acceptable manufacturer:

1) Square D “Mono-Flat”
2) Approved Equal

J. Wiring Devices:

1. Wiring Devices (toggle switches, key switches, receptacles, dimmers, occupancy sensors) shall be specification grade as a minimum. Switch handle and receptacle shall be ivory or brown unless noted otherwise. Provide ivory cover plates in multi-compartment surface raceways, and elsewhere. Provide device cover plates of satin finish type 302 stainless steel in finished areas and Yorkville “Invisoplage” for round or octagonal boxes only in unfinished areas. Provide neoprene gasketed cast aluminum box with raintight cover for switches and receptacles designated “WP”.

a. Although only one manufacturers model number has been noted in each device description, acceptable manufacturers are:

1) Pass and Seymour
2) Hubbell
3) Arrow Hart
4) Leviton

2. Toggle Switches:

a. UL verified to meet latest Federal Specification WS-896, NEMA WD-1 and UL Test 20.

b. 20 ampere, 1-pole, 277 volt: P&S 20AC1.

c. 20 ampere, 2-pole, 277 volt: P&S 20AC2**.**

d. 20 ampere, 3-way, 277 volt: P&S 20AC3**.**

e. 20 ampere, 4-way, 277 volt: P&S 20AC4.

f. 20 ampere, 1-pole, 277 volt: w/neon pilot light: P&S 20AC1-RPL.

g. 20 ampere, 2-pole, 277 volt: w/neon pilot light: P&S 20AC2 – RPL.

h. 20 ampere, 3-way, 277 volt: w/neon pilot light: P&S 20AC3 – RPL.

3. Key Switches:

a. 20 ampere, 1-pole, 277 volt: P&S 20AC1-L**.**

b. 20 ampere, 2-pole, 277 volt: P&S 20AC2-L**.**

c. 20 ampere, 3-way, 277 volt: P&S 20AC3-L.

d. 20 ampere, 4-way, 277 volt: P&S 20AC4-L.

4. Pilot Lights:

a. 120V, P&S 437

b. 277V, P&S 438

5. Receptacles:

a. Back and side wiring options which accept No. 14 to No. 10 AWG solid and stranded conductors. One-piece plated steel or brass mounting strap. Bronze contacts. Meet requirements of Federal Specification W-C-596 and UL 496.

b. NEMA 5-20R, 20 ampere**,** 125 volt, duplex receptacle: P&S 5362, Hubbell HBL5352, Leviton 5362.

c. NEMA 6-20R (250V – 20A):

1) Normal use, Hubbell 5461, brown

d. NEMA 6-30R (250V – 30A):

1) Normal use, Hubbell 9330, black

e. NEMA 10-30R (125/250V – 30A):

1) Normal utility, Hubbell 9350G, black face

f. NEMA 10-50R (125V/250V – 50A):

1) Normal utility, Hubbell 7962-G, black face

g. NEMA 14-30R (125/250V – 30A):

1) Normal utility, Hubbell 9430, black face

h. NEMA 14-50R (125/250V – 50A):

1) Normal utility, Hubbell 9450, black face

i. NEMA 5-20R, 20 ampere, 125 volt, duplex G.F.I., 6ma trip receptacle: P&S 2091S.

j. NEMA 5-20R, 20 ampere, 125 volt, duplex receptacle, melamine construction, yellow color, corrosion resistant: P&S CR6300.

k. NEMA 5-15R, Clock Hanger Outlet – 15 ampere, 125 volt with hanger plate: P&S S3713-I.

l. 20 ampere, 125 volt, duplex, weather-proof: Crouse Hinds WLPD-5-20.

6. Telephone/Data Communications Outlets:

a. 4 in. x 4 in. outlet box with single gang plaster ring with connector and plate per 270000 Series Specifications and 1 in. conduit stubbed to accessible ceiling space, arranged for further continuation.

7. Television Outlets:

a. 4 in. x 4 in. outlet box with single gang plaster ring with coax connector and plate per 270000 Series Specifications and 1 in. conduit stubbed to accessible ceiling space, arranged for further continuation.

8. Rotary Time-out Switches:

a. Mechanical spring wound timer, which requires no electricity to operate the timing mechanism. Device shall fit a standard 2-1/2 in. deep wall box. Stainless steel coverplate with increment labeling. Switch contacts shall break current carrying contacts at the end of the timed cycle.

1) 0-4 Hours: Tork A504HH or equal.

9. Release Delay Relay:

a. Ice cube relay with 11-pin socket base mounted in NEMA 1 enclosure with label.

b. Delayed shutdown operation: Supply voltage must be constantly applied. When the control switch is closed the internal relay will energize. Timing begins when the control switch is opened. The delay can be reset by reclosing the control switch. On completion of the delay period, the relay will de-energize. Delay cannot be stopped during unless relay power is interrupted.

c. 120 volt, 10 amp, DPDT contacts.

d. DIP switch adjustable timing delay from 1 second to 1023 minutes.

e. Time Mark #361 with #51X016 base.

10. Occupancy Sensors:

a. Switchbox type shall be single gang switchbox mounting, 180º viewing angle, 40 ft. nominal viewing range, dual element passive infrared detection. Adjustable 7-second to 15-minute time-out delay. Ambient light override adjustable from full daylight to 7 fc. Capable of switching solid state electronic and magnetic ballasts, and incandescent lighting loads up to 15A at 277V. Manual off override.

1) P&S OSC 3020-I (Design Make)
2) Watt Stopper WS-120, WS-277

b. Ceiling Mount: Passive infrared sensor, switching module, and load relays (quantity as required for control indicated). 110º viewing angle/25 ft. nominal viewing range by 360º.

1) P&S OSC-1000, OSC-2020 and OSC2120 as required
2) Watt Stopper CI-205

c. Wall Mount (Subscript "W"): Passive infrared sensor, switching module and load relays (quantity as required for control indicated). Nominal viewing range of 36 ft. by 50 ft.

1) Watt Stopper CI-100 with wall or ceiling mounting bracket.

d. Ceiling Mount, Hallway (Subscript "H"): Ultrasonic sensor and power packs as required. Nominal 90 ft. x 10 ft. coverage.

1) Watt Stopper W-2000H (Design Make)

e. Ceiling Mount, Ultrasonic (Subscript "U"): Ultrasonic sensor and power packs as required. Nominal 24 ft. x 40 ft. coverage.

1) Watt Stopper W-1000A

f. Ceiling Mount, Ultrasonic (Subscript "U2"): Ultrasonic sensor and power packs as required. Nominal 40' x 55' coverage.

1) Watt Stopper W-2000A (Design Make).

g. Provide low voltage transformers, control relays, etc. required to provide area control indicated.

h. On projects where fifty (50) or more units of any type are used, provide the on-site services of an authorized representative of the manufacturer to

provide placement recommendations, connection details, start-up supervision and adjustment.

11. Lighting Control Contactors shall be provided with NEMA 1, General Purpose, surface mounted enclosure unless otherwise noted, electrically operated, mechanically held, 120 volt fused control circuit 30 amp contact rating eight (8) poles, unless otherwise noted: Square-D, Class 8903, or approved equal.

12. Lighting Control Contactors shall be provided with NEMA 1, general purpose, surface mounted enclosures with cover mounted hand-off auto selector switch, electrically operated, electrically held, 120 volt fused control circuit 30 amp contact rating eight (8) poles, unless otherwise noted: Square-D, Class 8903, or approved equal.

K. Ductbanks:

1. Ductbanks shall be rigid non-metallic conduit encased in concrete system. Provide all sleeve joints, couplings, bend sections, bends, elbows, offsets, angle couplings, bell ends, caps, base spacers and intermediate spacers as required to meet field conditions. All bends, stub-ups and wall, slab or floor-building penetrations shall be rigid steel conduit without exception.

L. Waterproofing Seals:

1. Provide expanding link type seal, for installation between duct/conduit, and sleeve or core-drilled hole in concrete.

2. Make: Link Seal, manufactured by Thunderline Corp., or approved equal.

M. Flashing, Sealing, Fire-stopping

1. Fire-stopping for Openings Through Fire and Smoke Rated Wall and Floor Assemblies:

a. Provide materials and products listed or classified by an approved independent testing laboratory for “Through-Penetration Fire-Stop Systems.” The system shall meet the requirements of “Fire Tests of Through-Penetration Fire-Stops” designated ASTM E814.

b. Provide fire-stop system seals at all locations where piping, tubing, conduit, electrical busways/cables/wires, ductwork and similar utilities pass through or penetrate fire rated wall or floor assembly. Provide fire-stop seal between sleeve and wall for drywall construction.

c. The minimum required fire resistance ratings of the wall or floor assembly shall be maintained by the fire-stop system. The installation shall provide an air and watertight seal.

d. The methods used shall incorporate qualities, which permit the easy removal or addition of electrical conduits or cables without drilling or use of special tools. The product shall adhere to itself to allow repairs to

be made with the same material and permit the vibration, expansion and/or contraction of any items passing through the penetration without cracking, crumbling and resulting reduction in fire rating.

2. Acceptable Manufacturers:

a. Dow Corning Fire-Stop System Foams and Sealants
b. Nelson Electric Fire-Stop System Putty, CLK and WRP.
c. S-100 FS500/600, Thomas & Betts.
d. Carborundum Fyre Putty.
e. 3-M Fire Products.

N. Hand Dryers:

1. Hand dryers shall include die-cast zinc alloy cover, finished with chip proof white epoxy paint. Motor shall be universal type, 5/8 HP at 20,000 rpm. Dryer shall deliver 16,000 linear feet of air per minute. Dryer shall be activated by means of a infrared control device and cam-operated timer. Dryer shall be listed by Underwriters Laboratories, Inc.

2. Electrical Characteristics:

a. Nozzle: Fixed.
b. Volts: 115.
c. Amps: 12.5
d. Frequency: 60 Hz.

3. Make: Xlerator, Model XL-2.

O. Ceiling Fans:

1. Ceiling fans shall have a 52 in. blade sweep. Motor shall be digital inverter drive type. Shall operate at 120 volt, 60 HZ, .39 amps form 49-178 RPM. Provide complete with three (3) airfoils, all mounting hardware and downrod with white enamel finish. Shall have min. 8" downrods for high ceilings. Provide mounting per manufacturer's recommendations. Shall have white housing and airfoils. Verify all heights of fans prior to ordering.

2. Controller: 3-speed controller; non-blue tooth.

3. Warranty: Minimum 2-year motor warranty.

4. Make: Big Ass Fans: Model No.: Haiku L series 52 with Senseme Technology.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Unless otherwise noted, wiring for all systems indicated in the contract documents shall consist of insulated conductors installed in raceways. Raceways shall be continuous from outlet box to outlet box and from outlet box to cabinet, junction or pull box. Secure and

bond raceways to all boxes and cabinets so that each system of raceways is electrically continuous throughout.

Unless otherwise indicated on the drawings, install all wiring in the following raceway system:

1. Wiring 600 volts or less in dry locations: Electrical metallic tubing**.**

2. Wiring 600 volts or less in outdoors, above grade locations: Rigid metal conduit.

3. Wiring 600 volts or less installed below grade, in concrete floor slabs or below ground floor slab: Rigid non-metallic conduit encased in concrete with rigid metal conduit bends and penetrations through building floors and walls.

4. All wiring installed in hazardous locations: Galvanized Rigid metal conduit.

5. All wiring installed in corrosive locations: PVC coated rigid metal conduit.

6. Flexible metal conduit shall be used for final connection to all motors, final connection to rotating or vibrating equipment, final connections to dry type transformers and final connections to recessed lighting fixtures. Liquidtight flexible conduit shall be used in all wet or damp locations. Maximum length of flexible conduit shall be 36 in., except that from outlet boxes to lighting fixture maximum length shall be 6 ft. Provide green insulated equipment grounding conductor in all flexible metal conduit.

7. Surface metal raceway may be used for surface runs in finished area where concealed conduit cannot be run or where specifically indicated on drawings. Submit detailed description and/or layout for approval prior to roughing.

B. Raceways:

1. Sized as indicated on the drawings. Where sizes are not indicated, raceways shall be sized as required by the National Electrical Code in accordance with the quantity, size, and type of the insulation conductors to be installed. Raceways shall be minimum 1/2 in. trade size for branch circuit wiring and minimum 3/4 in. trade size for all telephone intercommunications, instrumentation, fire alarm, television and computer systems and for all branch circuit “Home Runs” to panelboards.

2. Installed to provide adequate grounding between all outlets and the established electrical system ground.

3. Cut square, free of burrs due to field cutting or manufacture, and bushed where necessary.

4. Installed with exterior surfaces not less than 6 in. from any surface with normal operating temperature of 200ºF or higher.

5. Plugged at the ends of each roughed-in raceway with an approved cap or disc to prevent the entrance of foreign materials during construction.

6. Concealed throughout except where exposure is permitted by the Owner's Representative. All exposed raceways shall be painted to match existing adjacent surface finish as directed by Architect.

7. Installed parallel or perpendicular to floors, walls and ceilings where exposed wiring is permitted.

8. Installed with a minimum of bends and offsets. All bends shall be made without kinking or destroying the cross section contour of the raceway. Factory made bends are acceptable and should be considered for raceways larger than 2".

9. Installed with U.L. approved rain-tight and concrete-tight couplings and connectors.

10. Firmly fastened within three feet of each outlet box, junction box, cabinet or fitting. Raceways shall not be attached to or supported by wooden plug anchors or supported from mechanical work such as ductwork, piping, etc.

11. Installed with a #14 AWG fish wire in all telephone, intercommunication, "Spare" or "Empty" conduit runs to facilitate future installation of conductors.

12. Installed with expansion fittings at all building expansion joints such that no undue stress is placed on any electrical raceway due to the proper functioning of expansion joints.

13. Arranged in a neat manner for access and allow for access to work installed by other trades.

14. Raceways installed in concrete slabs shall be located so as not to effect structural integrity of slab, and such that conduit shall have a minimum of one inch of concrete cover on all sides. Obtain approval from the Owner's Representative prior to installing conduit larger than 1 in. trade size in concrete slabs. Raceways in slabs shall be for floor box use only.

15. Raceways installed below ground floor slab shall be encased in concrete with 3 in. minimum coverage on all sides. Where possible, install conduit directly below slab with concrete envelope poured monolithic with slab. Where this is not possible, support raceways and envelop maximum 5 ft. – 0 in. on centers from underside of structural slab by means of galvanized pipe hangers.

    Pipe hangers shall be coated with asphalt mastic. Installation shall maintain integrity of waterproofing membrane.

16. If it is necessary to burn holes through webs of beams or girders, call such points to the attention of the Owner's Representative and receive written approval both as to location and size of hole before proceeding with work. All holes shall be burned no larger than absolutely necessary.

17. Become familiar with the general construction of the building and place sleeves, inserts, etc., as required. All penetrations through existing floors shall be core drilled and sleeved.

18. Wherever a cluster of four (4) or more raceways rise out of floor exposed, provide neatly formed 6 in. high concrete envelop, with chamfered edges, around raceways.

19. All raceways shall be supported adequately by malleable iron pipe clamps or other approved methods. In exterior or wet locations, supports shall allow not less than 1/4 in. air space between raceway and wall. Firmly fasten raceway within 3 ft. of each outlet box, junction box, cabinet or fitting. The following table lists maximum spacing between conditions, strength of supporting members, etc.

20. Furnish and install such supports at no additional cost to owner.

Conduit Trade Size	Type of Run	Horizontal Spacing in Feet	Vertical Spacing in Feet
1/2 in., 3/4 in.	Concealed	7	10
1 in., 1-1/4 in.	Concealed	8	10
1-1/2 in. and larger	Concealed	10	10
1/2 in., 3/4 in.	Exposed	5	7
1 in., 1-1/4 in.	Exposed	7	8
1-1/2 in. and larger	Exposed	10	10

21. Where raceways puncture roof, install pitch pockets as required in order that the roof warranty is maintained. Coordinate with representative of roofing material manufacturer.

22. At each flush mounted panelboard, terminal cabinet, control cabinet, etc., provide 4 spare 3/4 in. raceways from panelboard, etc., to an area above the nearest accessible ceiling space. Make 90º turn above the ceiling, arranged for further continuation of raceway, and cap.

23. Provide a bushing at each conduit termination unless fitting at box where conduit terminates has hubs designed in such a manner to afford equivalent protection to conductors.

    Provide grounding type insulated bushings on all conduit sizes 1-1/4 in. trade size and larger, and on all feeder raceways regardless of size. Provide standard bushings for conduits 1 in. and smaller unless otherwise stated.

C. Wiring Methods:

1. Conductors shall not be installed until raceway system, including all outlets, cabinets, bushings and fittings, is completed. Verify that all work of other trades

which may cause conductor damage is completed. Use only U.L. approved cable lubricants when necessary. Do not use mechanical means to pull conductors No. 8 or smaller.

2. In general, conductors shall be the same size from the last protective device to the load.

3. All wiring systems shall be properly grounded and continuously polarized throughout, following the color-coding specified. Connect branch circuit wiring at panelboards, as required, in order to provide a "balanced" three-phase load on feeders.

4. Provide insulated green ground conductor and white (gray for 277 volt) insulated neutral conductor in each branch circuit.

5. All feeder connections shall be made to bus and other equipment using solderless, pressure type terminal lugs.

6. For splices and taps, No. 10 AWG and smaller, use solderless "twist on" connectors having spiral steel spring and insulated with a vinyl cap and skirt.

7. For splices and taps, No. 8 and larger, use solderless "Split Bolt" type connectors or compression fittings.

8. Use cast connections for ground conductors.

9. Make all splices and connections in accessible boxes and cabinets only.

10. Cover uninsulated splices, joints, and free ends of conductor with rubber and friction tape of PVC electrical tape. Plastic insulating caps may serve as insulation**.** Heat shrink sleeves shall be acceptable for crimp type splices.

11. On termination at branch circuit outlets, leave a minimum of 8 in. free conductor for installation of devices and fixtures.

12. Feeder conductors shall be continuous from point of origin to load termination without splice. If this is not practical, contact the Owner's Representative and receive written approval for splicing prior to installation of feeder(s). Where feeder conductors pass through junction and pull boxes, bind and lace conductors of each feeder together. For parallel sets of conductors, match lengths of conductors as near equal as possible.

13. Branch circuit conductors installed in panelboards, and control conductors installed in control cabinets and panels shall be neatly bound together using "Ty-Raps" or equivalent.

14. Provide conduit seals and explosion proof devices as indicated on the plans and as dictated by the National Electrical Code for all hazardous locations indicated on the drawings.

15. Lighting fixtures, detectors, etc., in mechanical equipment, boiler and pump rooms shall be installed with exposed wiring after equipment, ductwork, piping, etc., are in place. In general, lighting shall be as located on the drawings; where conflicts exist, locate lights for best distribution.

D. Outlet Boxes:

1. Consider location of outlets shown on drawings as approximate only. Study architectural, process piping, mechanical, plumbing, structural, roughing-in, etc., drawings and note surrounding areas in which each outlet is to be located. Locate outlet so that when fixtures, motors, cabinets, equipment, etc., are placed in position, outlet will serve its desired purpose. Where conflicts are noted between drawings, contact Owner's Representative for decision prior to installation. Comply with Article 370 of National Electrical Code relative to position of outlet boxes in finished ceilings and walls.

2. Prior to installation, relocate any outlet location a distance of five feet in any direction from location indicated on drawings if so directed by the Owner's Representative. Prior to completion of wall construction, adjust vertical height of any outlet from height indicated if so directed by Owner's Representative. The above modifications shall be made at no additional cost to the Owner.

3. Where outlets at different mounting heights are indicated on drawings adjacent to each other (due to lack of physical space to show symbol on drawings), install outlets on a common vertical line.

4. Where switch outlets are shown adjacent to strike side of door, locate edge of outlet box approximately 3 in. from door frame.

5. Outlet boxes in separate rooms shall not be installed "back-to-back" without the approval of the Owner's Representative.

6. Outlet boxes shall be sized to accommodate the wiring device(s) to be installed.

7. Outlet boxes installed in plaster, gypsum board or wood paneled walls shall be installed with raised plaster covers or raised tile covers.

8. Outlet boxes installed in tile, brick or concrete block walls shall be installed with extra-deep type raised tile covers or shall be 3-1/2 in. deep boxes with square corners and dimensions to accommodate conductors installed.

9. Surface ceiling mounted outlet boxes shall be minimum 4 in. square, 1-1/2 in. deep, galvanized sheet metal.

10. Surface wall mounted outlet boxes shall be cast type boxes having threaded or compression type threadless hubs. Exterior boxes shall be cast type with threaded hubs and gasketed cover plates secured by non-ferrous screws.

11. Floor outlet boxes shall be installed flush with finished floor, adjust level and tile as required. Where finished floor is terrazzo, provide boxes specifically designed

for installation in terrazzo. Where floors are to receive carpet, provide floor outlet with carpet flange.

12. Install a device cover plate over each and every outlet indicated on drawings. Do not install plates until painting, cleaning and finishing of surfaces surrounding the outlet are complete. Install single one-piece multi-gang covers over multi-gang devices.

E. Receptacles:

1. Provide 20 ampere 125 volt, duplex receptacles unless noted otherwise on the Drawings.

F. Junction and Pull Boxes:

1. Install junction and pull boxes in readily accessible locations. Access to boxes shall not be blocked by equipment, piping, ducts and the like. Provide all necessary junction or pull boxes required due to field conditions and size as require by the National Electrical Code.

G. Equipment Mounting Heights: Coordinate with architectural interior and exterior elevations.

1. Unless otherwise noted, mount devices and equipment at heights measured from finished floor to device/equipment centerline as follows:

a.	Toggle switches (up position “on”)	46 in.
b.	Receptacle outlets (long dimension vertical, ground” pole farthest from floor)	18 in.
c.	Receptacle outlets above counters	8 in. above counters
d.	Receptacle outlets, above hot water or steam baseboard heaters. Do not install receptacle outlets above electric baseboard heaters	30 in.
e.	Receptacle outlets, hazardous areas; also for refrigerators	48 in.
f.	Receptacle outlets, weatherproof, above-grade	24 in.
g.	Clock outlets (104 in. AFF or 10 in. below ceiling, whichever is lower). For large, high spaces, coordinate with Architect.	104 in.

h.	Telephone outlets	18 in.
i.	Telephone outlets, wall mounted	46 in.
j.	T.V. outlet	18 in.
k.	Fire alarm manual stations	46 in.
l.	Fire alarm combination audio/visual and standalone visual device (entire strobe lens at heights indicated)	80 in. to bottom of the notification device
m.	Standalone fire alarm audio device	90 in. (min) to 96 in. (max)
n.	Distribution panelboards, to top of backbox	72 in.
o.	Terminal cabinets, control cabinets, to top of backbox	72 in.
p.	Disconnect switches, motor starters, enclosed circuit breakers.	48 in.

2. Where structural or other interferences prevent compliance with mounting heights listed above, consult Owner's Representative for approval to change location before installation.

H. Hangers and Supports:

1. Provide steel angles, channels and other materials necessary for the proper support and erection of motor starters, distribution panelboards, large disconnect switches, large circuit breakers, pendant mounted lighting fixtures, etc.

2. Panelboards, disconnect switches, circuit breakers, cabinets, large pull boxes, cable support boxes and starters shall be secured to ceiling and floor slab and not supported from conduits. Small panelboards, etc., as approved by Owner's Representative, may be supported on walls. Racks for support of conduits and heavy electrical equipment shall be secured to building construction by substantial structural supports.

I. Identification:

1. Provide engraved lamicoid identification nameplates on main switchboard, main service disconnects and on all panelboards using designation shown in panelboard schedule. Include voltage, phase, equipment served, voltage source to panel or equipment.

2. Provide engraved lamicoid identification nameplates for each circuit breaker in the main distribution panel listing the panelboard or equipment connected to each device.

3. Provide engraved lamicoid identification nameplates on all items of equipment including individual circuit breaker enclosures and disconnect switches, listing the equipment connected to the particular device provided under Specification Section 262000, including, but not limited to: starters, disconnect switches, variable speed drives, circuit breakers, etc. Include voltage, phase, equipment served, voltage source to panel or equipment.

4. Provide complete type written directory for each panelboard listing room number, function, etc, for each circuit breaker**.** Provide type written updated panelboard directories for existing panelboards affected by this work.

5. Nameplates shall be engraved black, with white core, with Helvetica medium 3/8 in. lettering. 1/4 in. lettering is acceptable where space of 3/8 in. is not available.

6. Mechanically fasten nameplates to equipment using screws or pop rivets.

7. Identify junction and pullboxes for particular service such as power, lighting, fire alarm, telephone, interphone, public address, nurse call, etc. using stencil lettering on cover.

8. Using durable 3/8 inch white laminated tape, label all receptacle and switch coverplates, power poles, etc. listing panel designation and circuit number. Labeling tape shall be attached to outside of receptacle or switch coverplates.

J. Spare Parts:

1. Deliver to Owner and obtain receipt for spare parts including key switches, fuses, etc.

3.2 TESTS

A. Branch circuits shall be tested during installation for continuity and identification and shall pass operational tests to determine that all circuits perform the function for which they are designed. For all feeder wiring rated 600 volts or less, provide 1,000 volt "Megger" insulation test prior to energizing feeders. Use a 1,000-volt motor driven megger for all tests. Test voltage shall be applied until readings reach a constant value, and until three (3) equal readings, each one (1) minute apart, are obtained. Minimum megger reading shall be 45 megohms for feeder conductors. Documents test results and submit for approval prior to energizing conductors.

END OF SECTION 260501

SECTION 260526 - GROUNDING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide grounding system equal to or exceeding the requirements of NEC, latest issue, Article 250 and in the event of a conflict or discrepancy with NEC Article 250, the more stringent requirement shall apply. Raceway system which includes metal conduit, wireways, pullboxes, junction boxes, bus ducts, built-up enclosures, enclosures, motor frames, etc., shall be made to form a continuous, conducting permanent ground circuit of the lowest practical impedance to enhance the safe conduction of ground fault currents and to prevent objectionable differences in voltage between metal nonload current carrying parts of the electrical system.

1.2 QUALITYASSURANCE

A. All methods of construction, details of workmanship, that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated in their respective sections of the specifications. The equipment specified is based upon the acceptable manufacturers listed. Equipment types, device ratings, dimensions. etc., correspond to the nomenclature dictated by those manufacturers. Where "or equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Conductors:

1. Exposed grounding conductors such as bars, straps, cables, flexible jumpers, braids, shunts, etc., shall be bare copper unless otherwise called for.

2. Cable size shall be as required by NEC Code, Section 250, stranded, soft drawn or soft annealed copper, unless otherwise called for.

3. Provide cable insulation type and color as called for.

a. Acceptable Manufacturers:

1) Same make as for 600 volt conductors.

B. Connectors, Clamps, Terminals:

1. Provide mechanical connectors and clamps made of silicon bronze. Solderless compression terminals shall be copper, long-barrel, NEMA two bolt.

a. Acceptable Manufacturers:

1) Burndy
2) Anderson
3) T & B
4) Penn-Union
5) Approved equal

C. Molded Fusion Welds:

1. Provide fusion welds designed for size and type of cable, rods, structure. Solder prohibited for connections, except for high voltage cable metallic tape shields.

a. Acceptable Manufacturers:

1) Cadweld
2) Metalweld
3) Thermoweld
4) Approved equal

D. Hardware:

1. Provide silicon bronze alloy.

a. Acceptable Manufacturers:

1) Durium
2) Everdur
3) Approved equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. Raceway Systems:

1. All metal supports, cable trays, messenger cables, frames, sleeves, brackets, braces, etc. for the raceway system, panels, switches, boxes, starters controls, etc., which are not rigidly secured to and in contact with the raceway system, or which are subject to vibration and loosening, shall be bonded to the raceway system, the size of the bonding conductor is accordance with NEC Table 250-122.

2. Termination of rigid conduit at all boxes, cabinets, and enclosures shall be made up tightly with a double locknut arrangement and a bushing, bushings being of the insulated type where required by NEC.

3. Conduit which runs to or from all boxes, cabinets, or enclosures having concentric or eccentric knockouts which partially perforate the metal around the conduit and hence impair the continuity of system ground circuits shall be provided with bonding jumpers sized in accordance with NEC Table 250-122 connected between a grounding type bushing/locknut on the conduit and a ground bus or stud inside the box, cabinet, or enclosure and attached thereto.

4. Conduit expansion joints and telescoping sections of metal raceways shall be provided with bonding jumpers sized in accordance with NEC Table 250-122.

5. Where flexible metallic conduit and/or liquid-tight conduit is used, a bonding jumper shall be provided, sized in accordance with NEC Table 250-122.

6. All nonmetallic runs of conduit and/or raceway shall be provided with a system ground conductor sized according to Table 250-122.

B. Secondary Electrical Systems:

1. The neutral conductor of low voltage, single and/or polyphase system or distribution system, except special isolated double insulated systems, shall be solidly connected at the transformer neutral bushing, or at the main secondary switchgear to system ground, and shall be sized for current carrying capacity, not to be less than as required by NEC, Table 250-66.

2. Provide equipment grounding conductor, green colored insulation, with phase conductors, to primary side of all transformers rated 600 volts or less circuited to case and secondary neutral bushing, to motors, starters Industrial Arts Equipment, heating equipment, elevator equipment, panelboards and convenience outlets; insulation shall be same type as phase conductors.

3. Transformer secondary neutral bushings shall be circuited to nearest metallic water pipe, building steel, or ground rod.

4. Equipment grounding conductors, shall extend from the point of termination back to the ground bus of the serving panelboard, switchboard, transformer, or switchgear.

5. The grounding conductors contained in the interstices of interlocked armor cable shall be connected to the ground bus at every equipment termination point and to each other and to system ground; ground at every splice location.

3.2 TESTS

A. Grounding:

1. Grounds and grounding systems shall have a resistance to solid earth ground not exceeding following values:

a. For grounding secondary service neutral 25 Ohms

b. For grounding non-current carrying metal parts associated with secondary distribution system 25 Ohms

2. Providing grounding tests to verify the above values. Where these values are not met, add additional ground rods or connections in order to meet these values.

END OF SECTION 260526

SECTION 262000 - ELECTRIC DISTRIBUTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide a complete distribution system as indicated on the Contract Documents and as specified herein.

1.2 QUALITY ASSURANCE

A. All methods of construction, details of workmanship, that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated in their respective sections of the specifications. The equipment specified is based upon the acceptable manufacturers listed. Equipment types, device ratings, dimensions, etc., correspond to the nomenclature dictated by those manufacturers. Where "or equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.

B. Installation shall be in accordance with NFPA-70 (National Electrical Code), National Electrical Safety Code (NESC), state codes, local codes, and requirements of authority having jurisdiction.

C. Equipment shall be designed, manufactured, assembled, and tested in accordance with the latest revisions of applicable published ANSI, NEMA, UL and IEEE Standards.

1.3 SUBMITTALS

A. Submit the following equipment, materials, products, etc.:

1. Dry type transformer(s) including shielded and linear load transformer(s)

2. Distribution and branch circuit panelboards and circuit breakers.

3. Enclosed circuit breakers.

4. Motor starters, contactors and relays.

5. Disconnect switches.

6. Adjustable Speed Drives or Variable Frequency Drives

7. Submit settings and adjustments for Starters as recommended by starter and motor manufacturers, as follows:

a. Where reduced voltage autotransformer type starters are called for, submit Autotransformer voltage tap settings and start-run time delay relay.

b. Where "part winding" or "wye start, delta run," starters are called for, submit START-RUN time delay relay setting.

c. Where special features are called for, submit voltage taps and settings, resistor adjustments, time delay relay settings.

d. Where time delay relays are called for to achieve staggered restarts upon restoration of failed electric power, submit time delay relay settings.

8. Submit documentation of all grounding tests.

9. Surge Suppression Units.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Dry-Type Transformers:

1. Transformers to be self-cooled ventilated dry type. Transformers that require internal or external fan assisted forced air cooling to obtain ambient air (AA) rated kVA are not acceptable. Transformers 15 kVA and less shall have 185°C insulation system and shall be designed not-to-exceed 115°C rise above 40°C ambient. Transformers 30 kVA and higher shall have 220°C insulation system and shall be designed not-to-exceed 150°C rise above 40°C ambient. Insulation systems shall be U.L. listed. Cores shall be manufactured from a high-grade, non-aging, silicon steel with high magnetic permeabilities, low hysteresis and eddy current losses, and shall be clamped with structural angles and bolted to the enclosure to prevent damage during shipment or rough handling. Remove clamping after installation. Coils shall be copper, vacuum impregnated with non-hydroscopic thermosetting varnish and shall have a final wrap of electrical insulating material designed to prevent injury to the magnet wire. Transformers having coils with magnet wire visible will not be acceptable. 30 KVA, and larger, floor mounted. Under 30 KVA, wall mounted. Provide Mason type ND, Korfund or Vibrex vibration isolation devices for each transformer.

2. Ratings: Shall be as indicated on the "Transformer Schedule" or as noted on the drawings. IEEE #462 and NEMA #TP-1 Standards shall apply. The transformer efficiencies shall meet or exceed the requirements of the Energy Conservation Construction Code of New York State.

3. For transformers up to 300 kVA, provide with 6-2-1/2% full capacity taps, 2-FCAN (for connections above nameplate) and 4-FCBN (for connections below nameplate). For transformers above 300 kVA, provide 4-2-1/2% fully rated taps, 2-FCAN and 2-FCBN.

4. Acceptable manufacturers:

a. Square D (Sorgel) BOARD RESOLUTION

B. Distribution Panelboards (Nominal 600 Volt):

1. Provide distribution panelboards as indicated in the "Panelboard Schedule" and as located on the drawings. Panelboards shall be equipped with quick make/quick break thermal magnetic, molded case circuit breakers as scheduled. U.L. listed as suitable for use as service equipment.

2. Panelboard bussing and lugs shall be copper. Provide grounding bus in each panelboard, securely bonded to the box. Panelboard bus structure, main lugs, and main breaker shall have current ratings as indicated. Such ratings shall be established by heat rise tests with maximum hot spot temperature on any connector or bus bar not to exceed 50°C rise above ambient.

3. Circuit breakers shall be equipped with individually insulated, braced and protected connectors. Large permanent, individual circuit numbers shall be affixed to each breaker in a uniform position. Tripped indication shall be clearly shown by the breaker handle taking a position between "ON" and "OFF." Provisions for additional breakers shall be such that no additional connectors will be required to add breakers. Circuit breakers rated 400 amp frame and above shall be equipped with adjustable solid state trip units. Adjustable trip shall include long time, long time delay, short time, short time delay and instantaneous functions. Main breakers rated 1000A and above at 480 volt shall contain ground fault function.

4. Each Panelboard, as a complete unit shall have a short circuit rating equal to or greater than the rating shown on the panelboard schedule. All panelboards shall be fully rated. "Series ratings" are NOT acceptable. The use of series rating of panelboards for short circuit rating is not acceptable.

5. Panelboard assembly shall be enclosed in a steel cabinet. The rigidity and gauge of steel to be as specified in UL Standard 50 for cabinets. The size of wiring gutters shall be in accordance with UL Standard 67. Cabinets shall be equipped with locks and all locks shall be keyed alike. End walls shall be removable. Fronts shall be of code gauge, full-finished steel with rust-inhibiting primer and baked enamel finish.

6. The panelboard interior assembly shall be dead front with panelboard front removed. Panelboard front shall be door in door construction. Main lugs or main breakers shall be barriered on five sides. The end of the bus structure opposite the mains shall be barriered.

7. Panelboards shall be U.L. listed for use intended.

8. Ratings shall be as indicated on the Panelboard Schedule.

9. Design Make: Square D, BOARD RESOLUTION

C. Branch Circuit Panelboards (480Y/277 volt, 208Y/120 volt):

1. Provide branch circuit panelboard as indicated in the "Panelboard Schedule" and as located on the drawings. Panelboards shall be equipped with quick

make/quick break thermal-magnetic, molded case circuit breakers as scheduled. U.L. listed as suitable for use as a service equipment.

2. Panelboard bussing and lugs shall be copper. Provide grounding bus in each panelboard, securely bonded to the box. Panelboard bus structure and main lugs or main circuit breaker shall have current ratings as indicated. Such ratings shall be established by heat rise tests, conducted in accordance with UL Standard 67.

3. Circuit breakers shall be quick-make, quick-break, thermal-magnetic and trip indicating, and multipole breakers shall have common trip. Provisions for additional circuit breakers shall be such that field addition of connectors or mounting hardware will not be required to add circuit breakers to the panelboard. Bus connections shall be bolt-on. Single pole 15 and 20 ampere circuit breakers shall be UL listed as "Switching Breakers" at 120V ac or 277 V ac and carry the SWD marking.

4. Each panelboard, as a complete unit, shall have a short circuit current rating equal to or greater than the rating shown on the panelboard schedule or on the plans. All panelboards shall be fully rated. "Series ratings" are NOT acceptable. Reducing breaker ratings on the basis of series rating is not acceptable.

5. The panelboard bus assembly shall be enclosed in a steel cabinet. The rigidity and gauge of steel to be specified in UL Standard 50 cabinets. Wiring gutter space shall be in accordance with UL Standard 67 for panelboards. Each front shall include a door and have a flush, stainless steel, cylinder type lock with catch and spring-loaded door pull. All panelboard locks shall be keyed alike. Doors shall be mounted by completely concealed steel hinges. A circuit directory frame and card with a clear plastic covering shall be provided on the inside of the door. Fronts shall be of code gauge, full-finished steel with rust inhibiting iron phosphate sealer and baked enamel finish. Minimum box width shall be 20 in. Provide corbin locks keyed to match the Owner's existing system. Provide hinged trim allowing access to wiring gutters without removal of trim.

6. Ratings shall be as indicted on the Panelboard Schedule.

7. Acceptable manufacturers:

   a. 480Y/277 Volt:

      1) Square D "NF" BOARD RESOLUTION

   b. 208Y/120 Volt:

      1) Square D "NQOD" BOARD RESOLUTION

D. Motor Starters:

1. Provide motor starters, disconnect switches, etc. as listed on the Electric Equipment and Control Schedule on the drawings.

2. Starters, contactors and controllers shall comply with NEMA standards having general purpose NEMA 1 or 1B enclosure unless otherwise called for. Provide explosion proof, weather resistant of watertight construction as required. Starters shall be minimum NEMA size 0 with thermal overloads in each phase sized per NEC, motor full load amperage, service factor, and motor operating conditions.

3. Pad lock arrangements shall be provided to lock the disconnect device in the "off" position. Magnetic starters shall be provided with a control power transformer with 120V secondary and primary and secondary fusing and be sized to accept the loads imposed there on. Starters shall have LED type pilot lights. Each starter subject to electrical interlock and/or automatic control shall have necessary auxiliary contacts.

4. Auxiliary devices: Provide pushbutton stations, pilot lights, devices, relays, transformers, selector switches, electric thermostats, auxiliary starter contacts as required for functions called for. Provide separate relay for each speed to operate electric dampers or other devices as required for multispeed motor circuit.

5. Manual Motor Starter:

   a. Provide all starters with thermal overload(s); and pilot light(s) except explosion-proof types, and handle lock-out provisions. Gang starter with selector switch for multispeed applications. Provide single or 2-pole as required:

      1) 120 volt, single-pole, H-O-A selector, surface mounted: Square-D FG-71P and handle guard.

      2) 120 volt, single-pole, H-O-A selector, flush mounted: Square-D FS-71P and handle guard.

      3) 240 volt, two-pole, H-O-A selector, surface mounted: Square-D FG-72P and handle guard.

      4) 120 volt, single-pole, surface mounted, explosion proof: Square-D FR-1.

5) 240 volt, two-pole, surface mounted, explosion proof: Square-D FR-2.

6. Manual Starter with Relay: Shall be similar to "Manual Motor Starter", above, except two-gang with relay sized for load indicated, and hand-off-automatic switch. Connect relay for 120V operation on load side of starter in "automatic" mode. Coordinate connection of Form C maintained contact for control with Mechanical Contractor.

7. Magnetic Starter: Shall be single-speed, across-the-line type rated in accordance with NEMA standards, sizes and horsepower ratings. Starters shall be mounted in NEMA 1 enclosures unless otherwise indicated. Magnetic starters shall be equipped with double break silver alloy contacts; all contacts shall be replaceable without removing starter or disconnecting power wiring. Starter shall have straight-through wiring. Coils shall be of molded construction and shall be replaceable from the front without removing starter. Overload relays shall be melting alloy type with replaceable control circuit module. Thermal units shall be of one-piece construction and interchangeable. Starter shall be inoperative if thermal unit is removed. Provide hand-off-auto selector switch and start-up pushbuttons and "run" pilot light in cover. Wire for maintained contact unless otherwise noted.

8. Combination Magnetic Starter: Shall be similar to "Magnetic Starter", above, except shall include fusible disconnect switch connected ahead of starter. The disconnect handle shall be in control of the disconnect device with the door open or closed. Disconnect handle shall be clearly marked as to whether the disconnect device is "on" or "off".

9. Packaged Control Unit: Shall be furnished and mounted by others, and installed and connected by Electrical Contractor. Generally consists of one or more starters, disconnect switches and additional control devices prewired.

10. Contactor: Shall be similar to "Magnetic Starter", above, except without thermal overload units.

11. Acceptable manufacturers:

    a. Square-D, BOARD RESOLUTION

E. Disconnect Switches:

1. Shall be heavy-duty type three-pole, with "Quick-Make, Quick-Break" operating handle mechanically interlocked with the cover, horsepower and voltage rated to match equipment served. Where indicated switches shall be provided with dual-element, time delay, rejection type fuses. Switches shall be installed in NEMA 1, General Purpose Surface Enclosures, unless otherwise noted. Provide provisions for padlocking in the "off" position. Provide neutral bar in single phase or three phase, four wire circuits, and ground bar in all switches. Provide auxiliary contacts where called for. U.L. listed as suitable for use as service equipment.

2. Acceptable manufacturers:

   a. Square-D

F. Enclosed Circuit Breakers:

1. Circuit breakers shall be molded case, thermal-magnetic type, ratings as noted, with overcenter, trip-free, toggle-type operating mechanism, quick-make, quick-break action and positive handle indication. Multiple pole breakers shall be common trip type. Each circuit breaker shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pose. Provide provisions for padlocking in the "off" position. Breakers shall be calibrated for operation in an ambient temperature of 40°C and shall be suitable for mounting and operating in any position. Breakers shall have removable lugs, U.L. listed for copper and aluminum conductors. Breakers shall be installed in NEMA 1 general purpose, surface enclosures, unless otherwise noted. U.L. listed as suitable for use as service equipment.

2. Acceptable manufacturers:

   a. Square D

G. Fuses:

1. All fuses rated 600 volts and below shall be rejection type dual-element, time-delay type. Provide two (2) complete sets of fuses for all fusible disconnect switches. Deliver spare fuses to the Owner and obtain receipt.

2. Acceptable manufacturers:

   a. Fuses 600 amperes and below: Bussman Type FRS-R (600 volts), Bussman Type FRN-R (300 volts) or equivalent.

   b. Fuses rated above 600 amperes: Bussman Type KRP-C or equivalent.

3. Ratings shall as indicated on the Drawings.

H. Circuit Breakers for existing branch circuit panelboards (480Y/277 volt, 208Y/120 volt, and 240/120volt:

1. Circuit breakers shall be quick-make, quick-break, thermal-magnetic and trip indicating, and multipole breakers shall have common trip. Provisions for additional circuit breakers shall be such that field addition of connectors or mounting hardware will not be required to add circuit breakers to the panelboard. Bus connections shall be bolt-on. Single pole 15 and 20 ampere circuit breakers shall be UL listed as "Switching Breakers" at 120V ac or 277 V ac and carry the SWD marking.

2. Modifications to each panelboard, as a complete unit shall maintain the existing short circuit rating equal to or greater than the integrated equipment rating shown on the panelboard schedule. This rating shall be established by testing with the overcurrent devices mounted in the panelboard.

3. Modifications to panelboards shall maintain U.L. listing for use intended.

4. Acceptable manufacturers shall be compatible with existing equipment.

5. Circuit breakers installed in existing panels shall be UL listed for use in the panel in which they are installed.

I. Adjustable Speed Drive (ASD) or Variable Frequency Drives (VFD) with Drive Bypass:

1. The ASD shall be 5 HP minimum size, UL Listed, NEMA standard frame size for horsepower rating indicated including 115% motor service factor. Short circuit rating shall be 42kA minimum. Integral solid state programmable overload relay with selectable time class (10, 20 or 30) shall be provided.

2. Units shall be wall or floor mounted as suitable for the intended location. Units shall be an integral component of a motor control center where indicated. Units shall be in NEMA 1 enclosure.

3. The unit shall be provided with a 120V control power transformer. The control power transformer shall be provided with primary and secondary fusing.

4. Cooling fans shall have removable washable filter.

5. Unit shall be of six (6) pulse design with separate common mode choke on the input and output of the drive, if not already built in the unit to minimize total harmonic distortion. Provide with 5% input line reactor.

6. The allowable conductor length between the unit and the controlled motor shall be 100 feet. Ambient temperature range shall be 0 to 40ºC with a 3300' altitude.

7. Provide a dv/dt filter to minimize voltage doubling at the motor terminals caused by excessively long motor conductors from the ASD. The dv/dt filter shall be installed at the ASD unit, preferably in the same enclosure as the ASD. The dv/dt filter shall be factory installed in the ASD.

8. Door mounted selector switch for Auto-Manual control. In the auto mode, the start command and speed control shall be provided from a remote source. In the manual mode, the start-stop and speed control shall be provided through the door

mounted controls. Provide extra contact blocks on the selector switch for monitoring of switch position.

9. Door mounted pushbuttons for start-stop control. Stop pushbuttons shall always be active. Door mounted LED type pilot lights for indication of On (Red) and Off (Green). Door mounted human interface module for programming, display and speed control.

10. Programming shall include:

    a. One isolated, configurable analog input.

    b. Two isolated, configurable analog outputs.

    c. Alarm digital input for automatic shutdown, field configurable for ramped deceleration, full stop and manual/auto reset. Digital input to force unit to a preprogrammed speed for smoke control or other need.

    d. Four field programmable digital outputs.

11. Field selectable isolated process control interface to enable the ASD to follow 0-5 mA, 1-5 mA, 4-20 mA, 10-50 mA, 0-8 VDC, 1-4 VDC, or 0-10 VDC grounded or ungrounded signal from a process controller. Provide RS232 or RS485 communication module board.

12. Network connection shall be suitable for unit on/off and speed control. Communication to the building control system shall include actual motor speed verification, amperage, voltage, kW, and kWh. All unit programming functions shall be accessible through network communication. Communication shall be selectable for BACnet, Metasys, Modbus, Lonworks, Profibus and the project building control system.

13. Isolation Disconnect Switch: Provide isolation disconnect switch integral to unit with a provision for padlocking in the "Off" position.

14. Drive shall be a part of a unit with a three contactor isolated manual drive bypass as described below:

    a. The manual isolated drive bypass unit will consist of two units - a bypass starter unit and an adjustable speed drive (ASD) unit. The intent of the manual isolated drive bypass unit is to isolate the adjustable speed AC drive for servicing. The ASD unit door shall be interlocked with the bypass starter unit. When in the bypass mode the motor can be energized and de-energized with the across-the-line bypass starter. Starter shall meet the requirements of a magnetic starter defined in this section.

    b. All power components shall have a normal duty rating suitable for the nominal horsepower of the application.

    c. Bypass Starter Unit: The bypass starter unit shall include the fusible disconnect or circuit breaker, the bypass contactor and solid state

overload relay, control circuit transformer and terminal blocks. "DRIVE ON" and "BYPASS ON" pilot lights shall be provided to indicate operational status. Shall be three contactor design.

d. ASD Unit: A "DRIVE-OFF-BYPASS" selector switch, a "BYPASS START" push button and a "BYPASS STOP" push button shall be provided. These pilot devices shall be located in the same control station as the "DRIVE ON" and "BYPASS ON" pilot lights on the bypass starter unit.

e. Isolating Disconnect: The isolating disconnect shall be a six-pole device capable of making and breaking the load. Auxiliary isolating disconnect contacts will permit the operation of only one unit at a time either the Bypass Starter or the ASD.

f. Isolation Switch Operation:

1) Bypass Mode: When in bypass mode the "BYPASS ON" pilot light shall be energized when the bypass motor control circuit is energized. When in bypass mode the bypass starter unit and the ASD unit are isolated from one another. In addition, the isolation switch shall have means to be padlocked, to prevent being switched to drive mode. In this mode no power shall be present in the ASD enclosure.

2) Drive Mode: When in drive mode the isolating disconnect shall permit the starter bypass unit to supply power to the ASD unit and connects the ASD unit to the motor. When the isolation switch is in the drive mode the "DRIVE ON" pilot light shall be energized. In addition, the isolation switch shall have means to be padlocked to prevent being switched to bypass mode.

3) Unit shall be of three contactor construction.

15. Harmonic Analysis:

a. A harmonic analysis shall be undertaken before and after the installation of the equipment, by the successful bidder, which shall include current waveform analysis at the source, which feeds the respective ASD's. A report shall be submitted with the shop drawings to show current waveform, Crest Factor, Form Factor, and % THD for both odd and even current harmonics calculated to the 49^{th} Harmonic.

b. The successful bidder shall perform actual field measurements of the system harmonics once the ASD equipment is installed and functioning. The report shall be submitted to the engineers for review before final acceptance. Minimum values required are:

1) 1.5 Crest Factor.

2) Form Factor.

3) Current distortion limits shall not exceed the limits of IEEE 519-1992, Table 10-3 for the I_{sc}/I_{load} ratio for the power distribution system.

4) Graphic Display of current harmonics as a percentage of the fundamental current to at least the 15^{th} harmonic.

5) Voltage THD:

a) If the voltage THD exceeds 5%, the ASD manufacturer is to recommend the additional equipment required to reduce the THD to an acceptable level.

16. Design Make: Square D, BOARD RESOLUTION

PART 3 - EXECUTION

3.1 INSTALLATION

A. Grounding:

1. All equipment shall be grounded per the NEC.

B. Install dry-type transformers with adequate clearances for proper ventilation. Bolt floor mounted transformer to floor utilizing vibration isolators.

C. Distribution switchboards, motor control centers and floor mounted dry-type transformers shall be mounted on 4 in. high concrete pads which shall extend 3 in. on all sides. Securely bolt the unit to the pads for proper horizontal and vertical alignment.

D. Coordinate transformer pad dimensions with transformer manufacturer's requirements. Coordinate transformer pad locations, dimensions and details with General Contractor.

E. Motor Starters:

1. Coordinate overload and fuse sizes with Division 23 Contractor.

2. Coordinate termination of control wiring with Division 23 Contractor.

F. Identification:

1. Identify all items of equipment as described in Section 260510-3.1.

3.2 SPARE PARTS

A. Deliver loose equipment to the Owner and obtain receipt for fuses, keys to panelboards, etc.

END OF SECTION 262000

SECTION 262713 - ELECTRIC SERVICE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Provide labor, materials, equipment and services for the complete installation of an electric service and related Work required in these Contract Documents. The Utility Company is Rochester Gas & Electric.

B. Work performed by this contract shall include, but not be limited to at Hilton Quest Elementary School:

1. Exterior transformer box pad (per RG&E requirements).
2. Underground duct bank with primary conduit (per RG&E requirements) from pole to new utility transformer.
3. Underground duct banks and feeder between pole and transformer.
4. Underground duct bank and feeder from transformer to Webster Transportation Building.
5. Conductor terminations in transformer secondary compartment.
6. Removal of existing (5 kV) service cable back to existing pole.
7. Removal of existing underground vault
8. Ground grid.
9. Utility pole connectivity.
10. Backfill, compaction and finish grade work of existing underground vault.
11. Provide primary cable (5 kV).

C. Work performed by the Utility:

1. Submit Utility Cost Estimate.
2. Provide new pole.
3. Provide pad mounted transformer, review transformer box pad submittal.
4. Provide (5 kV) elbow terminations inside transformer primary compartment.
5. Transformer removal from existing vault.
6. Provide three phase, overhead service from existing RG&E pole, to new transformer.

7. Utility pole.

1.2 **OWNER SHALL PAY ALL UTILITY COMPANY FEES AND CHARGES FOR SERVICE AS PART OF CONTRACT.**

1.3 QUALITY ASSURANCE

A. All methods of construction, details of workmanship, that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated in their respective sections of the specifications. The equipment specified is based upon the acceptable manufacturers listed. Equipment types, device ratings, dimensions, etc., correspond to the nomenclature dictated by those manufacturers. All equipment shall be tested at the factory. Standard factory inspection and operational tests will be acceptable.

B. Installation shall be accordance with NFPA-70 (National Electric Code), National Electric Safety Code (NESC), state codes, local codes, and requirements of authority having jurisdiction.

C. Equipment shall be designed, manufactured, assembled, and tested in accordance with the latest revisions of applicable published ANSI, NEMA and IEEE Standards.

1.4 SUBMITTALS

A. All items of equipment and accessories including the following:

1. Site layout drawings.

2. Underground ductbank materials.

3. (5 kV) Primary cable and secondary cable.

4. Qualifications of splice installer.

5. Transformer box pad foundation and cover.

6. Existing transformer pole work.

7. Test results of (5 kV) cable test.

B. Send three copies of submittals to the utility company for review before sending submittals to Engineers. Include one utility company approved copy with submittal drawings for review.

1.5 SERVICE CHARACTERISTICS

A. Secondary Service:

1. Low voltage: 480/277 grounded, wye, three phase, four wire, 60 Hz.

2. Existing source (to be removed): Utility Company transformer mounted on pad/vault.

3. New source: Utility Company pad mount transformer with underground feeders on new pad/vault.

1.6 UTILIZATION VOLTAGES

A. Building Power System shall be a nominal 480/277 volt, three phase, four wire, solidly grounded, 60 Hz system.

1.7 UTILITY COMPANY COORDINATION

A. Coordinate entire electric service with utility company.

B. Do not interrupt electric system until approved in writing, coordinated so outages occur at Project Site convenience.

C. Coordinate switching requirements with utility company, as approved in writing by the Owner.

PART 2 - PRODUCTS

2.1 UNDERGROUND SERVICE DUCTBANK

A. Refer to drawings and details.

PART 3 - EXECUTION

3.1 ELECTRIC SERVICE WORK

A. Work shall meet all codes, OSHA, and Utility requirements.

B. Coordinate locations with Site Engineer. Located gear away from low areas, wet areas and areas with tree roots.

C. Arrange for stake out. Provide underground circuit location survey with circuit tracer. Protect all existing utilities.

D. Provide all underground ductbanks. Provide hand digging around existing utilities.

E. Arrange for Utility and independent inspections of ductbanks.

F. Provide concrete encasement of ductbanks.

G. Provide transformer box pad.

H. Provide secondary service conductors from utility pad mounted transformer to ATS gear.

I. Arrange to de-energize service with Utility and Owner.

J. Provide primary conduit from transformer to pole.

K. Provide transformer box pad cover.

L. Test 5 kV cable.

M. Arrange for utility pad mount transformer installation.

N. Arrange for utility 5 kV load break elbow installation.

O. Disconnect and remove secondary service conductors from existing vault busway lugs to existing vault utility transformers.

P. Seal all penetrations.

Q. Test and re-inspect system. Re-energize with Utility and Owner approval.

R. E.C. to remove existing vault in its entirety; Restore surface to match.

END OF SECTION 262713

SECTION 263213 - POWER GENERATION

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services for the complete installation of emergency generator systems, automatic transfer switches and related Work required in these Contract Documents.

1.2 QUALITY ASSURANCE

A. All methods of construction, details of workmanship that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated in their respective sections of the specifications. The equipment specified is based upon the acceptable manufacturers listed. Equipment types, device ratings, dimensions, etc. correspond to the nomenclature dictated by those manufacturers. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.

B. Installation shall be accordance with NFPA-70 (National Electric Code), NFPA 110 (Standard for Emergency and Standby Power Systems), National Electric Safety Code (NESC), state codes, local codes, and requirements of authority having jurisdiction.

C. Equipment shall be designed, manufactured, assembled, and tested in accordance with the latest revisions of applicable published ANSI, NEMA, UL and IEEE Standards. If skintight enclosure is used, the equipment shall conform to UL 2200.

1.3 SUBMITTALS

A. Submit shop drawings only for manufacturer's named. Submission of other manufacturers will be rejected unless the terms of equivalents and substitutions stated in the General Provisions are followed.

B. Submit shop drawings on equipment and accessories to include the following:

1. Engine-generator set, including engine, alternator, circuit protection, fuel consumption, performance ratings, thermal ratings, heat generation.

2. Engine controls, including starting controls.

3. Generator instrumentation and controls.

4. Catalog cuts, bill of materials, descriptive data, spare parts list for specified equipment.

5. Mounting arrangement, floor plans, elevations, overall dimensions including accessories, foundation, bedrail, and/or bolts, power and control conduit entrance space.

6. Weather protective sound reduction UL 2200 enclosure.

7. Battery charger and regulator.

8. Batteries, mounting rack, accessories.

9. Automatic transfer switch and accessories.

10. Remote annunciator panel.

11. Software, computer and details of remote monitoring system.

12. Exhaust equipment, flexible pipe, including method of mounting and overall height above floor.

13. Wiring diagrams of all equipment, external and internal connections and interconnections.

14. Factory tests and field supervision reports as called for. Include information described in 1.3 below pertaining to field supervision.

15. Load analysis to demonstrate generator system will start and operate loads, within generator ratings.

C. Record Drawings:

1. Provide seven (7) record copies of all drawings, revised to reflect changes, corrections, modifications, etc., made to equipment prior to shipment or installed in the field. Submit to Engineer for review.

2. Drawings shall accurately cover equipment at time of project closeout.

D. Composite Instruction Books shall include as a minimum the following:

1. Instructions covering overall equipment.

2. Instructions covering all major and serviceable components, and accessories.

3. Recommended spare parts with current prices.

4. Complete renewal parts information.

5. Instructions, both individually and collectively, shall adequately describe receipt, handling, care, inspection, installation, operation, and maintenance of equipment.

6. Instruction books shall be used for equipment installation, and submitted prior to project closeout.

7. Submit three (3) copies to Engineer for review.

1.4 STANDARDS AND TESTS

A. Equipment covered by these specifications shall be designed, manufactured, assembled, and tested in accordance with the latest revisions of all applicable published ANSI, NEMA, and IEEE Standards, the requirements of NEC, NFPA 37, NFPA 110, UL 1008 and UL 2200 Standards. State and local requirements.

B. Furnish submittals of field test reports covering field tests and inspections performed and conducted by manufacturer's representative.

1.5 FIELD SUPERVISION

A. Submittal shall state that adequate local within 75 mile radius of project locations field supervision and service, by competent qualified representative of the manufacturer, who is regularly engaged in working on this type of equipment, will be available at any time.

B. Submittal shall state address of nearest vendor's place of business, telephone number and name of person to contact for field service.

C. Provide field supervision/service at no additional cost to cover inspection, test, and start-up of this equipment.

D. Submittal shall state the amount of field supervision/service recommended by vendor to cover critical points of installation, inspection, test, and start-up.

E. The above data shall be included with submittals.

1.6 RIGGING

A. Provide rigging to unload, move, transport, set in place, erect, etc.

1.7 ADDITIONAL WARRANTY REQUIREMENTS

A. Provide a warranty for the specified equipment to be free from defects in materials and workmanship, whether functional or nonfunctional, replace or repair without cost, defects which, with normal usage, appear within one year of project closeout, or within 24 months from date of shipment, whichever occurs first.

1.8 INSTRUCTION

A. Provide verbal and written instructions to Owner appointed personnel in the proper and safe manner of operating equipment.

B. In addition to requirements for instruction, video tape instruction session.

1.9 DESCRIPTION OF SYSTEM OPERATION

A. Provide Engine-Generator System to meet the following functions:

1. Arrange system for automatic starting upon failure of normal source voltage.

2. Provide programmable three-second time delay, field adjustable from 0 to 9999 seconds. Delay time between normal source failure and engine**(s)** starting.

3. Initiate engine**(s)** starting cycle from transfer switch auxiliary contact.

4. Transfer life safety loads from normal source power to emergency source when engine-generator reaches 90% of its rated voltage.

5. Retransfer emergency loads from emergency generator**(s)** to normal source ten minutes after normal source has reached 90% or more of normal voltage. Control shall be field programmable from 0 to 9999 seconds.

6. Retransfer emergency loads from emergency generator to normal source instantaneously when normal source has reached 90% or more of normal voltage, if emergency generator has failed while supplying load.

7. Run engine**(s)** for a period of five minutes after retransfer of emergency loads to normal source. Engine-generator**(s)** will then shut down, automatically resetting and leaving all controls ready for the next emergency start condition. Period shall be programmable from 0 to 9999 seconds.

8. Use time clock to automatically exercise engine once each every two weeks for 1/2 hour. Time clock contacts shall simulate loss of normal voltage; start engine, and shut engine down after fifteen minutes of operation. The load shall transfer to the emergency source during the exercise time. Provide a selector switch to permit cycling engine-generator under load or no-load conditions.

9. Provide interconnection with Facility building management system. Communication shall be through the Facility network system and shall communicate generator status including, faults.

B. Description of Loads:

1. Rating and Capacity:

   a. Generator ratings specified are minimum acceptable capacity. Vendor shall provide larger size set if required to properly operate the load.

   b. Sequenced or delayed start loads will be called for, otherwise, loads shall start immediately upon transfer to the emergency source.

2. Motors shall be started across the line unless otherwise called for. This includes fire pumps.

3. The generator set manufacturer shall verify the engine is capable of driving the generator with all accessories in place and operating, at the generator set kW rating after derating for the range of temperatures expected in service and the altitude of the installation. Site conditions are: 120^0 maximum ambient, and 600 feet altitude.

PART 2 - PRODUCTS

2.1 ENGINE-GENERATOR SET

A. Engine - Natural Gas Fuel:

1. Dual-Fuel carburetion, set initially for natural gas.

2. Minimum six cylinder, four stroke cycle, 1800 rpm, per manufacturer's standard.

3. Stand-by rating shall be adequate to provide maximum kW output of generator under full load and motor starting kVA requirements. The engine generator set shall be capable of picking up 100% of nameplate kW, after adjusting for site conditions (altitude, temperature), in one step with the engine generator set at operating temperature, in accordance with NFPA-110. A resistive load bank (1.0 pf) shall be acceptable for meeting the load requirements.

4. Dual-fuel carburetor, secondary gas regulator, electric solenoid shutoff valve, strainer (fuel filter), gas shutoff cock.

5. Provide primary gas regulator if required by characteristics of local utility gas supply. Verify with Utility Co. the gas pressure at engine generator.

6. Full pressure lubrication system with positive displacement, mechanical, full pressure gear type oil pump, full flow oil filters with replaceable filter element, equipped with spring-loaded bypass valve as an insurance against stoppage of lubricating oil in the event filter becomes clogged; water-cooled oil cooler and thermostat.

7. One or more oil or dry type air cleaners of sufficient capacity to protect engine working parts from dust and dirt.

8. Water cooled with skid mounted, closed loop fresh water type radiator, belt-driven pusher fan, centrifugal water circulating pump, thermostat temperature control, liquid-cooled exhaust manifolds. Provide radiator duct connection flange. Rotating parts shall be protected against accidental contact. The cooling system shall be rated for full rated load operation in 50°C ambient conditions.

9. Provide water jacket heater, thermostat and wiring, rated for 120/208 volt, single phase operation.

10. Engine speed isosynchronous (0% droop) electronic governing system capable of parallel operation with load sharing controls. Provide a control panel mounted engine speed control adjustment.

11. 12 or 24 volt starting system per manufacturer's standard.

12. Engine mounted battery charging alternator (belt driven), 35 ampere minimum, and solid-state voltage regulator.

13. An electric starter capable of three complete cranking cycles without overheating, before overcrank shutdown. Shall comply with NFPA 110.

14. The engine-generator set shall be mounted with vibration isolators on a heavy duty steel base to maintain proper alignment between components. The engine-generator set shall incorporate a battery tray with battery hold down clamps within the base rails. Provisions for stub up of electrical and fuel connections shall be within the footprint of the generator set base rails.

B. Generator:

1. 480Y/277 volts, 12 lead, three phase, four wire, wye connected, 60 Hz.

2. 375KVA, 300 kW continuous rating at 0.8 power factor.

3. Synchronous, four pole, compatible with engine rpm, revolving field, fireproof construction. Brushless, permanent magnet exciter with solid state voltage regulator.

4. Insulation rating of alternator shall, at a minimum, meet requirements of NEMA Class H construction to comply with NEMA standard MG1-22.40 and 16.40. Temperature rise of rotor and stator shall be limited to Class F (155°C or 105°C maximum temperature rise of winding, measured by resistance method, at 40°C ambient) for standby rating.

5. Voltage regulation within 0.5% plus or minus of rated voltage for any constant load from no load to full load. Frequency regulation shall be isosynchronous from steady state no load to steady state rated load. Cyclic variation in RMS voltage shall not exceed $\pm$ 0.5% of rated for constant loads from no load to rated load, with constant ambient and operating temperature. Speed variations for constant loads from no load to rated load shall not exceed $\pm$ 0.25% of rated speed, with constant ambient and operating temperature.

6. Rheostat to provide plus or minus 5% voltage adjustment.

7. Total harmonic distortion (THD) shall not exceed 5% of rated voltage and no single harmonic shall exceed 3% of rated voltage.

8. Telephone influence Factor; TIF shall be less than 50 per NEMA MG1-22-43.

9. The engine-generator set shall be capable of picking up 100% of nameplate kW, less applicable derating factors (temperature and altitude), in one step with the engine generator set at operating temperature, in accordance with NFPA Standard 110.

10. Minimum motor starting maximum kVA shall be ### at 0.4 5 pf,.

11. Terminal voltage re-established to within 2% of rated voltage within two seconds following any sudden change in load between no load and full load or between full load and no load.

12. Sealed, prelubricated ball bearings.

13. Direct-driven generator cooling blower.

14. Provide fixed field connections to AC output leads in extra large terminal box with removable cover.

15. Provide adequate wiring space for conduits. Power cables shall exit the bottom of the generator.

16. Exciter shall be brushless, permanent magnet type.

C. Generator Auxiliary Equipment:

1. Provide multiple generator output circuit breakers, three pole, common trip, thermal magnetic type, to completely protect the generator from overloads; frame size and trip rating as called for. Provide solid state trip unit for circuit breakers 400A and above with long time, short time and instantaneous adjustable settings.

2. A 120 VAC space heater shall be provided within the generator walk around enclosure to eliminate condensation. The contractor shall provide a branch circuit to the heaters.

3. Outdoor, Level 2 Acoustical, weather-protective housing with critical grade exhaust muffler installed and located within the housing. The housing shall have hinged side-access doors and rear control door. All doors shall be lockable. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturers standard color. Provide concrete pad as detail on the drawings. Generator unit shall be UL 2200 labeled with enclosure installed.

4. Vibration isolators, quantity and type as recommended by the generator set manufacturer or as shown on the drawings.

D. Design Make: Generac

E. Or approved equal by:

1. MTU

2. Onan/Cummins

2.2 MICROPROCESSOR ENGINE-GENERATOR SET CONTROL

A. The control shall have automatic remote start capability. Starting cycle shall be initiated by auxiliary contact(s) in automatic transfer switch(es). A panel mounted switch shall stop the engine in the STOP position, start and run the engine in the RUN position, and allow the engine to start and run by closing a remote contact, and stop by opening the remote contact when in the REMOTE or AUTOMATIC position.

B. The control shall include a cycle cranking function. The cranking cycle, nonadjustable, shall consist of an automatic crank period of approximately 15 seconds duration followed by a rest period or approximately 15 seconds duration. Cranking shall cease upon engine starting and running. Two means of cranking termination shall be provided, one as a backup to the other. Failure to start after three cranking cycles (75 seconds) shall shutdown and lockout the engine, and visually indicate an overcrank shutdown on the panel.

C. The control shall shut down and lock out the engine upon: failing to start after the specified time (over crank), overspeed, low lubricating oil pressure, high engine temperature, or operation of a remote manual stop station. Provide audible alarm and visual indication of the particular contact that operated, and reset pushbutton. Provide common fault contacts, wired to terminal board for remote alarm indication.

D. The control shall provide a twelve light (LED) minimum engine monitor on the control panel; one red light for each of the five shut downs (except the remote manual stop), and one yellow light each for the high engine temperature and low engine oil pressure prealarms, and one green run light. The control panel monitor shall include; a flashing red light to indicate the generator set is not in automatic start mode, a yellow light to indicate low coolant temperature, a yellow light to indicate low fuel, a red light to indicated battery charger failure, and one red light for auxiliary use (for a total of twelve). A panel mounted switch shall reset the engine monitor and test the lamps. The engine-generator set starting battery(ies) shall power the monitor. Operation of shut down circuits shall be independent of indication and prealarm circuits. Individual relay signals shall be provided for each indication for external circuit connections (not to exceed 1/2 amp draw) to a remote annunciator. A common contact for external connection to an audible alarm shall be provided.

E. Provide a low coolant level shutdown, which shall be indicated as a high engine temperature fault.

F. The NEMA 12 enclosed control panel shall be mounted on the generator set with vibration isolators. The control shall include surge suppression for protection of solid state components. A front control panel illumination lamp with On/Off switch shall be provided. Control panel mounted indicated meters and devices shall include: Engine Oil Pressure Gauge, Coolant Temperature Gauge, DC Voltmeter, and Running Time Meter (hours); Voltage adjusting rheostat, locking screwdriver type, to adjust voltage $\pm$ 5% from rated value; Analog AC voltmeter, dual range, 90 degree scale, 2% accuracy; Analog AC Ammeter, dual range, 90 degree scale, 2% accuracy; Analog Frequency meter, 45-65 Hz, 90 degree scale, $\pm$ 0.6 Hz accuracy; Seven position phase selector switch with OFF position to allow meter display of current and voltage in each generator phase. Provide shorting-type terminal boards for all current transformer secondary windings. Liquid crystal display (LCD) may be utilized as an equal to the analog gauges.

G. Provide remote annunciator in Custodial Office for engine-generator alarm function. Provide derangement signal at Custodial Office Alarm functions for [each] generator are as follows:

1. Visual signals for: Battery charger AC supply failure, battery charger DC output failure, engine-generator running.

2. Visual and audible signals for: Overspeed, low lube oil pressure, high and low water temperature, overcranking (failure to start), overload.

3. Provide all of the indications and audible alarms called for by NFPA Standard 110, and in addition, indications of high and low battery voltage, normal battery voltage, and battery charger malfunction. Provide alarm silence and lamp test switches.

2.3 REMOTE BATTERY CHARGER

A. Provide battery charger and regulator as follows:

1. Automatic battery charge sensing device.

2. Automatic charging at rate necessary to maintain battery at full charge; with full charge in 24 hours after 5 minutes of cranking. SCR controlled constant voltage current limiting float type charger providing 2A maximum charging rate.

3. Automatically disconnects from battery during engine starting.

4. Test switch to allow manual sensing of battery charge.

5. Sheet steel NEMA 1 enclosure for wall mounting.

6. Design equipment: Sens.

7. Or approved equal by: Sens, Exide, LaMarche.

2.4 BATTERIES

A. Provide batteries as follows:

1. Lead acid type, VDC, quantity and connections as recommended by the generator set manufacturer.

2. Provide corrosion-resistant battery mounting rack, battery interconnecting cables and terminals, etc.

2.5 AUTOMATIC TRANSFER SWITCHES (ATS)

A. Description:

1. The automatic transfer switch shall consist of a power transfer switch and a microprocessor based control module, interconnected to provide complete automatic operation. Double throw, mechanically and electrically interlocked.

All main contacts shall be of silver composition. The operating transfer time shall be a maximum of 1/2 of a second. Transfer switch shall be capable of manual transfer in order to meet the requirements of UL 1008 and UL listing requirements as described UL's "Electrical Construction Materials."

2. Operated by momentary energization of a double coil with mechanical latching in both normal and emergency positions.

3. Operating voltage for transfer obtained from source to which load is to be transferred.

4. Three phase, four wire, three pole, solid, neutral normal and emergency power source contacts.

5. Ampere rating as called for, rated for continuous duty.

6. Provide magnetic blowout coils and arc barriers on each pole.

7. Provide voltage supervisory relays on each phase of both normal and emergency sources, such that transfer and engine start is effected should any one phase of the three phase supply be below 80% of normal voltage.

8. Three-cycle closing and withstand rating minimum 42,000A for 100-400A ATS rms symmetrical amperes at 480 volts without the use of current limiting fuses.

9. Manufacturer's standard mechanical type lugs suitable for aluminum or copper conductors. Provide lugs for each power cable, phase and neutral. Cable size and conductor type as called for. Terminals front connected.

10. Provide dual transfer switch operator with adjustable time delay 0-9999 seconds set at 3 seconds to allow motor loads residual voltage to decay between the time that the closed source is opened and the open source closed.

11. Provide pilot lights (LED's) as follows:

    a. Green, indicating normal switch position.

    b. Red, indicating emergency switch position.

    c. Fuse for each light.

12. Provide the following accessory features:

    a. Adjustable time delay before engine starting, field programmable from 0-9999 seconds. Factory set at 1s.

    b. Adjustable time delay on transfer to emergency, field programmable from 0-9999 seconds. Factory set at 3s.

    c. Adjustable time delay on retransfer to normal field programmable from 0-9999 seconds, factory set at 300 seconds.

d. After retransfer to normal, the engine generator set shall be allowed to run, unloaded, for an additional 0-9999 seconds, factory set to 300 seconds.

e. Test switch, engine start and transfer.

f. Pushbutton to bypass time delay on retransfer back to "normal" position.

g. Engine start contact.

h. Time clock exerciser with transfer. Retransfer shall be automatic at end of exercise period. Provide a bypass switch for manual exercise and a selector switch to permit cycling engine-generator under load or no-load conditions.

i. Auxiliary contacts on shaft. No common wires for auxiliary contacts. Bring wires to terminal block, suitably labeled.

j. A contact which closes when normal source fails for initiating engine starting, rated min, 10A @ 32 VDC.

k. Provide ground studs to enclosure for 5 mechanical lugs for size #4/0 copper cables.

l. Provide any other accessories as may be required to achieve operation as described in Article 1.9.

m. Provide box of spare fuses and LED's for pilot lights.

n. Provide NEMA 1sheet metal enclosure for all mounting, front door hinged.

o. All time delay relays shall be field programmable and shall show the actual setting time in minutes or seconds.

B. Make: ASCO, Onan, Russelectric or acceptable generator set manufacturer's ATS utilizing specified make's transfer switch.

2.6 EXHAUST SYSTEM

A. Muffler:

1. Quiet, spark arrester, Critical classification. Suitable for intended installation.

2. Size as recommended by engine manufacturer.

3. Meet engine manufacturer backpressure requirement.

4. Provide four bracket supports welded to sides of muffler for horizontal installation.

5. Make: Engine manufacturer recommended, or approved equal.

B. Exhaust Piping: Sections of seamless, stainless steel flexible exhaust piping between engine exhaust manifold and muffler.

C. Provide with insulation blankets for the turbocharger, exhaust manifold and any piping that someone may come into contact with.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. General Requirements:

1. Completely coordinate installation, assure that elements of the system are compatible, operational and correct.

2. Provide rigging to unload, move, and set in place engine-generator(s) and ATS's. Provide concrete pad as detailed on the drawings.

3. Provide miscellaneous bolts, washers, nuts, clips, lockwashers, small hardware, etc., of durium of equal rest resistant material, to make installation complete.

4. Refer to "Grounding" section of specifications.

5. Install equipment plumb, level, and true.

6. Leave maximum space available in front, along side, etc., all items of equipment, to allow easy access and servicing of serviceable components. Meet NEC requirements.

3.2 WIRING

A. Install power and control wiring between engine-generator set, transfer switch, battery charger, louvers, dampers, controls, coolers, batteries, day tank and all other various and related equipment. Provide all necessary wiring and interface equipment to interconnect generator system with the Facility building management system.

B. Comply with Manufacturer's Instruction Books.

C. Maintain phasing standards as called for.

D. Color code and identify control and power wires and cables as called for.

E. Provide copper, 600 volt insulation minimum, control wiring; do not splice.

F. Provide "crimp-on" type terminal for control wire terminations, as called for.

G. Provide liquid-tight jacketed flexible conduit for all connections to engine, generator, and to day tank.

H. Provide green ground conductor in each conduit run.

3.3 ENGINE - GENERATOR INSTALLATION

A. Install where called for. Refer to drawings for installation detains, pad details, etc.

B. Provide necessary anchor bolts at proper locations, place by templates if required, for proper setting of engine-generator.

C. Manufacturer's Representative shall provide lube oil and anti-freeze for initial start-up. Electrical Contractor shall provide all fuel for start-up and testing and leave tank at the full level upon completion.

D. Entire system shall be complete and operational and shall be test operated, including simulated loss of normal power, all control devices shall be operated to test their function.

E. Determine exact requirements, verify locations, and comply with applicable regulations in installing equipment.

F. Provide the services of the manufacturer's representative to check out the system and instruct the Owner in the operation of the system. Furnish written statement to the Owner's Representative that the checkout and instruction service has been provided. Include statement that system operates properly, as called for. Submit statement as a submittal for review.

3.4 FUEL PIPING

A. Division 15B shall provide complete natural gas piping to engine-generator and make final connection.

B. Furnish fuel filter, fuel solenoid valve, secondary regulator, gas shutoff cock, flexible fuel piping and fuel piping diagram.

C. Coordinate fuel piping size with these items.

3.5 VENTILATION

A. Factory shall provide exhaust fans, flexible duct connector for radiator, all louvers, dampers and operators necessary for cooling.

B. Provide all wiring to fans, starters, controls, electric solenoid for pneumatic operators, or electric motor for electric operators, including all breakers, switches, transformers, etc., as required.

C. Coordinate all work.

3.6 EXHAUST SYSTEM

A. Factory shall provide complete exhaust piping system, including stack supports to floor or structure, except flexible connection at engine and muffler. Installation shall comply with NFPA-37 and all other applicable codes. Components shall be sized to assure full load operation without excessive backpressure.

B. Factory shall install mufflers, flexible exhaust connections, and provide condensate trap with valve on exhaust piping system and on muffler, in accordance with manufacturer's recommendations.

C. Factory shall provide necessary insulation, wall and/or roof thimbles, including openings, flashing, etc., where exhaust system penetrates roof.

3.7 ELECTRICAL LOAD TEST

A. Conduct a resistive load bank test to the full capacity of the generator for four hours after completion of installation, but before connecting to the building system. Upon successful completion of load bank test, complete connections to building system and perform an operational test as outlined in "B" below.

B. Conduct a full operational test of complete system prior to request for final payment and comply with the following:

1. Start the generator by simulating a loss of utility power at each transfer switch.

2. Energize maximum emergency light and power load for a period of one hour when schedule.

3. Record voltage at generator and at each panel, using the same digital meter at each location.

4. Measure current in each phase of all feeders, using the same digital meter at each location.

5. Reconnect circuits in an effort to provide balanced (within 10%) load on all feeders.

6. Provide and install all necessary metering equipment.

7. Owner's Representative shall witness the test.

8. Before final acceptance, specified tests shall be completed to the satisfaction of the Owner's representative who shall be sole judge of the acceptability of such test and who may direct the performance of such additional tests as deemed necessary in order to determine the acceptability of the systems, equipment, material and workmanship. Additional tests required by the Owner's representative shall be provided at no additional cost. Notify Engineer when load bank test is scheduled.

3.8 EQUIPMENT PROTECTION

A. Provide repair or replacement for all damage and defacement, whether functional or nonfunctional, to all equipment from the time it is unloaded, during installation, and during period of beneficial use, and until installation is accepted.

END OF SECTION

SECTION 265000 - LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide interior and exterior lighting systems, including luminaires, hangers, supports, fittings, lamps, wiring, connections and controls, as indicated in the Contract Documents for complete and operational systems. The lighting layouts on the drawings are diagrammatic only. Refer to architectural "Reflected Ceiling Plans" for exact location of interior luminaires. Luminaires, in general, have been specified for the particular type of ceiling in which they are to be installed. Verify the ceiling construction details and provide luminaires suitable for the respective ceiling types and room finish schedule.

1.2 QUALITY ASSURANCE

A. All luminaires shall be new and bear a NRTL label for the service intended. Luminaires shall be standard products of manufacturers regularly engaged in the manufacture to the specific type light luminaires specified and shall be the manufacturer's latest standard design that complies with specification requirements. Manufacturer's luminaire catalog numbers as indicated on the "Luminaire Schedule" indicate quality, type, and style, but may not cover required special design details. Provide luminaires having such special details as noted in the "Luminaire Schedule", as indicated by the specified luminaire model number and as required for proper installation. Verify the availability of all luminaires proposed to be used in the execution of the work prior to submitting same for approval. The discontinuance of production of any luminaire after such approval has been granted shall not relieve the Contractor from furnishing an approved luminaire of comparable quality and design at no additional cost. Luminaires shall be as specified in the "Luminaire Schedule". Luminaire types, appearance, characteristics, photometrics, finishes, etc., correspond to the specified manufacturer, and associated catalog number, listed in the "Luminaire Schedule". Products of other listed acceptable manufacturers shall be equivalent in every way to that of the luminaire specified. The Engineer reserves the right to disapprove any luminaire type submitted which he feels is not equal in quality, appearance or performance to the luminaire specified.

B. Should there be any difference between drawings and schedules, secure from Architect/Engineer such information as is necessary before tendering his proposal. When finishes are not definitely specified, they shall be as selected by the Architect.

C. Locations indicated for luminaires are approximate. Field coordinate exact locations as near as possible to the location indicated. Coordinate with the Engineer for any major location changes.

1.3 SUBMITTALS

A. Submit shop drawings as described in Section 260500. Luminaire shop drawings shall include photometric data for each luminaire utilizing the specified lens/louver type, lamp(s) and ballast(s). All luminaire types for the project shall be submitted in a single complete package which shall be in the form of a soft cover binder with each luminaire separated by an identified index tab. Information on each luminaire shall include:

1. Manufacturer and Catalog Number.

2. Dimensioned Construction Drawing(s).

3. Complete Catalog "Cut" Sheet.

4. Photometrics (space to mounting height ratio, coefficient of utilization complete values, IES distribution hard and electronic copy, candlepower distribution by angle and luminaire efficiency).

5. Lens/Louver Type.

6. Reflector information (type, material, reflectance, etc).

7. Ballast with each type luminaire as applicable (type, sound rating, overload protection, voltage, input/fixture wattage, ballast factor, power factor, etc.).

8. Materials for all components.

9. Socket Type.

10. Lamp (rated life, initial lumen output, mean lumen output, Kelvin color, color rendering index, dimensions, wattage, socket type, mercury content).

11. Certification of IES LM-79 an IES LM-80 testing for LED luminaires.

1.4 DELIVERY, STORAGE AND HANDLING

A. Luminaires and equipment shall be delivered with NRTL and manufacturer's labels intact and legible. Broken, cracked and damaged materials and equipment shall be removed from the site immediately and be replaced with new materials and equipment. Luminaires and accessories shall be stored in protected dry locations in their original unbroken package or container. Luminaires shall be protected from dust and dampness both before and after installation. Luminaires shall be protected from paint and cleaning solvents during all phases of construction.

PART 2 - PRODUCTS

2.1 LUMINAIRES

A. Luminaires shall be identical in construction features, options, performance and appearance to the luminaires specified in the Luminaire Schedule. Luminaires and all components shall be suitable and rated for the intended use and location.

B. LED luminaires shall be identical in construction features, options and appearance to the luminaries specified in the Luminaire Schedule. LED luminaires include white and RGB systems respectively.

1. LED luminaries shall be provided with all cables, controllers, power supplies, connectors, terminators and accessories required for a complete installation. LED system shall utilize pulse width modulation, non-linear scaling techniques and reverse polarity protection for high-resolution output.

2. RGB LED systems shall be capable of at least 8-bit control of red, green and blue module. RGB LED system shall be capable of setting each module with a unique and individual address. Each address shall be controlled independently by DMX or alternate method protocol. All RGB LED fixtures shall undergo a minimum of eight-hour burn-in testing during manufacturing.

3. LED luminaries shall be high brightness and binned for forward voltage, luminous flux and wavelength.

4. LED luminaires shall be tested in accordance with IESNA LM-79 (luminous output, power input, luminaire efficacy (lumens/watt), color temperature and color rendering index) and IESNA LM-80 (output luminous maintenance, 10,000 hour minimum test). Luminaire output shall be a minimum of 60 lumens/watt. Rated life shall be a minimum of 50,000 hours at 50% output. Testing shall be performed by a US Department of Energy (DOE) accredited laboratory.

5. LED drivers shall be solid state Class 1 power supply/driver. The system shall have a minimum 90% power factor and a maximum of 30% THD, and heat sensing with color sensing feed-back. Adequate heat sink capability shall be provided to ensure the rated life.

6. The luminaire (to include LED lamps and LED drivers) shall have a full five (5) year minimum warranty for replacement and labor.

a. Acceptable LED Node Manufacturers:

1) Philips
2) Osram
3) Cree
4) Nichea
5) Lumiled

C. Lenses:

1. Shall be listed materials tested in accordance with ASTM D-635, "Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position" and burns less than 2/5 inches per minute.

2. The products shall have a smoke density of less than 75 when tested in accordance with ASTM D-2843, standard test method for "Density of Smoke from the Burning or Decomposition of Plastics".

3. The flame spread rating shall not exceed 0-25 and smoke developed rating shall not exceed 450 in accordance with ASTM E-84, standard test method for "Surface Burning Characteristics of Building Materials".

4. Self-ignition shall not occur below 600°F, in accordance with ASTM D-1929, standard test method for "Ignition Properties of Plastics".

5. Materials shall remain in place 15 minutes at 175°F and fall from frame at 200° below ignition temperature in accordance with ASTM D-648, "Deflection Temperature of Plastics Under Flexural Load".

D. Wiring:

1. Wiring within lighting fixture for connection to branch circuit shall be:

a. NEC Type AF for 120 volt, minimum No. 18 AWG.

b. NEC Type SF-2 for 277 volt, minimum No. 18 AWG.

2. Stranded wire within lighting fixture shall be lead dipped.

E. General:

1. Parabolic open cell luminaires shall have reflector channels for symmetrical distribution at all lamp operations. A minimum of two channels shall be provided.

F. Sockets - Lampholders:

1. Lampholders shall be of porcelain or bakelite with a 660 watt, 660 volt rating. Lampholders approved for use may be the type providing for screw-type wire terminal connections or the type of socket provided with attached leads, or the type permitting push-in locking connection of the ballast wiring; Makes: Bryant, Leviton or Kulka or approved equal. Sockets shall be attached to the socket bars by means of screw/nut arrangement or any other approved means that will insure solid mounting and support of the lampholders. Lampholders shall be of the pressure lock or push-in-and-hold type, and shall be UL listed.

G. Exit Luminaires:

1. Electrical characteristics:

a. LED type for 120/277 volt supply.

b. Use two LED strips for indirect illumination of the face. Meet or exceed illumination requirements of NFPA 101, and all of the requirements of UL924.

c. Maximum input power of 5 watts per illuminated face.

d. Provide fully automatic internal emergency power pack including a premium grade battery, three-stage charger (constant current, equalize and float charge), relay, low voltage battery disconnect and brownout protection circuits. Battery shall provide sufficient capacity to operate the lamps for 1-1/2 hours to an end voltage of 87-1/2% of nominal battery voltage.

e. Provide self-diagnostic circuitry to warn at malfunction of battery, charger, transfer circuit or emergency lamps by means of separate LED indicator lights. Also provide automatic programming which will include five minute discharge/diagnostic cycling every 28 ± days to exercise the unit's battery and check emergency operation.

2. Construction:

a. Cast aluminum housing.

b. Natural brushed aluminum faceplates(s).

c. Black finish for frame.

d. 6 in. H x 2 in. W x 3/4-in. stroke exit letters on cast stencil face.

e. Red fiberglass reinforced polyester diffusing panel(s).

f. Removable snapouts provided in stencil face housing for right, left, or double directional arrows.

g. Luminous bottom with prismatic lens for even downlighting.

h. Light tight assembly.

i. Polycarbonate vandal covers with tamperproof screws.

j. Provide wire guard for Gymnasium exits.

k. Provide Universal mount unit.

l. Provide single or double face and arrows as indicated on Contract Documents.

m. Design Equipment: Dual Lite Sempra Series.

n. Acceptable Manufacturers: Emergi-Lite Prestige, Siltron Vanguard II, Lithonia Signature or approved equal.

H. Emergency Battery Pack Luminaries:

1. Completely self-contained in compact, low profile injection molded UL 94V-0 flame rated thermoplastic housing with universal mounting plate.

2. Premium grade, pure lead maintenance free battery. Two with sufficient capacity to operate the lamps for 1-1/2 hours to an end voltage of 87-1/2% of nominal battery voltage. Three stage charger (constant current, equalize and float charge), relay, low voltage battery disconnect and brownout protection circuits.

3. Two fully adjustable glare-free 7.2 watt sealed halogen beam type lighting heads. Test switch and charge rate indicator.

4. Universal 120/277 volt supply.

5. Provide self-diagnostic circuitry to warn malfunction of battery, charger, transfer circuit of emergency lamps by means of separate LED indicator lights. Also provide automatic programming which will include five minute discharge/diagnostic cycling every 28 ± days to exercise the unit's battery and check emergency operation.

6. Make: Dual-Lite CV Series.

I. Luminaire Schedule:

1. Luminaire schedule is found on contract drawings.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Provide for every luminaire shown on the plans, as scheduled on the drawings.

B. Where a luminaire is specified or approved for certain locations, all luminaires in those locations must be of the same manufacturer and style. All luminaires shall be NRTL tested.

C. Obtain exact location of all ceiling and wall mounted luminaires from the Architect/Engineer.

D. Luminaire fasteners or hangers shall be capable of supporting four times the luminaire weight.

E. Luminaires shall be supported independent from ceiling system or other building services. Support luminaires at two locations, using #10 steel wire similar to that used to support the ceiling grid. Directly attach steel wire to structural member.

F. Mount luminaires in true vertical and horizontal alignment. Offset luminaires as required to avoid obstructions. Provide all necessary hangers and supports for proper luminaire installation. Such supports shall be anchored to channels in the ceiling construction, to the structural slab or to structural members above the suspended ceiling.

G. Provide all necessary accessories for "end-to-end" mounting where continuous rows of fluorescent luminaires are indicated. All luminaire assemblies shall be grounded.

H. New luminaires may be provided to replace existing luminaires scheduled to remain or be reused, subject to shop drawing approval.

3.2 SURFACE CEILING MOUNTING

A. Mount surface luminaires tight to surface in a manner such that mounting surface does not distort fixture.

B. Luminaires installed in continuous rows may be fed by a single outlet if fixtures are UL approved and suitable for through wiring in luminaire raceway.

C. Luminaire fasteners or hangers shall be capable of supporting four times luminaire weight.

D. Luminaires shall be supported independent from ceiling system or other building services.

3.3 RECESSED MOUNTING

A. The Electrical Contractor shall verify ceiling type, construction, and material prior to placing an order for recessed luminaires.

B. The Electrical Contractor shall furnish fixtures with an IC rating for all recessed incandescent fixtures installed in direct contact with insulation.

C. The Electrical Contractor shall furnish and install plaster frames for plaster ceilings and flanged frames for drywall ceilings.

D. The Electrical Contractor shall furnish and install all required mounting hardware and accessories to adapt fixtures to ceiling construction.

E. Lay-in type luminaires shall be supported independent of the ceiling system at each end of the luminaire with galvanized support wire.

F. Provide and install seismic hold-down clips for all lay-in type lighting fixtures.

3.4 PENDANT MOUNTING

A. Mount pendant mounted luminaires from 1/4 in. threaded rods of required length.

B. Sleeve threaded rods with 1/2 in. EMT painted with color as directed by Architect/Engineer.

C. Luminaires installed in continuous rows may be fed by a single outlet if they are UL approved and suitable for through wiring in luminaire raceway.

3.5 REMOTE BALLASTS

A. Remote ballasts shall be mounted in an approved NEMA 1 enclosure. Remote ballasts shall be located in areas easily accessible to maintenance personnel.

B. Wiring from luminaire to remote ballast shall not exceed the ballast manufacturer's recommendations for distance.

C. Remote ballast shall be clearly labeled indicating fixture served, voltage, panelboard and circuit number served from.

3.6 AIRCRAFT CABLE SUSPENSION

A. Cables shall be 1/16 in. aircraft cable with end safety fittings. Cable shall be provided with 2 in. diameter mini-canopy and threaded coupler for attachment to a 1/4 in.-20 threaded stud extending 3/4 in. below ceiling.

B. Cable assembly shall include a spring-loaded adjustment device mounted in the fixture.

C. The Contractor shall be responsible for providing required supports for cable attachment.

D. For cord feed to the luminaire provide continuous cord clip of matching color to attach the cord to the cable.

E. Support per manufacturer's recommendations.

3.7 COVE LIGHTING

A. Fluorescent cove lighting shall be installed so as to produce a continuous and unbroken band of light with no shadows or light gaps.

B. A combination of 2 ft., 3 ft. and 4 ft. lamp fixtures may be required to accomplish a continuous band of light.

3.8 LAMPS

A. Furnish and install required lamps in all luminaires. Any lamp which fails prior to project close-out shall be replaced at no additional cost.

B. Replace any lamp or lamps whose color is determined to be unsatisfactory.

3.9 BALLASTS

A. Furnish and install ballasts for all luminaires requiring ballasts.

B. To facilitate multi-level lamp switching, lamps within fixture shall be wired with the outermost lamp at both sides of the fixture on the same ballast, the next inward pair on another ballast and so on to the innermost lamp (or pair of lamps). Within a given room, each switch shall uniformly control the same corresponding lamp (or lamp pairs) in all fixture units that are being controlled.

C. Provide two-lamp ballasts for fixtures with two (2) fluorescent lamps or multiples of two (2) lamps. On four (4) lamp luminaires, the two (2) outside lamps shall be on one ballast and the two (2) inside lamps shall be on the other ballast.

D. Where three-lamp luminaires are indicated, unless switching arrangements dictate otherwise, utilize a common two-lamp ballast to operate the center lamp in pairs of adjacent units that are mounted in a continuous row. The ballast luminaire and the slave-lamp luminaire shall be factory wired with leads or plug devices to facilitate this circuiting. Individually mounted luminaires and the odd fixture in a row shall utilize a single-lamp ballast for operation of the center lamp. Contractors shall verify lengths of factory wired leads.

E. Dimming ballasts and lamps shall be burned in at full brightness for a minimum of 100 hours prior to being used for dimming. Keep a record of all rooms with dimming luminaires and when the lamps and ballasts were burned in. Submit this record with the lighting operation and maintenance manual.

3.10 GROUNDING

A. Ground all non-current carrying parts of all lighting fixtures.

B. All grounding shall be accomplished with NRTL tested grounding connectors suitable for this purpose.

3.11 LABELING

A. Attach a self-adhesive red dot label, 1/2 in. in diameter, to all lighting fixtures with an integral battery back up and/or those tied into an emergency generator. Labels shall be attached to these fixtures or to adjacent ceiling tiles so that they are readily discernible for testing and maintenance purposes.

3.12 FINAL CLEANING

A. Immediately prior to acceptance, damp clean diffusers, glassware, luminaire trim, reflectors, lamps, louvers, lens and similar objects of all luminaires. Remove all dirt, corrosion, foreign material, finger marks, and blemishes. Replace all burned out lamps and failed components.

3.13 REMOVAL OF BALLASTS IN EXISTING LUMINAIRES

A. Assume ballasts contain PCB material unless labeled otherwise or test samples show materials are not PCB; submit a test report. Remove all ballasts from existing luminaires indicated on contract documents. Dispose of all ballasts which do not have non PCB labels in PCB containers and pay all costs to have containers taken to EPA approved incinerators and disposed of all EPA regulations. Follow all EPA regulations for transporting material. If ballast has leaked in existing luminaires, remove material deposited in luminaire and dispose of those materials as indicated above. Provide documentation verifying disposal of PCB contaminated ballasts.

3.14 REMOVAL OF LAMPS IN EXISTING LUMINAIRES

A. The Contractor shall employ the service of a certified disposal/recycling service company to dispose of all removed fluorescent and/or HID lamps. All disposal procedures shall be performed in accordance with EPA Requirements and Subtitle C for the disposal of mercury contaminated lamps.

END OF SECTION 265000

SECTION 270510 - COMMUNICATIONS, GENERAL

PART 1 – GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents. This section specifies general wiring requirements for systems provided under 27000 and 28000 series sections of these specifications.

1.2 SUBMITTALS

A. Refer to particular Specification Sections covering all systems. Submit and provide system test reports as called for.

1.3 GENERAL REQUIREMENTS

A. Provide conduit systems and special systems as called for.

1. Provide conduit, wireway, wire terminations, etc., necessary to provide for system functions.

2. Cross-sectional area of wires installed in a conduit shall not exceed 40% of the cross-sectional area called for in the National Electrical Code.

3. Provide separate circuit power source for each system.

B. Identification:

1. Provide consistent color code wiring and identify with permanently attached number to each end of each wire, except where color coding is prohibited to meet UL burglary protection requirements.

C. Termination:

1. Unless special terminations are required, such as coaxial cable termination, wires shall be terminated on screw type terminal blocks with metal terminal cabinets.

D. Wiring Diagrams:

1. Install systems in accordance with manufacturer’s certified correct wiring diagrams.

2. Provide record drawings for each system, with wire identification, numbers and colors, as installed.

E. Existing Systems:

1. Any system being extended or connected to an existing system shall be tested for full functionality prior to beginning work. System shall be signed off by Owner as fully functional. Submit test reports prior to starting work.

PART 2 – PRODUCTS

2.1 MAKE AND SERVICE

A. Provide devices and equipment by an established manufacturer for respective systems. All devices and equipment for which there is a listing shall be UL listed and FM approved.

B. Provide system equipment and devices of one manufacturer who maintains a competent service organization and who shall be prepared to offer a service contract for maintenance of the respective system.

C. Provide three service organization inspections for each system at four-month intervals during the year following final acceptance.

D. Correct defects found in the system at the time of these inspections.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Provide complete installation in a neat and workmanlike manner including all accessories and appurtenances for a complete operating system, including equipment mounting backboards, power supplies, wiring, etc.

B. Each system installation shall be supervised, tested, adjusted and approved by authorized representative of the manufacturer of the system devices and equipment.

C. Provide written statement from the authorized representative of the manufacturer of the system devices and equipment that the completed system has been inspected and tested and is approved.

D. Riser and wiring diagrams are not intended as final installation drawings but only as a guide for bidding. Install system based on final wiring drawings prepared by the manufacturer of the system.

E. All fire alarm wiring shall be installed in separate and segregated conduit system.

3.2 WIRING

A. Wire sizes shall be as recommended by system manufacturer.

B. #14 AWG wire, minimum unless otherwise called for.

C. #12 AWG wire, minimum for alarm signal circuits and all power supplies.

D. Provide #20/2 copper minimum twisted and shielded with overall jacket for audio frequency circuits. Shield shall be Mylar backed aluminum foil with drain wire, or copper braid. Do not provide spiral wrap shielding.

E. Provide coaxial cable and fiberoptic cable as called for video and RF distribution.

F. Do not install low level lines such as microphone wires in same conduit with high level lines such as speaker wires.

G. All final wire connections and terminations shall be performed by an authorized representative of the equipment manufacturer who is regularly engaged in, and experienced in this type of work. Subcontracting this work to others is not acceptable.

END OF SECTION 270510

SECTION 272100 - LOCAL AREA NETWORK SYSTEM

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation of Local Area Network (LAN) and related work as required in the Contract Documents.

B. The systems to be provided shall be for a switched LAN environment. The system shall hereafter be referred to as the data network system.

C. Basic Intent:

1. Located throughout the building as shown on the drawings, are places where computers and associated equipment are intended to be placed and connected to the network for the purposes of utilizing common resources.

2. The telecommunications room for the data network in the building(s) is located as shown on the drawings.

3. Located in various other places are additional Telecommunication Rooms (data racks). It is intended that these be connected with the central Telecommunication Room by a fiber optic cable backbone. From each of these locations, data cable is to be run to the data jacks where computer equipment is connected.

4. Patch panels are to be used as termination points for the fiber optic cable backbone so that the system can be easily reconfigured in the future.

5. Patch panels are to be used as termination points for the data cables and the individual fiber cables. This is to provide for easy system growth and reconfiguration.

D. Scope of Work:

1. Existing cable plant shall remain unless noted otherwise.

2. Existing electronics shall remain and be reused.

3. Existing software shall be updated as necessary to the latest revision released.

4. Expansion of data network shall be compatible with existing network configuration and characteristics.

5. New cable plant and LAN system at transportation building.

1.02 QUALITY ASSURANCE

A. All methods of construction, details of workmanship that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated in their respective sections of the specifications. The equipment specified is based upon the acceptable manufacturers listed. Equipment types, device ratings, dimensions, etc. correspond to the nomenclature dictated by those manufacturers. All equipment shall be tested at the factory.

B. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.

C. Installation shall be in accordance with NFPA-70 (National Electric Code), National Electric Safety Code (NESC), EIA/TIA, IEEE, IEC, state codes, local codes, and requirements of authority having jurisdiction.

D. Equipment shall be designed, manufactured, assembled, and tested in accordance with the latest revisions of applicable published ANSI, NEMAIEC, TIA/EIA and IEEE Standards.

E. Each item shall bear the UL Label.

F. The system provider must:

1. Provide equipment from manufacturers for which they maintain a contract, distributorship, are an agent, or other formal arrangement for which documentation can be produced showing authority to sell and service the equipment in this territory.

2. Demonstrate that they have successfully installed these systems, utilizing their standard products, for a period of five (5) years.

3. Maintain a service organization to provide both normal and emergency service. Emergency service must be available 24 hours per day; 365 days per year, and staff must be adequate to respond within 2 hours of an emergency call.

4. Maintain adequate spare parts inventory to provide both normal and emergency service.

5. Employ service technicians who are trained in accordance with the systems manufacturer's recommendations.

6. Own and demonstrate proficiency in the use of the required test equipment, tools, etc. for the proper installation, set-up, testing and maintenance of the system. If requested, must provide a listing of tools and/or equipment and where appropriate, certifications in the proper training and use of the tools and/or equipment.

7. Provide all system programming to deliver a customized system to the Owner ready for use.

a. All system programming is to be completed to the satisfaction of the Owner. If after preliminary use of the system, and/or training, the increased understanding of the system's features and capabilities necessitates reprogramming to any extent, it is to be performed at no additional cost.

1) Any system being extended or connected to an existing system shall be tested for full functionality prior to beginning work. Owner/Engineer shall sign off System as fully functional.

1.03 SUBMITTALS

A. Manufacturers catalog sheets, specifications and installation instructions for all components.

B. Detailed description of system operation.

C. Itemized list of all features and functions.

D. Dimensioned drawings of all system control cabinets and layouts for all equipment rooms.

E. Wiring diagrams showing typical connections for equipment.

F. Riser diagrams showing all components, devices and interconnecting cable types.

G. List of three (3) installations of equivalent or larger systems that have been installed within the past two (2) years and have been operating satisfactorily for a minimum of one year.

H. Warranty information.

I. Information detailing future additions and pending upgrades to the system.

J. Cut sheets on all cables.

1.04 COORDINATE WITH OWNER

A. Upon shop drawing approval and prior to roughing, perform interviews with the Owner to obtain exact locations of all devices. Submit layout drawings with “Agreed” locations for review and approval.

1.05 SYSTEM DESCRIPTION

A. Provide a state-of-the-art Category 6A 10 Gigabit Ethernet (10GBaseT) and/or Category 6 Gigabit Ethernet (1000BaseT) Local Area Networks (LAN) with connectivity to Owner’s Wide Area Network (WAN). Include any and all interface equipment to supply a complete network with complete equipment connections necessary to form a complete “turnkey” network system as outlined in these specifications.

1. All parts of this system shall match the horizontal/backbone cable performance and must be of the same manufacturer of the horizontal/backbone cable.

B. The complete system shall include, but is not limited to, the following:

1. Equipment cabinets and racks.
2. Patch panels and patch cables.
3. Fiber optic backbone cabling.
4. Premises wiring.
5. Modular jacks, backboxes and faceplates.
6. Terminations and testing.
7. Raceways.
8. Router (furnished by Owner).
9. Core switch (furnished by Owner).
10. PoE switches (furnished by Owner).
11. Edge switches (furnished by Owner).
12. Fringe switches (furnished by Owner).
13. UPS units (furnished by Owner)
14. Wireless Access Points (furnished by Owner).
15. Fiber adapters and downlinks.
16. Training and system programming.

C. The work included in this section is shown on the drawings or described in the specifications, and consists of furnishing all labor, material, services, and skilled supervision necessary for the construction, erection, installation, and connection of all circuits, apparatus, and equipment specified herein or shown on the drawings in a first class, workmanlike manner, and its delivery to the Owner ready for use.

D. Each part of work is to be complete in detail and operable in unison with all other sections, to constitute completely installed computer network systems and connections of same, as shown on drawings and described in specifications.

E. Any other electrical work not listed in this scope of work but shown or specified in the contract documents.

F. Deliver all materials to be stored on site in protective containers. These protective containers shall be clearly marked with unit designation as indicated on drawings or specifications.

G. Any material stored in the existing building by the Contractor must be distributed to prevent blocking of passageways and stored as directed by the Engineer. No material shall be stored in the existing building without the Owner's approval.

PART 2 – PRODUCTS

2.01 BACKBONE WIRING - FIBER OPTIC

A. 100% of the fiber optic cable must meet or exceed the following requirements and specifications.

B. The backbone shall be collapsed type fiber optic, originating at the Data Main Distribution Frame (DMDF) to each intermediate distribution frame (DIDF).

C. All fiber cables shall contain quantity of strands as indicated on the drawings for backbone use.

D. Individual fiber cables shall consist of:

1. The fiber.

2. Tight buffer.

3. Thermoplastic jacket.

E. All strands must be bend-optimized/bend-insensitive fiber.

F. Central strength member.

G. Aramid strength member.

H. Second core wrap with ripcord.

I. Polyester Barrier.

J. Outer Jacket.

K. Fiber shall be terminated at each fiber patch panel.

L. Multimode Fiber (Indoor/Outdoor):

1. Type: OM4, bend-optimized

2. Maximum attenuation (dB for each strand of fiber in the cable at operating temperatures ranging from -40°C to +75°C.

a. 850 nm: 2.8 dB

b. 1300 nm: 0.8 dB

3. Minimum Bandwidth (MHz/km).

a. 850 nm: 4700 Mhz

b. 1300 nm: 500 Mhz

4. Shall be interlocking armored, tight buffer, plenum rated, indoor-outdoor breakout style.

5. Core Type: Graded Index Glass

6. Core Diameter: 50 Microns ±2.5µm

7. Clad Diameter: 125 Microns ±1µm Numerical aperture: 0.200 µm .

8. Minimum bend radius:

a. Installation – 15 x O.D.

b. Long Term – 10 x O.D.

9. Maximum loading:

a. Short term - 660 lbf

b. Long term - 330 lbf

10. Strength members shall be FGE/Aramid yarn.

11. Shall meet requirements for plenum and vertical tray cable specifications of the NEC.

12. All fibers shall be terminated with connectors compatible with patch panel specified.

13. Shall have individual fiber tube colors per TIA/EIA-598 and overall orange jacket.

14. Shall be 100 Kpsi proof-tested.

15. Meet or exceed requirements for TIA/EIA 568B.

M. Single Mode Fiber (Indoor/Outdoor):

1. Type: OS2, bend-optimized.

2. Maximum Attenuation: 0.5/0.5 dB per KM

3. 1310/1550 nm

4. Shall be tight buffer, plenum rated, indoor-outdoor breakout style.

5. Core Type: Single Mode

6. Mode Field Diameter: 9.2 ± 0.4 Microns @ 1310 nm

7. Clad Diameter: 125 Microns

8. Minimum bend radius shall be 20 times the diameter.
9. Strength members shall be FGE/Aramid yarn.
10. Shall meet requirements for plenum and vertical tray cable specifications of the NEC.
11. Provide number of fibers/cable as indicated in riser diagram on Drawings.
12. Shall have individual fiber tube colors per TIA/EIA-598 and an overall yellow jacket.

N. Single Mode Fiber (Outdoor):

1. Maximum Attenuation: 0.4/0.3 dB per KM
2. 1310/1550 nm
3. Core Type: Single Mode
4. Core Diameter: 9.2 ± 0.4 Microns @ 1310 nm
5. Clad Diameter: 125 Microns
6. Central loose tube
7. 250 Micron fiber bundles with color coded binder threads.
8. Flooding compound
9. Central buffer tube
10. Moisture barrier
11. Dielectric strength member
12. Rip cord
13. Outer Jacket.
14. Cable shall be continuous without splices.
15. All fibers shall be terminated with connectors compatible with patch panel specified.
16. Acceptable Manufacturers:
    a. Berk-Tek, Leviton Network Solutions
    b. Corning
    c. CommScope

2.02 HORIZONTAL SYSTEM PARAMETERS

A. Category 6A UTP Cable:

1. Initially, the manufacturer shall perform qualification tests on each cable. These tests shall be performed in accordance with the latest revision of the EIA/TIA 568B prior to shipment.

2. The completed cable, while on the shipping reel, shall be tested at room temperature to insure it meets or exceeds the design specifications. Submit test results to Engineers for review and comment before proceeding.

3. Certification shall be provided to show the results of the tests for each reel.

4. Date of Manufacture: No insulated cable over one year old, from date of manufacture when installed, shall be acceptable.

5. Cable shall be plenum rated, 4 pair, 100 OHM, 23 AWG.

6. Cable shall meet all requirements of FCC 68, the latest revision of the EIA/TIA-568B and Addendum.

7. Cable shall have white colored thermoplastic jacket with overall diameter not to exceed 0.230".

   a. Color for cable shall be as follows:

      1) Wireless cables and patch cords are yellow.

      2) Data patch cords and cable are blue.

      3) VoIP patch cords and cable are blue.

      4) CCTV Cameras patch cords and cable are green.

      5) Clock speaker patch cords and cable are orange.

      6) Access control, audio entry and intrusion detection are purple.

8. Pulling tension shall be 25 pounds maximum.

9. Cable shall be able to withstand a minimum bend radius of 1 inche at -20ºC without insulation cracking.

10. Cable shall be color coded in accordance with the latest revision of the TIA/EIA T568B polarization sequence.

11. Cable shall not exceed maximum length of 90 meters.

12. Performance:

a. Less than 9.38 ohm per 100 m DC resistance.

b. Less than 5.1 nf/100 meters at 1 KHz, mutual capacitance.

c. Structural return loss ≥ 15.2 dB at 500 MHz.

d. Insertion loss ≤ 45.3 dB/100M at 500 MHz.

e. Near end cross talk ≥33.8 dB at 500 MHz.

f. Power Sum NEXT ≥ 31.8 dB at 500 MHz.

g. DC resistance unbalance between any two conductors of any pair shall not exceed 4%.

h. The capacitance unbalanced to ground at 1 Khz of any pair shall not exceed 330 pF per 100 meters.

i. Delay skew ≤ 45ns at 100meters.

13. Acceptable Manufacturers:

a. Berk-Tek, Leviton Network Solutions

b. Belden

c. CommScope

B. Category 6 UTP Cable:

1. Initially, the manufacturer shall perform qualification tests on each cable. These tests shall be performed in accordance with the latest revision of the EIA/TIA 568B prior to shipment.

2. The completed cable, while on the shipping reel, shall be tested at room temperature to insure it meets or exceeds the design specifications. Submit test results to Engineers for review and comment before proceeding.

3. Certification shall be provided to show the results of the tests for each reel.

4. Date of Manufacture: No insulated cable over one year old, from date of manufacture when installed, shall be acceptable.

5. Cable shall be plenum rated, 4 pair, 100 OHM, 23 AWG.

6. Cable shall meet all requirements of FCC 68, the latest revision of the EIA/TIA-568B and Addendum.

7. Cable shall have white colored thermoplastic jacket with overall diameter not to exceed 0.225”.

a. Color for cable shall be as follows:

1) Wireless cables and patch cords are white.

2) Data patch cords and cable are white.

3) VoIP patch cords and cable are white.

8. Pulling tension shall be 25 pounds maximum.

9. Cable shall be able to withstand a minimum bend radius of 1 inch at -20ºC without insulation cracking.

10. Cable shall be color coded in accordance with the latest revision of the TIA/EIA T568B polarization sequence.

11. Cable shall not exceed maximum length of 90 meters.

12. Performance:

a. Less than 9.38 ohm per 100 m DC resistance.

b. Less than 5.1 nf/100 meters at 1 KHz, mutual capacitance.

c. Structural return loss ≥ 20.5 dB at 250 MHz.

d. Insertion loss ≤ 32.6 dB/100M at 250 MHz.

e. Near end cross talk ≥43.3 dB at 250 MHz.

f. Power Sum NEXT ≥ 41.3 dB at 250 MHz.

g. DC resistance unbalance between any two conductors of any pair shall not exceed 5%.

h. The capacitance unbalance to ground at 1 Khz of any pair shall not exceed 330 pF per 100 meters.

i. Delay skew ≤ 45ns at 100meters..

13. Acceptable Manufacturers:

a. Berk-Tek, Leviton Network Solutions

b. Belden

c. CommScope

C. Patch Cables (UTP):

1. Patch cords shall match horizontal cable performance and must match manufacturer of cable and connectivity.

2. Provide patch cords for use to connect devices and network to patch panels and field outlets. Quantity of patch cords shall be sufficient to terminate all field outlets indicated on drawings as well as 25% spare outlets.

3. Verify patch cord lengths with the client before bidding and again before ordering. All patch cords shall be by the same manufacturer, of the same performance level/line as the connectivity and cable, and must be third party verified by ETL or an equivalent organization. Assembly house patch cords are not acceptable.

4. Patch cord shall be stranded with overall white jacket for data, white jacket for VoIP and white jacket for wireless and factory-made connectors with protective boots.

5. Acceptable Manufacturers:

   a. Leviton Network Solutions

   b. Belden

   c. CommScope

D. UTP Cable Patch Panels:

1. All panels should consist of a faceplate, mounting, hardware, isolation bushings, connector assemblies and labels for all ports.

2. Provide patch panels in each enclosure/rack to which the cable is to be terminated.

3. Patch panels shall be mounted in standard 19” racks/cabinets.

   a. Contractor shall provide multiple 48-port patch panels having wiring configuration specified with insulation displacement connectors on the back and universal modular jacks on the front where required.

   b. Contractor shall provide quantity of patch panels to terminate all UTP cable. There shall be a minimum of 25% spare capacity for future installation.

4. Jacks shall be RJ-45, T568 universal.

5. Jacks shall have 110 style termination blocks or toolless termination style.

6. Panels shall have labels for each port.

7. All cables are to be terminated per TIA 568B standards and dressed in a neat workmanship way.

8. Provide wire management panels in rear of rack for cable organization and strain relief.

9. Provide grounding strap at patch panel; ground per Section 26 0526.

10. Shall exceed TIA-568B, UL1863 and FCC Part 68 performance specified.

11. Design Make: Leviton Network Solutions or Owner approved equal.

E. UTP Telecommunications Outlets/Connectors:

1. Physical Specifications:

a. Shall be 8-pin connector compatible with the latest revisions of Category 5, Enhanced Category 5, Category 6, Category 6A standards.

b. Shall be modular and snap-in to user configurable faceplates for future retrofits meeting durability requirements specified in the latest revision of the CEI/IEC standard.

c. Shall be IDC type suitable for eight 22-24 AWG wires with a gas-tight connection.

d. Each contact surface shall have at a minimum, copper alloy with 50 micro-inches gold over nickel and a minimum contact force of 100g.

e. Conductors shall be separated and aligned internally by jack comb.

f. Shall have easy to read 568A/B color scheme to prevent termination errors.

g. Wired in accordance with TIA/EIA polarization sequence specified in Patch Panel section of this specification.

h. Transmission characteristics shall meet the requirements for the UTP cabling specified.

i. Minimum durability shall be 1000 mating cycles.

2. Design Make: Leviton Network Solutions eXtreme or Owner approved equal.

F. Fiber Optic Patch Cable:

1. Shall be single and/or multimode duplex fiber.

2. Shall have single mode 8.3/125/900 and multimode 50.5/125/900-micron core/clad/buffer.

3. Patch cords shall be a duplex fiber cable, minimum of two (2) meters long as specified above, on each end.

4. Assembly house fiber patch cords are not acceptable.

5. Acceptable Manufacturers:

a. Leviton Network Solutions

b. Corning

c. CommScope

G. Fiber Optic Patch Panels:

1. Provide fiber optic patch panels in each enclosure to which the fiber backbone fiber is to be terminated.

2. Provide LC to LC style panel base, unless specified otherwise on the drawings. Provide quantity of ports to terminate all backbone cable +25% spare ports.

3. Shall mount in standard 19" rack and d have hinged door for easy access.

4. Provide wire management below and in rear of patch panel.

5. Provide patch panels for fiber ports mounted in racks expandable to 6 panels each.

6. FOR LC TYPE CONNECTORS: Terminate the fiber cables on the patch panels connectors with ceramic ferrules.

7. Acceptable Manufacturers:

a. Leviton Network Solutions

b. Corning

c. Panduit

H. Multimode Fiber Telecommunications Outlets/Connectors:

1. Physical Characteristics:

a. Shall be LC type connectors.

b. Shall terminate up to 125 micron fiber.

c. Shall meet dimensional criteria of the latest revision of ANSI/EIA/TIA.

d. Typical outlet box shall be sized to insure minimum bend radius and store 1 meter of two fiber cable.

2. Transmission Characteristics:

a. Maximum loss of .3 dB per pair.

3. Acceptable Manufacturers:

a. Leviton Network Solutions

b. Corning

c. Panduit

d. Belden

e. Ortronics

2.03 DISTRIBUTION ENCLOSURES/RACKS

A. All enclosure/racks shall be properly sized and of the proper quantity to house all of the required components and 25% spare capacity.

B. Label each rack/enclosure designating it per the latest EIA/TIA standard:

1. Engraved laminated plastic plate.

2. (1/2" letters) mount to top of each rack/enclosure.

C. Provide CAD diagrams indicating scaled data racks, location of patch panels, fiber optic patch panels, wire management, etc. for each wire closet.

D. Enclosed, Floor Mounted Cabinet:

1. Mesh Steel Door with lock.

2. Steel Rear Door with Lock (Lower half vented).

3. Two (2) eight position power strips.

4. Fan Assembly - 3 fan(s) at 250cfm per fan.

5. Wire management brackets.

6. Adjustable front and rear mounting rails.

7. Adjustable 19" rack mount shelf.

8. Color black.

9. Verify swing of door in the field prior to ordering.

10. In locations requiring two or more enclosures, side panels shall be removed and cabinets shall be bolted together allowing access between cabinets.

E. Open, Floor Mounted Racks:

1. Nominal size shall be 19 inch wide x 7 foot high x 20 inch deep.

2. Rack shall be constructed of 6061-T6 aluminum extrusion, with EIA = 3” x 1.265” channel, 1/4” thick flange.

3. Provide base angles and top cross bars.

4. The back of rack shall have wire management panels and cable tray to wall.

5. Rack shall have baked enamel finish.

F. Enclosed, Wall Mounted Cabinet:

1. Standard 19” wide, 24” deep cabinet.

2. Height as required

3. 16 gauge cold rolled steel.

4. Rack shall have locking front Plexiglas door.

5. Ventilated side panels.

6. Two (2) six position power strips.

7. Rack construction shall match freestanding.

8. Racks shall have dual hinges to allow access to front and rear.

9. Provide vertical and horizontal wire management.

10. Verify swing of door in field prior to ordering.

G. Floor mounted server racks (double racks):

1. Racks shall be as specified above for open, floor mounted racks.

2. Racks shall be provided where shown on the drawings or identified in the equipment schedule.

H. Equipment Shelves:

1. Provide quantity of equipment shelves required by Owner during interviews.

2. Shelves shall be made of .09” aluminum and shall support up to 30 lbs. on each side. All mounting hardware shall have baked enamel finish.

3. Acceptable Manufacturers:

a. Chatsworth

b. Tripp Lite by Eaton

c. Mid-Atlantic

d. Great Lakes

2.04 WIRE MANAGEMENT

A. All racks are to be provided with wire management hardware to insure a neat, functional system when complete. Racks shall as a minimum, include the following:

B. PVC construction; duct fingers to manage cabling; color to match enclosure.

C. All racks shall have two space vertical panels, including cover, front and rear, on both sides of rack.

D. All racks shall have one space horizontal panels, front and rear, above and below each patch panel and piece of equipment.

E. Cabinets shall have one space horizontal panels, front and rear, above and below each patch panel and piece of equipment.

F. All data distribution frame plywood backboards shall be provided with vertical and horizontal systems with capacities to house all possible future cabling and patch cords for a neat and orderly installation.

G. Provide cable wraps. Wraps shall be Velcro construction; installed at 6-inch intervals throughout closets; installed every 36 inches elsewhere.

H. Acceptable manufacturers:

1. Leviton Network Solutions

2. Panduit

3. Tripp Lite by Eaton

2.05 NETWORK ELECTRONICS

A. Router

1. Shall be used to connect the core switch to Owner's WAN and/or to connect network platforms, such as voice and video, supported by the switching equipment.

2. Shall support the following WAN platforms:

a. TCP/IP (Transmission Control Protocol/Internet Protocol

b. PPP (Point to Point Protocol)

c. Frame relay

3. Shall route to the following protocols:

a. TCP/IP

4. Shall support the following protocols:
    a. OSPF
    b. BGP-4
    c. RIP
5. Shall provide the following bridging technologies:
    a. Spanning tree algorithm (STA) with transparent 802.1 bridging.
    b. Source route transparent (SRT) bridging.
6. Shall support serial line connections at data rates ranging from 9600 bps to TI/EI.
7. Shall be RISC processor based with 4 MB of RAM, 4 MB of DRAM.
8. Shall be a layer 3 switch with a minimum 100 Gbps capacity backplane and a non-head-of-line blocking backplane architecture.
9. The switch shall allow the Owner to create a virtual network that will allow segmenting of areas into individual LANS that are seamlessly connected through the switch.
10. The switch shall support gigabit Ethernet, Fast Ethernet, Ethernet networks. The switch bridge/route internally between these types of segments as well as performed port switching within the segments.
11. The switch shall be stackable type with rack mount shelf and/or stackable rack fasteners.
12. The switch shall have hot swappable redundant power supplies, diagnostic LED's, front accessible network connectors, in band SNMP management and MIB support and out of band management from local serial interface.
13. Bridging Technologies:
    a. Transparent bridging (IEEE 802.1d spanning tree).
    b. Logical link control (IEEE 802.2).
    c. CSMA/CD 10 Base-T (IEEE 802.3).
    d. CSMA/CD 100 Base-TX and 100 Base-FX (IEEE 802.3U).
    e. VLAN Support (IEEE 802.1Q).
    f. Link Aggregation (IEEE 802.3).
    g. User Authentication (IEEE 802.IX).
14. Routing Technologies:

a. IP v4 routing (RIP v1/v2) (OSPF) (IGMP).

15. Quality of Service:

    a. IEEE 802.1p support

    b. 4 queues per port

    c. DiffServ support

    d. Hardware-based rate lighting

16. Shall have 64,000 address table.

17. Switch shall support a minimum of 24 full duplex auto-sensing 10 Mbps/100 Mbps ports/1000 Mbps and 2 ports of 1000/10,000 Mbps Gigabit Ethernet.

18. Ethernet, Fast Ethernet, ATM and Gigabit Ethernet modules shall comply with latest IEEE, ANSI and ISO specifications.

19. Ports shall provide power to cable plant in Power-over-Ethernet (PoE) format.

20. Provide GBIC's and stacking harnesses for full connectivity.

21. Provide equipment shelves to rack mount switch, fiber adapters and integral down links.

22. Design Make: Cisco.

B. Existing Core Switch

1. Input existing core switch and details.

2. Existing Manufacturer: Input existing core switch manufacturer

C. PoE Switch

1. Shall be a layer 3 switch with a minimum 100 Gbps capacity backplane and a non-head-of-line blocking backplane architecture.

2. The switch shall allow the Owner to create a virtual network that will allow segmenting of areas into individual LANS that are seamlessly connected through the switch.

3. The switch shall support gigabit ethernet, Fast Ethernet, Ethernet networks. The switch bridge/route internally between these types of segments as well as performed port switching within the segments.

4. The switch shall be stackable type with rack mount shelf and/or stackable rack fasteners.

5. The switch shall have hot swappable redundant power supplies, diagnostic LED's, front accessible network connectors, in band SNMP management and MIB support and out of band management from local serial interface.

6. Bridging Technologies:

    a. Transparent bridging (IEEE 802.1d spanning tree).

    b. Logical link control (IEEE 802.2).

    c. CSMA/CD 10 Base-T (IEEE 802.3).

    d. CSMA/CD 100 Base-TX and 100 Base-FX (IEEE 802.3U).

    e. VLAN Support (IEEE 802.1Q).

    f. Link Aggregation (IEEE 802.3).

    g. User Authentication (IEEE 802.IX).

7. Routing Technologies:

    a. IP v4 routing (RIP v1/v2) (OSPF) (IGMP).

8. Quality of Service:

        1) IEEE 802.1p support

        2) 4 queues per port

        3) DiffServ support

        4) Hardware-based rate lighting

9. Shall have 64,000 address table.

10. Switch shall support a minimum of 24 full duplex auto-sensing 10 Mbps/100 Mbps ports/1000 Mbps and 2 ports of 1000 Mbps Gigabit Ethernet.

11. Ethernet, Fast Ethernet, ATM and Gigabit Ethernet modules shall comply with the latest IEEE, ANSI and ISO specifications.

12. Ports shall provide power to cable plant in Power-over-Ethernet (PoE) format.

13. Provide GBIC's and stacking harnesses for full connectivity.

14. Provide equipment shelves to rack mount switch, fiber adapters and integral down links.

15. Design Make: Cisco 3560 Series.

D. Edge Switch

1. Shall be a layer 2 switch with a minimum 100 Gbps capacity backplane and a non-head-of-line blocking backplane architecture.

2. The switch shall allow the Owner to create a virtual network that will allow segmenting of areas into individual LANS that are seamlessly connected through the switch.

3. The switch shall support gigabit Ethernet, Fast Ethernet, Ethernet networks. The switch bridge/route internally between these types of segments as well as performed port switching within the segments.

4. The switch shall be stackable type with rack mount shelf and/or stackable rack fasteners.

5. The switch shall have hot swappable redundant power supplies, diagnostic LED's, front accessible network connectors, in band SNMP management and MIB support and out of band management from local serial interface.

6. Bridging Technologies:

    a. Transparent bridging (IEEE 802.1d spanning tree).

    b. Logical link control (IEEE 802.2).

    c. CSMA/CD 10 Base-T (IEEE 802.3).

    d. CSMA/CD 100 Base-TX and 100 Base-FX (IEEE 802.3U).

    e. VLAN Support (IEEE 802.1Q).

    f. Link Aggregation (IEEE 802.3).

    g. User Authentication (IEEE 802.IX).

7. Routing Technologies:

    a. IP v4 routing (RIP v1/v2) (OSPF) (IGMP).

8. Quality of Service:

    a. IEEE 802.1p support

    b. 4 queues per port

    c. DiffServ support

    d. Hardware-based rate lighting

9. Shall have 64,000 address table.

10. Switch shall support a minimum of 48 full duplex auto-sensing 10 Mbps/100 Mbps ports and 2 ports of 1000 Mbps Gigabit Ethernet.

11. Ethernet, Fast Ethernet, ATM and Gigabit Ethernet modules shall comply with latest IEEE, ANSI and ISO specifications.

12. Provide GBIC's and stacking harnesses for full connectivity.

13. Provide equipment shelves to rack mount switch, fiber adapters and integral down links.

14. Design Make: Cisco 2960 Series.

E. Fringe Switch

1. Shall be a layer 2 switch with a minimum 100 Gbps capacity backplane and a non-head-of-line blocking backplane architecture.

2. The switch shall allow the Owner to create a virtual network that will allow segmenting of areas into individual LANS that are seamlessly connected through the switch.

3. The switch shall support Fast Ethernet, Ethernet networks. The switch bridge/route internally between these types of segments as well as perform port switching within the segments.

4. The switch shall be stackable type with rack mount shelf and/or stackable rack fasteners.

5. The switch shall have hot swappable redundant power supplies, diagnostic LED’s, front accessible network connectors, in band SNMP management and MIB support and out of band management from local serial interface.

6. Bridging Technologies:

   a. Transparent bridging (IEEE 802.1d spanning tree).

   b. Logical link control (IEEE 802.2).

   c. CSMA/CD 10 Base-T (IEEE 802.3).

   d. CSMA/CD 100 Base-TX and 100 Base-FX (IEEE 802.3U).

7. Routing Technologies:

   a. IP routing (RIP) (OSPF).

8. Shall have 1024 MAC address table cache.

9. Switch shall support a minimum of 24 segments with 10 Mbps/100 Mbps full duplex switching, and two (2) full duplex auto-sensing 100 Mbps/10 Mbps ports.

10. Provide fiber adapters and down links for fiber connectivity for all segments to be connected to core switch.

11. Ethernet, Fast Ethernet and ATM modules shall comply with latest IEEE, ANSI and ISO specifications.

12. Provide GBIC's and stacking harnesses for full connectivity.

13. Provide equipment shelves to rack mount switch, fiber adapters and integral down links.

14. Design Make: Cisco.

F. UPS

1. Provide a rack mounted UPS at each data distribution frame. UPS shall be sized to accommodate all hubs, edge switches, core switch, routers, file servers and associated equipment in the closet.

2. UPS system shall consist of rectifier/chargers, inverters, AC transfer switches, maintenance switches and batteries.

3. In event of normal power failure, system shall maintain battery power to load for 1–1/2 hour duration. Upon return of normal power, UPS shall automatically equalize and recharge batteries and return to floating condition.

4. Acceptable Manufacturers:

a. Eaton

b. Powerware

c. Chloride

d. Liebert

e. Approved equal

2.06 WIRELESS NETWORK SYSTEM

A. General: Provide a wireless network in accordance with IEEE 802.11ax for Wi-Fi 6 (2.4 GHz and 5 GHz)[5] and/or Wi-Fi 6E (6 GHz) standards or better, unless detailed otherwise by the Client.

B. Layout: Perform system site survey prior to installation. Submit results to Engineer. Provide additional access points at no charge to Owner for complete coverage throughout the construction floors.

C. Access Points: Building mounted transmission – reception devices connected to the data distribution system.

1. Design Make: ICCN ARC60, Cisco 9115 or Owner approved equal.

D. PC Cards: Laptop mounted transmission – reception cards mounted in the notebook PC card slot.

1. Features:

a. Transmit/receive at speeds up to 11 Mbps and distances up to 100 m (330 ft).

b. Dynamic rate shifting adjusts connection speeds for more reliable connections.

c. Auto Network Connect with DHCP support maintains mobile users connected even while roaming.

d. Ad hoc support slows for simple peer-to-peer wireless networking.

e. Dynamic Security Link and 40-bit encryption allow exchange of information in full privacy.

f. Wi-Fi certification of multivendor interoperability.

2. Electrical Characteristics:

a. Bus Type: 16-bit Type II PC Card

b. Drivers: Windows ME/2000/98 or higher/NT 4.0 or higher

c. LAN Speeds: 1, 2, 5.5 and 11 Mbps

d. Media Interface: 802.11b High Rate

e. Protocol Support: TCP/IP, , NetBEUI, DHCP, 802.11b

3. User System Requirements:

a. Notebook PC with an available 16-bit Type II PC Card slot

b. The Notebook must be running Windows ME/2000/98 or higher/95B or higher/NT 4.0 or higher.

c. Package Contents For Each PC Card:

d. PC Card with antenna

e. Software and documentation on CD

f. Quick Start guide with CD-Rom tutorial

4. Design Make: Cisco.

E. Management Software:

1. Self-regulating, auto-negotiating.

2. System administration.

3. Common server platform based.

4. Design Make: Cisco.

F. System Design Make: Cisco Systems.

2.07 COMMUNICATION EQUIPMENT ROOM (CER) SCHEDULES

A. REFER TO DRAWINGS FOR ADDITIONAL WORK RELATED TO LAN AND CER ROOMS.

B. Provide additional network equipment for a complete system. Refer to alternate section for definitions of alternates where applicable.

1. DMDF/DIDF: CER# (Input Facility):

a. Provide the following equipment:

1) (x) Open Floor Rack

2) (x) PoE switches

3) (x) Edge switches

4) (x) UPS

5) Fiber adapters, down link modules and patch cables required to complete connectivity.

6) Provide (x) port fiber patch panels configured with (x) ports.

7) Provide (x) - 48 port UTP patch panels, Category to be as specified.

8) Coordinate exact lengths of all patch cables with Owner prior to installation.

C. Configure such that each switch is connected to equipment room core switch.

2.08 LABELING

A. Fiber Optic Cabling

1. Specifically label fiber optic cables at Telecommunication Room #1 indicating destination room, strand number and strand color.

2. Specifically label fiber optic cables at each remote Telecommunication Room indicating data rack #, strand number and strand color.

3. Each strand color shall match a specific fiber termination number in each closet, i.e. blue - fiber 1, orange - fiber 2, green - fiber 3, etc.

4. Insert copies of charts into Operating and Maintenance manuals.

B. Copper Data Cabling

1. Patch Panels

a. The Contractor shall utilize Interlink-Label for Windows 2 or approved equal; Network Labeling System to label all patch panel ports.

b. Turn over software to Owner upon completion of work with additional labels.

2. Field Outlets

a. Each data port shall have an identical label to the corresponding port in the Telecommunication Room.

b. The Contractor shall utilize Interlink-Label for Windows 2 or approved equal; Network Labeling System to label all patch panel ports. Labels shall be installed in a workman-like manner and fit completely in the recessed area of the labeled location.

c. Contractor shall utilize Interlink Icon labels at Poke-thru locations and any other locations that do not have a label location.

3. Each label shall contain the Telecommunication Room designated, the room number and the port number in the room. Verify color of label and size of font prior to completion. Provide samples as required.

4. Labels shall correspond to the room/names/numbers upon completion of the project. Contractor shall not necessarily utilize existing room/names/numbers or those indicated on the blueprints.

5. Contractor shall record each data port label on all record drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. HORIZONTAL CABLES

1. Cable shall be installed in accordance with ANSI/TIA-568.0-E, manufacturer's recommendations, and best industry practices.

2. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.

3. Cable raceways shall not be filled greater than the ANSI/TIA-569-D maximum fill for the raceway type.

4. Cables shall be installed in continuous lengths from origin to destination (no splices) except for approved consolidation points.

5. Where transition points or consolidation points are allowed, they shall be in accessible locations and housed in an enclosure intended and suitable for the purpose.

6. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.

7. If J-hooks are used to support cable bundles the J hooks shall be properly sized to accommodate the immediate need and future growth of the cable pathway. J Hooks shall be designed to control bend radius requirements of the cable categories being installed. J hooks shall be installed at intervals of 1.2 -1.5 m (4 - 5 feet) apart to effectively support and distribute the cable's weight and be randomly spaced. Randomly spacing cable supports is considered a best practice for all cable systems to reduce harmonics.

8. Cable supports shall be self-supporting and utilize independent wires, support rods and associated hardware for suspension. At no point shall cable(s) rest on acoustic ceiling grids, T-bars, ceiling support wires, acoustical panels, or other components of the suspended ceiling.

9. Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.

10. The bundle size recommendations of ANSI/TIA TSB-184-A shall be followed as it pertains to current or future support for POE applications.

11. Cable shall be installed above fire-sprinkler systems and shall not be attached to the fire-sprinkler 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.

12. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the Contractor prior to final acceptance at no cost to the Owner.

13. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA-568.0-E, manufacturer's recommendations, and best industry practices.

14. Leave a minimum of 12" of slack for twisted pair cables at the work area outlet. Cables shall be coiled in the in-wall box, surface-mount box, or modular furniture raceway if adequate space is present to house the cable coil without exceeding the manufacturers bend radius. In hollow-wall installations where box-eliminators are used, excess wire can be stored in the wall. Excess slack shall be loosely coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.

15. When cables are being installed, slack (service loops) shall be provided at both ends to accommodate future changes in the structured cabling system. Slack should be included in all length calculations to ensure that the permanent link does not exceed 90 m (295 ft). The amount of cable slack required will depend on the size and layout of the connecting hardware at the TR, TE or TO.

16. The recommended amount of cable slack shall be:

    a. 3m (10 ft) in telecom spaces (ER, TR, TE)

    b. 1m (3 ft) - 3 m (10 ft) in the ceiling above the outlet

    c. 30cm (1ft) at work are outlet

17. Cables shall be neatly bundled and dressed to their respective termination device. Each terminating device shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

18. Cable bundles shall not be painted.

19. Nylon or plastic tie wraps shall not be used, hook and loop fasteners shall be used to bundle and dress cables.

20. Each cable shall be clearly labeled on the cable jacket behind the termination device at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

21. Comply with BICSI TDMM and ANSI/TIA-569-E recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.

B. VOICE AND DATA MODULAR JACKS

1. 8-position, 8-contact (8P8C) modular jacks shall be installed in accordance with manufacturer's recommendations and installation guides, and best industry practices.

2. Pair untwist at the termination shall not exceed 6.35 mm (0.25 inch).

3. Termination wire map shall be 568B unless otherwise stated in drawings.

4. Data jacks shall be plenum rated when installed above ceilings or under raised floors.

C. PATCH PANELS

1. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568 standards as well as manufacturer’s recommendations and best industry practice.

2. Cables shall be separated into groups of twelve and routed symmetrically from both sides of the patch panel (e.g., split panel). 12" Slack should be incorporated in rear cable groups to facilitate re-terminations.

3. Cables shall be properly supported vertically in the rack or cabinet and supported at the rear of the patch panel using a cable management bar or a rear horizontal cable management to retain terminations.

4. Pair untwist at the termination shall not exceed 6.35 mm (.25 inch).

5. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.

6. Termination wire map shall be 568B unless otherwise stated in drawings.

7. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

D. PATCH CORD INSTALLATION

1. Patch cords shall be installed at IT room end and at workstation end with cords of appropriate length such that cables are routed through proper cable management ducts and patch ways in a consistent manner. Cords should be routed so as not to block panel labels where possible

2. Patch cords shall be installed with the proper color to match the adopted color scheme for the organization.

3. Patch cords shall be labeled at both ends according to the adopted labeling scheme for the organization. Labeling scheme shall adhere to ANSI/BICSI N1-2019 standard and ANSI/TIA-606-D.

4. Patching schedules and or records shall be updated by the Structured Cabling Plant Administrator after patching has been completed.

5. Patch cords that are no longer in use shall be removed from the patching frame and properly stored. Patch cords to be harvested for reuse shall have unique ID labeling removed and be retested prior to being made available for re-use.

6. Patch cords installed in plenum air handling spaces must meet appropriate fire/building codes.

E. FACEPLATES

1. Blank inserts shall be installed where ports are not used.

2. The same orientation and positioning of jacks and connectors shall be utilized throughout the installation.

3. Faceplates shall be installed straight and level.

4. Faceplates shall be installed at the same heights as electrical faceplates or as designated on architectural and construction plans.

F. SURFACE MOUNT BOXES

1. Blank inserts shall be installed where ports are not used.

2. The same orientation and positioning of jacks and connectors shall be utilized throughout the installation.

3. Surface mount boxes shall be installed straight and level.

4. Surface mount boxes shall be secured with screws to appropriate building structure or support bracket.

5. Plenum rated surface mount boxes shall be used for in ceiling and raised floor applications where required.

G. FIELD QUALITY CONTROL

1. Test 100 percent of all cable runs for defects in installation and verify cabling system performance under installed conditions in accordance with ANSI/TIA-568.0-D standards.

2. Defects in cabling system installation, including but not limited to cables, connectors, patch panels, and connector blocks shall be repaired or replaced to ensure 100 percent useable conductors in all cables installed.

3. Performance Certification Testing of Twisted-Pair Cables: (NOTE: Permanent Link Test results are recommended and are the expected norm).

4. Test twisted-pair copper cable links for continuity, pair reversals, shorts, opens, and performance as specified.

5. Test horizontal cabling using approved Level IIIe or III certification tester for Category 6/6A performance compliance in accordance with ANSI/TIA-1152-A.

6. Basic Tests Required:

a. Wire map.

b. Length (feet).

c. Insertion loss (dB), formerly attenuation.

d. NEXT (Near end crosstalk) (dB).

e. Return loss (dB).

f. ELFEXT (dB).

g. Propagation delay (ns).

h. Delay skew (ns).

i. PSNEXT (Power sum near-end crosstalk loss) (dB).

j. PSELFEXT (Power sum equal level far-end crosstalk loss) (dB).

k. Test Category 6A by auto test to 500 MHz.

l. Test Category 6 by auto test to 250MHz.

7. Provide test results in approved certification testers original software format on CD, with the following minimum information per cable:

   a. Circuit ID.

   b. Information from specified basic tests required.

   c. Test Result: “Pass” or “Fail”.

   d. Date and time of test.

   e. Project name.

   f. NVP.

   g. Software version.

8. Submit fully functional version of tester software for use by the Owner in reviewing test results.

9. Report in writing to the Owner immediately, along with copy of test results, failed test results that cannot be remedied through re-termination (as in the case of reversed or split pairs).

H. BACKBONE CABLES

1. Cables shall be dressed and terminated in accordance with the recommendations made in ANSI/TIA-568-E standards, manufacturer's recommendations, and best industry practices.

2. Minimum bend radius and maximum pulling tension for all cables shall be maintained during and after installation.

3. All cable and associated hardware shall be placed to make efficient use of available space in coordination with other uses. All cable and associated hardware shall be placed so as

not to impair the use or capacity of other building systems, equipment, or hardware placed by others (or existing).

4. Backbone cables shall be installed separately from horizontal distribution cables.

5. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.

6. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits.

7. Where backbone cables and distribution cables are installed in a cable tray or wireway, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.

8. Leave 3m of slack on each end of fiber backbone cable.

9. Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip and be supported by messenger strand, cable ladder, or other method to provide proper support for the weight of the cable on alternating floors or as required by local codes.

10. Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to support the cables.

11. The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.

12. Each optical fiber cable shall be individually attached to the respective enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.

13. Each optical fiber cable shall be clearly labeled at the entrance to the enclosure. Cables labeled within the bundle shall not be acceptable.

14. When splicing each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.

15. All spare fiber strands shall be installed into spare splice trays.

16. Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel.

17. SPLICE CASES

    a. Splice Cases shall be installed as per the requirements specified by the manufacturer's installation guidelines

18. Duplex SC or LC fiber connectivity shall be organized in patch panels such that reverse polarity positioning is implemented per ISO/IEC 11801 Standards.

19. OPTICAL FIBER PANELS/ENCLOSURES

    a. Cables shall be dressed and terminated in accordance with manufacturer's recommendations and best industry practices.

    b. Each cable shall be individually attached to the respective splice enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.

    c. Bend radius of the optic fiber cable in the panel/enclosure shall not exceed 10 times the outside diameter of the cable.

    d. Each fiber bundle shall be stripped upon entering the splice tray and the individual fiber routed in the splice tray.

    e. Each cable shall be clearly labeled at the entrance to the splice enclosure. Cables labeled within the bundle shall not be acceptable.

    f. A maximum of 12 strands of fiber shall be spliced in each tray.

    g. All spare strands shall be installed into spare splice trays.

    h. Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel.

    i. Installer will visually clean and inspect fiber connector endface prior to insertion into coupler plate.

    j. Installer will attach dust caps immediately after endface inspection and after testing.

20. OPTICAL FIBER CONNECTORS AND PIGTAILS

    a. All optical fiber shards shall be properly disposed in an approved container to prevent injury. The use of tape is not an approved method for disposal.

    b. Application of direct connect fiber connectors (crimp, adhesive or anaerobic) shall be done in accordance with manufacturer’s instructions and industry best practice.

    c. Pigtails shall be installed with appropriate fusion splicing equipment that has been calibrated per manufacturer’s recommendations.

    d. After polishing/splicing is completed, optical fiber connectors shall be visually checked with an inspection scope (min x200) for damage and debris.

    e. If the optical fiber core is fractured, chipped, or scratched it must be re-terminated.

f. Dust caps to be installed immediately after inspection and insertion into coupler plates.

21. OPTICAL FIBER PATCH CORDS

a. Fiber patch cords/workstation cords shall be installed as per the requirements specified by the manufacturer's installation guidelines.

b. Installer will visually inspect and clean fiber connectors at every stage of handling BEFORE mating them.

c. Inspection of both endfaces (Cord end and internal Bulkhead) before mating patch cords is required.

d. Cleaning both connectors each time you disconnect and reconnect is required.

e. Inspection and cleaning of simplex fiber interfaces will adhere to the procedures detailed in International Standard IEC 61300-3-35.

f. Objective inspection tools shall be used to perform endface inspection.

22. OPTICAL FIBER TESTING AND QUALITY ASSURANCE

a. Testing procedures shall be in accordance with the following:

1) ANSI/TIA-568-3-D.

2) ANSI/TIA-526-7, Method B.

3) Encircled Flux testing per the TSB-4979 and TIA-526-14-B standard.

b. Testing:

1) Test optical fibers at both 850 nm and 1300 nm wavelengths for multimode, 1310 nm and 1550 nm wavelengths for single mode, end-to-end insertion loss,

2) Maximum channel insertion loss for fiber optic cables without consolidation point: 2.0 db.

3) All OLTS units shall be of current calibration, submit calibration certificate with test results to Manufacturer.

c. Submit software copy of test results, in original tester software format, to the Owner and to Leviton.

3.02 PROGRAMMING

A. Two months prior to job completion, the supplier shall arrange a meeting with the Owner at which time the supplier shall configure the system per the Owner’s direction. Provide three (3) electronic copies of the program on three (3) different disks.

3.03 TRAINING AND INSTRUCTION

A. Provide eight (8) hours of instruction to three (3) Owner personnel regarding system set up configuration and management.

3.04 WARRANTY

A. All cable plant parts shall be warranted to the owner for a period of 25 years or more as a complete end-to-end system.

B. All network equipment shall be warranted to the owner for a period of two (2) years. Provide technical support at no charge to the customer for a period of one (1) year after system has been commissioned.

C. Make available an extended warranty to the customer.

D. Warranties shall commence upon final acceptance of the system.

END OF SECTION 272100

SECTION 273200 - PAGING AND INTERCOM SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation of the telecommunications system as described in this Section and detailed on the Drawings.

1.2 GENERAL REQUIREMENTS

A. All equipment shall be U.L. listed.

B. All materials furnished and all work performed shall comply with all State, County and Local Authority Codes.

C. All equipment and work shall comply with FCC regulations.

1.3 QUALITY ASSURANCE

A. Equipment furnished under this specification shall be the standard product of one supplier having a minimum of ten years experience in this field.

B. The supplier shall be an authorized Manufacturers Distributor with In-house Staff factory-trained in the installation, maintenance and programming of all components.

C. The Supplier shall have a local service department (within a 50 mile radius) and have available a minimum of three (3) factory trained technicians within a 24 hour period.

D. All components shall be fully tested and documented to operate as a complete system.

E. Supplier must guarantee that all replacement parts will be carried in stock for a period of 10 years minimum from the date that the system is commissioned.

1.4 SUBMITTALS

A. Manufacturer's catalog sheets, specifications and installation instructions for all components.

B. Detailed description of system operation.

C. Itemized list of all features and functions.

D. Dimensioned drawings of all system control cabinets and telecommunications room layouts.

E. Wiring diagrams showing typical connections for equipment.

F. Riser diagrams showing all components, devices and interconnecting cable.

G. List of five (5) installations of equivalent or larger systems that have been installed within the past five (5) years and have been operating satisfactorily for a minimum of one year.

H. Warranty information.

I. Programming books coordinated with Owner.

J. Provide a brief description of the size and scope of the suppliers organization, addressing the following issues:

1. Number of locations.
2. Number of employees by job classification.
3. Affiliated companies
4. Size and scope of account base.

1.5 SYSTEM DESCRIPTION

A. Provide a microprocessor based paging and intercom system at HFL Manor School.

B. The complete system shall include but is not limited to the following:

1. Equipment cabinets.
2. Distribution frames and patch panels.
3. Premises wiring and connections.
4. Jacks and face plates.
5. Testing.
6. Raceways.
7. Training.
8. Intercom devices.
9. Standby power.
10. Public address control equipment amplifiers, etc.
11. Speakers and housings.
12. CD player, AM/FM tuners, microphone(s), Antenna, i-Pod docking station.

C. All telephone handsets both analog and digital shall be connected directly to the digital telephone switch. Only speakers and call buttons shall be connected to the intercom/paging control equipment. The systems shall be interfaced via tie lines/or trunks to allow for the following functions:

1. All call, zoned and individual speaker paging from any analog or digital phone connected to the phone switch.

2. Night ring through all P.A. speakers.

D. Provide auxiliary relay at existing master clock to allow schedule tones to be broadcast over loud speakers.

PART 2 - PRODUCTS

2.1 ANALOG PHONES

A. Type "c" on drawings shall be single line telephones including ringer, transfer access button with time hook flash, DTMF dial, standard length mounting cord and handset coil cord. Color shall be selected by the Architect. Shall have message waiting lamp.

B. Acceptable Manufacturers:

1. ITT
2. AT&T
3. Northern Telecom

2.2 INTERCOM AND PAGING SYSTEM

A. Shall use advanced microprocessor technology, be user programmable and be controlled by a central administrative control station equipped with microphone, speaker, handset and control panel with appropriate buttons to program and operate the system.

B. The system shall have the following features:

1. Amplifiers for provision for up to eight programmable zones including emergency all page.

2. Amplifiers for program distribution from an AM/FM radio and cassette tape player to any of the programmable zones.

3. Speaker control assemblies for direct connection of speakers in each room and for zone connection of corridor speakers.

4. Intercom amplifier for hands free communication between speaker and any phone.

5. Intercom and program panel at rack mounted head end equipment providing inputs for microphone or auxiliary plus a built-in microphone for emergency announcements.

6. Connection port at head end equipment for connection of computer or modem line for system diagnostic checks.

7. Tone generator with four (4) emergency tones and three (3) class change tones.

8. Two way voice communication links to the telephone switch allowing the following:

a. Direct dialing two way "amplified voice" intercom between administrative telephones and classroom speakers.

b. Predetermination by administrative user as to whether to ring the telephone or the speaker.

c. Distribution of emergency announcements to all speakers from any authorized telephone (any phone shall be authorized using a 3 digit access code).

d. Night ring through selected zones.

9. Two way voice communication between classroom speaker and administrative control center via push to talk button.

10. Line link modules for connection of DTMF telephones to the intercom system. Provide one telephone at each location with type "C" phone.

a. Provide intercom amplifiers for hands free communication between any phone and any speaker.

11. Emergency call buttons at all rooms equipped with a speaker that will annunciate a trouble light at the administrative control center.

12. Built in master clock system for distribution of class change tones.

13. Provide emergency call buttons on the telephone handset in the classrooms that will annunciate 12 in H x 24 in. W flashing display showing room number, in the main office and open a communications channel from the office to the classroom. In addition, the room number shall be displayed at an annunciation panel at the front entrance of the building. The emergency button shall have the appearance of a normal function pushbutton on the phone. System shall be reset at the P.A. control console.

14. The intercom and paging system shall be equipped with a minimum of 4 hours of battery standby. The intercom and paging system shall be equipped with battery charging circuits sufficient to recharge fully depleted batteries to within 70% of maximum capacity within 12 hours.

C. Power amplifiers shall meet the following:

1. Capable of delivering 250 watts continuous RMS power.

2. Frequency response shall be 45 Hz to 20 Khz at rated output with less than .5% harmonic distortion over the full bandwidth.

3. Signal to noise ratio shall be greater than -90db below rated output for the 20-20 Khz bandwidth.

4. Input sensitivity shall be 1 volt RMS at 1 Khz for rated output and input impedance shall be 75 K ohms.

5. Separate amplifiers shall be provided for program and paging.

D. AM/FM tuner shall meet the following:

1. Tuning range, AM 525-1605 Khz; FM 88-108 MHz.

2. Sensitivity, AM 40 microvolt for 30 db signal to noise ratio; FM 20 microvolt for 30 db single to noise ratio.

3. Antenna input, AM 75 phms, single ended; FM 300 ohms balanced, twin lead, screw terminals.

4. Image rejection, AM greater than 30 db; FM greater than 25 db.

5. I.F. rejection, AM greater than 30 db; FM greater than 50 db.

6. Frequency response 100 - 4,500 Hz. Plus or minus 3 db on A.M. 50 - 15,000 Hz. plus or minus 2 db on FM.

7. Distortion less than 6% on A.M. and less than 2% on F.M.

8. Output 1.0 volt nominal.

9. Controls shall include power switch, AM-FM selector switch, AM-FM selector switch, tuning control and dual function signal reception/pilot light that shall glow when tuner is on and shall glow brighter with strong signal reception.

10. Provide roof mounted AM and FM antennas.

E. Compact Disk (CD Player) Meeting the Following:

1. Description: Five (5) disk CD player with programmable sequence playback of 32 tracks, random playback, repeat play, bypass play, play, pause, stop, search, track change, LCD display and disk change while another disk is engaged.

2. Performance:

   a. Frequency response of 20 to 20,000 Hz plus or minus 1.0 dB.

   b. .0025% harmonic distortion @ 1 KHZ.

   c. 100 dB dynamic range.

   d. 100 dB signal-to-noise ratio.

   e. 100 dB channel separation at 1 kHz.

   f. 2-channel 16-bit linear quantization with 8 or 12 LCM disks.

3. Outputs:

   a. Analog: XLR, balanced, 4.5 dBm, 1.3V, 600 ohm.

   b. Analog: RCA, unbalanced, 6 dBv, 2V, 47K ohms.

   c. Digital: Coaxial, S/PDIF 0.5V P-P, 75 ohms.

4. 120V AC, 60 Hz power input.

5. Physical Enclosure:

   a. Dimensions: 17-1/8" W x 4-1/2" H x 10-5/8" D.

   b. Rack mounted ears and hardware.

6. Design Make: Tascam CD-305.

F. Speakers:

1. Cone type speakers (main system, ceiling mounted) shall be 8 in. diameter with attached 25 volt line matching transformer and meet the following standards:

   a. Frequency range of 30 to 15,000 Hz.

   b. Power rating of 10 watts, 16 watts program.

   c. Voice coil impedance of 8 ohms.

   d. Magnet weight 4.8 ounces, ceramic.

   e. Flux density 9,000 lines/square cm.

   f. Axial sensitivity of 93 db at 4 ft. with (1) watt input.

   g. Line matching transformer shall have taps for 1/2, 1, 2, and 4 watts.

2. Exterior, Gymnasium and Pool: (Wall Mounted)

   a. Subscript "H" indicates horn type, subscript "HV" indicates vandalproof horn type.

   b. Wall mounted, 10-1/2 in. diameter projector type speaker 350 Hz - 12 Khz frequency response, 120 dB sound level with 130° dispersion.

   c. Outdoor type shall be weatherproof.

   d. Taps: 4, 8, 16 watts.

3. Provide volume control on all speakers located at the speaker**.**

G. Speaker Housings:

1. The housing for ceiling recessed speakers shall include a grille which has a round steel frame with perforated steel center, all finished in flat white, and a 4 in. deep round back box.

2. Speakers in Gymnasium shall be mounted in a square 4 in. deep surface mounted box finished with epoxy paint and constructed of 18 gauge sheet steel. Box shall be rigidly fastened to the structure.

3. Exterior speakers shall be mounted in a surface weatherproof, vandal resistant enclosure.

H. Upon failure of any electronic components in the system emergency announcements shall be able to be made from the microphone at the control center.

I. Provide switchbanks at the control center for reaching any room even if electronic components in the system have failed.

J. Existing Make/Model: Hilton CSD Quest: Bogen Multicom 2000

2.3 PREMISES WIRING

A. Phones:

1. Shall be 24 AWG, 4 pair unshielded twisted third party verified to category 3.

B. Speakers:

1. Shall be 18 AWG, single twisted pair solid, shielded with 18 AWG solid drain.

C. Speakers with call-in switch:

1. Shall be one 18 AWG, shielded twisted pair with one 18 AWG conductor.

D. Wiring between closets and distribution frames shall be multi-conductor combinations of the appropriate cables as called for by the system supplier. Provide sufficient quantity of spare conductors for 25% future expansion.

E. Acceptable Manufacturers:

1. Belden
2. West-Penn
3. AT&T

2.4 DISTRIBUTION FRAMES AND CONNECTORS

A. Wiring terminations at MDF and IDP's shall be made using 66 Style punch down. All terminations shall be labeled per TIA/EIA 606.

B. Provide 3/4 in. x 4 ft. x 4 ft. plywood backboard with two coats of medium gray fire proof paint at all IDF locations, at a minimum one in each telephone closet. Provide 8 ft. x 4 ft. x 3/4 in. plywood backboard at “MDF”. Cut backboards into sections as required to fit in space allotted.

C. Provide surge protection and grounding system.

D. Telephone/Intercom connectors shall be modular in construction and meet EIA/TIA category 5e requirements for near end cross talk (NEXT) and attenuation. Connectors shall be RJ11 6 position 4 wire. Provide connectors for all telephone instruments shown on plans.

E. 8 wire, 6 wire and 4 wire modular jacks shall fit in the same size opening of common faceplate.

F. Provide hardwired connection for all Type "C" phones shown on plans.

G. Acceptable Manufacturers:

1. Panduit
2. Amp
3. Ortronics
4. Hubbell

PART 3 - EXECUTION

3.1 INSTALLATION

A. Cable:

1. All wiring concealed in walls or so fits shall be installed in metal conduits.

2. All cable above accessible ceilings shall be installed in J-hooks, 3 ft. O.C.

3. Verify all wiring requirements with the Manufacturer. If the manufacturer recommends larger wire sizes, they shall be provided. However, smaller sizes or lower cable categories are not acceptable.

4. All Contract Documents are schematic. The system supplier shall incorporate their wiring requirements on the system drawings. The Contractor in conjunction with the system manufacturer shall be responsible for complete wiring requirements and conduit sizes.

5. After the system has been completely tested, the cables between the main control cabinet and the conduit access box shall be neatly bundled and held with either nylon lacing cord or nylon cable clamping devices similar to Thomas and Betts "Ty-Rap". More than one bundle may be used if one would be too large to be workable. Provide sufficient loop in cable bundle to allow moving the cabinet away from the wall. Internal cable shall be similarly bundled, and rounded in such a manner to permit easy access to internal equipment and connections. Where control equipment has a pullout feature, provide sufficient loop of cable to prevent binding.

6. Label all pullboxes in ceilings "telecommunications" using wide marking pen.

7. Label all cables per the latest TIA/EIA Standards.

B. Equipment and Devices:

1. Install all devices where shown on drawings. Provide all necessary conduit outlet boxes, junction boxes, supports, etc. Verify all required box sizes with the system supplier.

2. Install all head end equipment in 19 in. fixed racks leaving minimum 30 in. of access space on sides and back rack and 36 in. in front of rack.

3. Provide surge suppression per Manufacturers requirements for all equipment.

4. Provide all power outlets and plug strips required for system operation but not shown on plans.

C. Speakers:

1. Provide volume controls for speakers where indicated in plans. Volume controls shall have emergency call override.

2. Unless otherwise directed, each system speaker shall be wired to operate at the following wattages:

a. Classrooms, Library, Offices……1 Watt

b. Exterior Speakers……..…8 Watts

c. Corridors and Areas with Ceilings 10 ft. and higher…….2 Watts

d. Gymnasium……..16 Watts

3.2 PROGRAMMING

A. Two months prior to job completion the supplier shall arrange a meeting with the Owner to perform all programming functions. At this time all authorization codes, restrictions, etc. shall be determined.

3.3 TESTING

A. Upon completion of the system installations it shall be the responsibility of the Contractor to perform the necessary adjustments and balancing of all signals, amplifier level controls, and speaker taps to the satisfaction of the Owner.

B. In the presence of the Owner's Representative and the Contractor, the system supplier shall test each device and all system functions. The test shall be documented with a signed copy submitted to the Contractor, Owner and Architect/Engineer.

C. A cables shall be tested for continuity.

3.4 TRAINING SESSIONS

A. Provide two, one-hour training sessions for each administrative staff member. Training sessions shall be limited to five staff members at one time. Provide phones for staff members use during the training sessions.

1. The training sessions shall include the following:

a. All page, zone page and classroom page through public address from any phone on the system.

b. Detailed description of all digital phone features.

c. Detailed description on the handling of "911" calls at the attendant or "911" calls that have been routed from the attendant to another administrative phone. The procedure should include first calling into the classroom or office in over the speaker and then determining what action should be taken at that point.

2. Provide laminated short form instructions detailing all functions and emergency procedures for all administrative staff members.

B. Provide one, one-hour training session for each teacher. Training sessions shall be limited to 15 teachers at a time.

1. The training sessions shall include the following:

a. System description and functions.

b. Detailed description of emergency call procedures both with "911" and using the emergency call button on the phone. The training session shall be done in conjunction with the school superintendent or safety coordinator. The Contractor shall meet with the school to determine the exact policy and format of the training a minimum of two weeks prior to the scheduled date.

C. Provide 16 hours of trainers time within 30 days after completion to clarify any operating problems experienced by the users.

D. Provide two (2) eight-hour training sessions for four (4) maintenance personnel teaching emergency repairs to the system such as replacement of defective standard components such as loud speakers, lamps, etc. and basic programming required for system operation. Session shall be given by factory authorized representative of the Equipment Manufacturer.

3.5 INSTRUCTION MANUALS

A. The Contractor shall provide, in addition to three (3) approved copies of the telecommunications system submittals, three copies of complete written operating instructions, pertinent system orientation documents, system service and parts list and testing documentation and programming manual.

B. The Contractor shall provide four (4)complete sets of service manuals and wiring diagrams of the entire system, including manufacturer's parts and number, schematics, complete with operating information, including equipment characteristics, operating voltages, etc.

3.6 WARRANTY

A. Provide a 12 month warranty for all parts and labor from the date the system is accepted.

B. Provide written documentation from the Manufacturer that system parts will be available for a minimum of ten (10) years.

C. Make available an extended warranty that guarantees labor coverage for repairs in years 4-10.

D. If the supplier is not the manufacturer of the proposed system(s), the Supplier must provide:

1. Documented proof that the Supplier is an "AUTHORIZED" distributor of the proposed system(s) in good standing.

2. Written certification that the Supplier currently employs factory-trained and certified engineers/technicians who will install the cut over the proposed system(s) in accordance with the manufacturer's specifications.

3. Written certification that the Supplier will continue to employ factory-trained and certified engineers/technicians who will provide on-going service for the proposed system(s) and maintain the proposed system(s) according to the manufacturer's recommended level of performance.

4. Written certification that the Supplier will locally maintain a sufficient level of inventory of new, original equipment or equipment manufacturer recertified spare parts and components that will enable the Supplier to provide on-going service for the proposed system(s) according to the manufacturer's recommended level of performance.

3.7 MAINTENANCE

A. Supplier shall provide a detailed description of its service dispatch process, remote maintenance facilities and customer-site technician reporting procedures or protocol. This description must include:

1. A copy of suppliers service work order.

2. A description of supplier's computerized service dispatch and management system.

3. A list of names of all local technicians employed by the supplier, their factory certification level on the proposed system, and the number of years they have been installing/devicing the type of system being proposed.

4. A description of the technical support hierarchy that exists throughout the supplier's organization and that of the manufacturer of the proposed system with an indication of how this hierarchy provides technical support to field technicians as well as the name of the department within the manufacturer's organization which provides technical support of the supplier, field technicians and the method by which that support can be obtained.

5. For the system being proposed, the supplier shall identify the location and availability of necessary system spar parts and qualified technicians. The supplier should also indicate any other levels of support that can be provided for system service and maintenance.

6. The Supplier must be able to perform Move, Add and Change (MAC) software changes remotely whenever possible in order to minimize cost of such changes to the buyer.

7. The supplier shall describe and maintenance contracts or service agreements that are available.

END OF SECTION 273200

SECTION 27 53 13 - SYNCHRONOUS CLOCK AND PROGRAM SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related Work as required in Contract Documents.

1.2 SUBMITTALS

A. Complete equipment list including quantities.

B. Catalog descriptive literature for all equipment.

C. Riser Wiring Diagram showing all devices, wire quantities and sizes.

D. Typical terminal Wiring diagram for each type of device.

E. Terminal Wiring diagram for the master clock and program panel.

F. Provide wiring diagram showing connection to paging and intercom system.

1.3 RELATED SECTIONS

A. Basic Electric Requirements.

B. Basic Materials and Methods.

C. Paging and Intercom System.

1.4 SYSTEM DESCRIPTION

A. General:

I. The clock and program system is an integrated, microprocessor-based system for originating and distributing time and time correction signals. It displays the time at remote locations and provides programmed, audible signals and operation of remote switching. The system transmits times and program signals to indicate clocks and audible signal equipment over paging and intercom system wiring. The system shall be capable of 48-hour backup in the event of a power outage.

B. Provide all components and installation required for system features and functions that include, but are not limited to, the following:

1. Precision time reference independent of line frequency. Battery backup of timekeeping.

2. Operates and automatically corrects all secondary synchronous clocks.

3. Automatic daylight savings time correction.

4. Function and Performance of Program Control System: Provide all components d installation required for system features and functions that include, but are not limited, to the following:

   a. Continuously run a minimum of three independent schedules of events· simultaneously. Minimum of 125 events per schedule. Schedules shall correspond to the three grade levels K-4, 5-8 and 9-12.

   b. All event schedules can be programmed to run continuously, controlling any output circuit.

   c. Minimum of four output circuits for automatic remote function switching.

   d. All output circuits have automatic daylight savings time correction and automatic shift to a separately programmable holiday schedule.

   e. Events scheduled using keypad and LED or liquid crystal display. System shall be user programmable and user friendly.

   f. Nonvolatile memory for event schedules.

   g. Circuit duration for events adjustable from one of twenty-nine seconds minimum.

   h. Manual controls for all output circuits on integral control panel.

   i. The clock and program system shall interface with paging and intercom system to provide a program tone over the paging and intercom system speakers.

   j. The clock system head end equipment shall mount in surface mounted enclosure.

5. Remote programming of system via LAN.

PART 2- PRODUCTS

2.1 MASTER CLOCK AND PROGRAM CONTROLLER

A. The master clock and program controller shall be micro-processor based and of solid state, modular design. Each individual function shall be provided by solid state plug-in panels or modules.

B. Each program circuit shall be programmed for time of day, day of week and holiday routines. Programs shall be user changeable.

C. The programmer display shall consist of a minimum eight digital display to indicate day of week, hours, minutes and seconds. Programmer keyboard shall consist often numerical pushbuttons (0-9) and function pushbuttons as required to program the specified master clock and program controller.

D. From The Programmer/Display, The System User Shall As Minimum Be Able To Program The Functions Listed Below:

1. Set the date, day and time.
2. Clear previous programs.
3. Enable new time programs.
4. Enable or disable discrete outputs on command.
5. Program 10 discrete outputs based on day (including holiday), and time.

E. Provide a program channel selector switch with a minimum of four selectable positions, to allow up to four separate programs per circuit. Each program selector channel shall be user-programmable for such functions as half-day, regular day and Auditorium schedules.

F. In the event of 120 VAC power loss, the master clock and controller shall not lose memory and retain all programming. When 120 VAC power is restored, all system clocks and program circuits shall be automatically updated to the current day and time: Provide minimum 48 hours of battery reserve.

G. Provide correction each 4th hour and upon restoration of power.

H. Provide a temperature compensated crystal oscillator for 60 Hz reference to the controller. The controller shall be accurate within two seconds per month.

I. Provide a key operated lockout to prevent unauthorized programming of the controller.

J. The master clock and program controller shall operate on 120 VAC 60 Hz power. Operating temperature range shall be 32°F to 122°F. Operating humidity range shall be 0% to 95% RH noncondensing.

K. Enclosure shall be code gauge steel with baked-on enamel finish. Panel face shall be smooth with no projections. All components shall be located behind a lockable outer door made of plexiglass and metal. Enclosure shall be surface mounted.

L. Synchronized time received from roof-mounted GPS antenna. Correction of clocks via transmission from signal from transmitters.

M. Hilton Central School district: Existing Make Quest Elementary: Primex wireless system.

2.2 WIRING

A. Provide 120 volt branch circuits and clock outlets for all secondary clocks.

2.3 SECONDARY CLOCKS

A. Provide a direct wire synchronous motor driven clock. Provide correction each 4th hour, and upon restoration of power. Clock shall operate from a 120 volt power outlet

B. All clock components shall be heavy-duty and completely sealed.

C. Provide shatter proof lens.

D. Provide hour, minute bands. Hand color shall be black. Dial shall be 12 in. round for classrooms and 16 in. round for gymnasium, Pool and cafeteria and auditorium.

E. Provide wire clock guard for Gymnasiums, Pools and where noted on the drawings.

F. Design Make: Primex/Simplex

2.4 BACK BOXES

A. General: Provide recessed back boxes for all clocks and signal devices. Equip with knockouts and hanger straps. Provide box cover plate and grounded receptacle to suit mounting and connection of devices. Reuse existing backboxes where possible.

2.5 SIGNAL DEVICES

A. Class tone changes shall be broadcast over the paging and intercom speakers called for in Section 273200 and 27 3210.

2.6 ADDITIONAL WORK TO BE INCLUDED

A. Provide ten (10) spare secondary clocks.

B. Provide all power branch circuits and installation work required.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All installations shall be accomplished in a professional manner by qualified personnel regularly engaged in and experienced in this type of work.

B. Install all equipment in accordance with manufacturer's recommendations.

C. All 120 volt wiring shall be copper and installed in steel conduit in a separate and segregated systems. Refer to Section 26 OS01 for raceway systems requirements.

D. Clock system conduit may be reused where possible.

E. Provide on 20 ampere, 120 volt power circuit to the master clock and program controller; provide 20A- IP circuit breaker at panelboard and identify on panel directory.

F. All surface mounted devices shall be mounted on a special box furnished by clock equipment manufacturer. Total assembly shall be secure, smooth contour and have no protrusions:

G. Locate GPS receiver for 24/7/365 operation in all weather conditions.

3.2 TESTING AND INSTRUCTION

A. The complete clock system shall be fully tested and guaranteed for a period of one year after Owner's Representative written acceptance. (This guarantee shall also include any defects in wiring that may have been reused).

B. Provide four (4) - 4 hour sessions of instruction to the operating perso el designated by the Owner with regard to use and operation of the system during.the duration of the warranty period.

C. Provide five (5) sets of keys to all panels.

D. Prior to request for final payment submit bound Operator manuals that shall include as a minimum:

1. Bill of Material.

2. Manufacturer's equipment description for each type of device and control module type used.

3. Record drawings for wiring diagrams showing typical connection diagrams for each type of device and a complete riser diagram showing all devices, and wiring requirements. Record drawings for wiring diagrams shall show all terminal connections at the Master Clock and Program Controller.

4. Instruction report stating when instruction was given and who was in attendance, signed by Owner's representative.

5. A written test report of the approved equipment from the manufacturer certifying that each device and overall system operation bas been 100% tested and approved.

6. Ten-year FCC licenses.

7. Site Survey documentation.

8. Five-year warranty Statement in accordance with the General Provisions Section of these Specifications.

END OF SECTION 27 53 13

SECTION 283102 - POINT ADDRESSABLE FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide labor, materials, equipment and services to perform operations required for the complete installation of a fully operational network based analog addressable fire alarm system and related Work as described in the Contract Documents.

B. Provide system as approved by local Fire Marshal and the Authority Having Jurisdiction (AHJ). System materials and installation shall be in accordance with the manufacturer's recommendations.

1.2 QUALITY ASSURANCE

A. All methods of construction, details of workmanship that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated in their respective sections of the specifications. The equipment specified is based upon the acceptable manufacturers listed. Equipment types, device ratings, dimensions, etc. correspond to the nomenclature dictated by those manufacturers. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.

B. Installation shall be in accordance with NFPA-70 (National Electrical Code), NFPA-72 (National Fire Alarm Code), AHJ, state codes, local codes, requirements of authority having jurisdiction and the contract documents. Installer shall be certified in the State of New York for fire alarm installation.

C. Equipment shall be designed, manufactured, assembled, and tested in accordance with the latest revisions of applicable published UL, NFPA, ANSI, NEMA and IEEE Standards. All system equipment shall be compatible and of the same manufacturer.

D. Each item of the fire alarm system shall be listed as a product of a single fire alarm system manufacturer and shall bear the UL Label.

E. System installation shall be under the supervision of an accredited factory representative. Final connections to the FACP, annunciator panel and any other panels shall be by the factory representative.

F. The system provider must:

1. Provide equipment from a single manufacturer for which they maintain a contract, distributorship, are an agent, or other formal arrangement for which documentation can be produced showing authority to sell and service the equipment in this territory.

2. Demonstrate that they have successfully installed these systems, utilizing their standard products, for a period of five (5) years minimum.

3. Maintain a service organization to provide both normal and emergency service. Emergency service must be available 24 hours per day, 365 days per year and staff must be adequate to respond within 2 hours of an emergency call.

4. Have a service location not more than 50 miles from the project location.

5. Maintain adequate spare parts inventory to provide both normal and emergency service.

6. Employ service technicians who are trained in accordance with the systems manufacturer's recommendations.

7. Own and demonstrate proficiency in the use of the required test equipment, tools, etc. for the proper installation, set-up, testing and maintenance of the system. If requested, provide a listing of tools and/or equipment and where appropriate, certifications in the proper training and use of the tools and/or equipment.

8. Provide all system programming to deliver a customized system to the Owner ready for use.

9. All system programming is to be completed to the satisfaction of the Owner. If after preliminary use of the system, and/or training, the increased understanding of the system's features and capabilities necessitates reprogramming to any extent, it is to be performed at no additional cost.

10. Provide a minimum of two system inspections/tests each year during the warranty period as described in NFPA 72. Needed and requested system programming changes shall be provided at these times.

11. Warranty period shall be as described elsewhere with two years being minimum. Provide a service contract for the Owner review for two years beyond the warranty period. Warranty shall include all parts, materials, labor, transportation, etc.

1.3 SYSTEM DESCRIPTION

A. The system shall constantly monitor all initiation devices and notification circuits for any abnormalities or alarm conditions. System shall sample/poll each addressable device no less than every 10 seconds.

B. The system operation subsequent to the alarm activation by any initiating device (manual station, automatic detector, sensor, sprinkler flow switch, etc.) shall be as follows:

1. All audible alarm notification appliances within corresponding building or designated area shall provide a common audible fire alarm signal until the System Reset Key or the Signal Silence Key is depressed.

2. All visual alarm notification appliances shall flash continuously and synchronized until the system is reset or silenced.

3. The municipal box shall be activated notifying the fire department.

4. Shutdown of the corresponding HVAC system equipment shall occur with a supervisory alarm until the system is reset. All fans over or 1,000cfm shall be shut down.

5. Activation of all programmed outputs assigned to the initiating device shall occur until the system is reset or the silence key is depressed.

6. The alarm shall be displayed at the local Fire Alarm Control Panel (FACP) and the fire alarm annunciator panel.

7. The system alarm LED shall flash on the control panel and the fire alarm annunciator panel until the alarm has been acknowledged/reset. Once acknowledged, this same LED shall latch on. A subsequent alarm received shall flash the system alarm LED on the control panel and annunciator. The LCD display shall show the new alarm information.

8. A pulsing audible alarm tone shall occur within the local building control panel and, where applicable, the fire alarm annunciator panel until the event has been acknowledged.

9. Alarms shall be entered into the system event log history.

10. Refer to Appendix A for operational/sequence matrix.

C. Any subsequent alarm shall follow the operation described above.

D. The activation by any system smoke detector or sensor shall initiate an alarm verification operation whereby the panel will reset the activated detector and wait for a second alarm activation. If, within a preset time after resetting, a second alarm is reported from the same or any other smoke detector, the system shall process the alarm as described previously. If no second alarm occurs within the prescribed time, the system shall resume normal operation. The alarm verification shall operate only on smoke detector alarms. Other activated initiating devices shall be processed immediately. The alarm verification operation shall be selectable by device.

E. A manual evacuation (drill) switch shall be provided to operate the alarm notification appliances without causing other control circuits to be activated. However, should an actual alarm occur, all alarm functions shall occur as described previously.

F. The system shall have a password(s) to allow the operator to display all alarms, troubles, and supervisory service conditions log history including the time of each occurrence. This shall be able to be viewed from the front of the control panel, annunciator panel or from a computer connected to the FACP.

G. The actuation of the " walk test" program at the control panel shall activate the "Walk Test" mode of the system which shall cause the following to occur:

1. The remote central monitoring station connection shall be bypassed.

2. Only audible and visual appliances shall be operated. Other alarm functions (elevator recall, HVAC shutdown, etc.) shall not be affected.

3. Walk test shall be selectable by circuit or circuits.

4. Actual alarms received during a "Walk Test" shall cause the control panel to go into alarm and override the walk test mode.

5. The control panel shall show trouble conditions.

6. The walk test activation of any initiation device shall cause the audible signals to activate for two seconds or a distinguishable audible.

7. The panel shall automatically reset itself after signaling is complete.

8. The control panel shall automatically return to normal condition if there is no activity on a walk test circuit for a period of 30 minutes.

H. Any momentary opening of an initiating or notification appliance circuit wiring shall cause an audible signal to sound at the Fire Alarm Control Panel and, where applicable, the annunciator panel for four seconds indicating a trouble condition.

I. Elevator Operation:

1. Provide the following equipment as a minimum and as indicated on the drawings:

a. Smoke detection in the elevator equipment room.

b. Smoke detection at each elevator lobby.

c. Smoke detection in the elevator shaft if a smoke hatch.

d. Heat detection in the equipment room and shaft (high and low) if a sprinkler system is in the area. Detectors shall be within 2 ft. of the individual sprinkler heads.

e. Detection devices located in elevator lobbies, elevator hoistways and elevator machine rooms shall be used for elevator recall. Hoistway and equipment room heat detection shall initiate power shut down prior to water flow. Operation shall be in accordance with ASME A17.1, Safety Code for Elevators and Escalators. Signals shall be provided to the elevator controls for main level lobby alarm, any lobby alarm, elevator equipment room alarm and elevator hoistway alarm as a minimum. Provide addressable control modules for the signals to the elevator controls.

J. Alarm initiation of a detector associated with a smoke hatch or fire barrier shall initiate a system alarm. Also, provide connections between the auxiliary contacts on the detectors or addressable control module and the associated smoke hatches and fire barriers such that the smoke hatch or fire barriers will be operated upon its respective detector activation. Provide power supplies, wiring and accessories for fire alarm system and all supervisory functions required for proper smoke hatch and fire barriers operation.

K. Duct mounted smoke detectors associated with duct dampers shall have an addressable control module to operate the duct damper. In the event of an alarm initiation by the duct mounted smoke detector or the associated air handling unit/fan shut down the duct damper shall be closed. Control wiring shall be provided to shut the damper(s) when the associated air handling unit is not operational. Provide power supplies, wiring and accessories as needed for this operation.

L. Provide wiring and equipment such that alarm initiation of a heat detector located in the elevator machine room and/or the elevator shaft shall provide suitable voltage from the fire alarm control panel to be applied to the shunt trip coil of the elevator's supply circuit breaker. No fire alarm devices except the heat detectors in the elevator machine rooms and shaft shall cause this. Also, alarm initiation of these heat detectors shall initiate the system alarm functions described above. Provide an addressable control module with a Form C contact at the elevator controllers, which shall be normally closed and shall open upon alarm initiation of any of these heat detectors; this contact shall be used to disconnect the battery-powered emergency return unit if so equipped with the use of a relay suitable for the emergency power circuit. Also, provide an auxiliary contact on the main line disconnect switch (four pole unit) and two (2) #12 in conduit to the elevator controller from this contact for the same purpose.

M. Provide a minimum of two Form C contacts at the building's fire alarm control panel. This contact shall activate upon activation of any fire alarm initiating device.

N. Supplementary Remote Annunciation Network: System shall be compatible and report all status via Owner's LAN to existing master offsite networked fire alarm system. Signal shall be supplementary and not be in lieu of code required monitoring services.

1.4 SUPERVISION

A. The system shall utilize independently supervised initiation device circuits. The alarm activation of any initiation device shall not prevent the subsequent alarm operation of any other initiation device.

B. Notification appliance circuits shall be supervised to indicate an open or short circuit condition.

C. The incoming power to the system shall be supervised so that any power failure must be audible and visually indicated at the control panel and the remote annunciator. A green "power on" LED shall be displayed continuously while incoming power is present. This shall be a trouble alarm.

D. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visually indicated at the control panel and the remote annunciator. This shall be a trouble alarm.

E. The system shall have provisions for disabling and enabling all circuits individually for maintenance or testing purposes.

1.5 SUBMITTALS

A. Provide a complete system submittal prior to ordering of equipment and installation including but not limited to:

1. Complete equipment list.

2. Catalog descriptive literature for all equipment. This shall include a description of the unit, ratings, functions, capability, materials and compatibility with other components.

3. Riser Wiring Diagram showing all equipment, devices, device addresses, connections, control connections, remote notification connection(s), wire quantities and sizes.

4. Floor plan indicating equipment and device locations, addresses, power circuit information with power panel location, notification circuiting, initiation circuiting, control circuiting and any system applicable building characteristics (ceiling heights, structural members impeding detection, etc.). Contact the Engineer for an electronic copy of the project floor plans. Engineer logo shall be included in final drawing.

5. Typical Terminal Wiring Diagram for each type of device.

6. Terminal wiring Diagram for all Fire Alarm equipment.

7. Calculations including:

   a. Battery sizing calculations indicating total number of power devices, load associated with each type device, backup period and recommended battery capacity (AH).

   b. Voltage drop calculations with actual equipment loads used to derive battery back-up ampere-hour rating and individual circuit voltage drop (indicate the wire size to be used and the associated voltage drop with the allowed voltage drop) for each circuit.

8. Complete console enclosure and equipment configuration.

B. If required by the Authority Having Jurisdiction (AHJ) provide a submission of all requested information for review and comment by the AHJ. All AHJ comments shall be incorporated and resubmitted until approved.

C. Test reports at the completion of the project. Testing shall be of all system devices, equipment, circuits, features and functions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The project fire alarm system shall comply with and be in accordance with the drawings and specifications. All system equipment and materials shall be of the same

manufacturer unless otherwise indicated. System and component acceptable manufacturers include the following unless otherwise indicated:

1. Game Well FCI (Fire Control Instruments) HILTON CSD BOARD RESOLUTION

    a. Hilton CSD: Quest: Replace fire alarm system in it's entirety.

2.2 FIRE ALARM SYSTEM

A. The fire alarm system shall be comprised of the components specified as a minimum and also include components not indicated but required for a complete and operable system as described herein.

B. The system and all its components shall be UL listed and in accordance with NFPA 72, local and state codes.

C. The system shall have 25% spare capacity. This shall include all individual notification circuits, initiation circuits, initiating modules, alarm modules, power supplies, batteries, central processing unit memory and printed circuit card space. System initiation device and control device capacity shall be a minimum of the indicated percentage over the shown quantity or 250 whichever is greater.

D. Each initiating device shall have an individual address for system communication. The system addresses shall not exceed seven digits. Each address, initiation circuit, notification circuit and control point shall have an individual identification description.

E. System shall shut down all air handlers more than 1,000 cfm upon an alarm.

2.3 FIRE ALARM CONTROL PANEL (FACP)

A. The system shall be entirely solid state, microprocessor based, use digital transmission and shall be field programmable. All system programming including field modifications shall be stored in non-volatile memory. Field modifications shall be automatically stored without special actions. The panel shall be designed and manufactured expressly for the intent to detect the presence of fire and to provide indication of such detection. Panel shall contain as a minimum power supply(s), control module, main control printed circuit board, initiation modules, notification modules, terminals and back up battery(s). Control module shall have 80 character backlit LCD display and twelve control buttons (four being field assignable), minimum. Display shall indicate the battery voltage at all times.

B. The system shall be modular in design to allow for future expansion with a minimum of hardware additions.

C. The FACP shall be located where shown on the drawings. Enclosures shall accept all system items for an aesthetically suitable operator's console. Enclosures shall be of modular size to allow surface mounting of multiple boxes adjacent to each other, shall have hinged solid metal doors and contain a lock with a key common to all system devices. Enclosure shall have a red finish.

D. The FACP shall operate its integral LCD Display through an RS-232C port operating up to 9600 baud to indicate all operator transactions, alarms, trouble reports and any other conditions specified by system programming.

E. Conditions of the system shall be indicated at the operator interface by LED's. These conditions shall be alarm, supervisory, trouble and alarm silenced. An LCD 2 line, 40 character per line display shall also be included. It shall display "SYSTEM IS NORMAL" with the date and time under normal circumstances. The LCD display shall also indicate type of alarm, point status, number of alarms and location. Through the use of function keys, historical data can also be displayed.

F. The FACP shall include a password (three (3) levels of protection with individual passwords, minimum) protected key pad for access to programming, special functions and all system features.

G. Any event initiated by the FACP due to an alarm input shall be retained in nonvolatile EPROM memory. The FACP shall also have sufficient memory for 1200 individual alarm/trouble events.

H. The FACP shall have the following user connection types:

1. Ethernet connection for a computer, personal data device or printer. Connection shall allow for programming changes, history download, setting review/changes, etc.

2. RS 232 port for connection of a serial printer.

I. Provide modules for network interfacing and off site monitoring.

J. The FACP shall be equipped with a minimum of 24 hours of battery standby. The FACP shall be equipped with battery charging circuits sufficient to recharge fully depleted batteries to within 70% of the maximum capacity within 12 hours. When the system is operating on the battery supply, a trouble condition shall be generated. When utility power is restored, the system shall revert back to 120 VAC supply without any operator intervention.

K. Design Equipment: Game Well FCI

2.4 EMERGENCY VOICE COMMUNICATION SYSTEM

A. Provide a complete emergency voice communications system with audio evacuation system.

B. The Emergency Communications Control Panel (ECCP) shall be alerted to incoming calls from any remote emergency telephone station by individual line flashing lamps for each station and a common audible signal. When the attendant picks up the master handset located in the ECCP, the audible signal shall be silenced, but each line lamp shall continue to flash until the call is answered by placing individual switches in the talk position. The line lamp for the answered call shall remain constantly illuminated until the attendant terminates the call. The attendant shall be able to communicate privately with an individual station or simultaneously with several stations as required by placing the individual line switches in the talk position.

C. All wiring of the Emergency Voice Communication System shall be supervised. Open or short circuits shall report to the ECCP as trouble condition.

D. In the event of normal power failure, the entire communications system shall automatically transfer to standby power source. Provide separate and dedicated power circuit(s) for the ECCP.

E. Design Equipment: Game Well FCI

2.5 AUDIO EVACUATION SYSTEM

A. Notification speakers shall be located as shown on the drawings and shall be electrically supervised, and zoned as shown on the drawings. Minimum zoning shall be by floor. Provide zone selector switches, individual zone lamps, trouble lamp and test switch at the Emergency Communications Control Panel (ECCP). All-call capability shall be provided by operation of a single switch. Master microphone shall be located in the ECCP and shall have integral "press-talk" announcement. Signals shall automatically sound again upon lifting of "press-to-talk" switch at the end of the announcement.

B. Provide an audible amplifier unit and locate within the ECCP. All components shall be solid state. Preamplifier shall contain microphone input and necessary tone and volume controls. Power amplifier shall be rated 100 watts minimum for suitable power rating for the indicated system, locations and ambient sound level while having the system spare capacity factor indicated and have a frequency response of 125-12,000 Hz. System shall provide intelligible voice communication throughout the project.

C. Speakers shall be surface mounted, 4 in. size, 8 ohms impedance, 11 watts rating. Provide integral matching transformer for 70 volt line and with 0.25, 0.5, 0.75, 1.0 and 2 watt taps. Speakers shall have a steel housing, water-sealed compression driver, and baked epoxy finish. Color shall be red. Provide bi-directional or weatherproof mounting where shown on drawings.

D. In the event of 120 VAC power failure, the entire audio evacuation system shall automatically transfer to the system standby power source.

E. Design Equipment: Game Well FCI

2.6 VENTILATION FAN SHUTDOWN CONTROL

A. Provide supervised normally closed relays and contactors for connection into the fan motor control circuits ahead of all automatic devices.

B. Sequence fan shutdown for every air distribution system over 1000 cfm. Provide duct detectors in return of systems over 2,000 cfm and in both supply and return at each floor of systems over 15,000 cfm.

C. Provide drill bypass feature, locate switch on Fire Alarm Control Panel and label "DRILL-FAN SHUTDOWN BYPASS". Buzzer shall sound continuously while in bypass mode.

D. Provide fan reset feature, locate switch on Fire Alarm Control Panel and label "FAN RESET".

2.7 INITIATION DEVICES

A. General:

1. Provide analog addressable smoke and thermal sensors as shown. All detectors, control modules, monitor modules and all other initiation devices shall communicate with twisted pair cable and have an individual address. Peripheral devices shall be of the some manufacturer as the FACP.

2. Spot type detectors shall utilize the same interchangeable bases.

3. If a device is removed or taken out of service a trouble signal shall be initiated.

B. Photo-Obscuration Type Smoke Detector:

1. The photo-obscuration detector shall operate on the photo electronic principle and provide an analog signal to the system indicating the amount of smoke. Detector shall be an analog addressable type.

2. The detector shall incorporate a built in type identification so the system can identify the type of detector. The sensor shall be continually monitored to measure any change in their sensitivity because of the environment (dirt, smoke, temperature, humidity, etc.). Unit shall not be affected by exterior light or EMF.

3. The detector shall be designed and arranged to prevent interference from exterior electromagnetic fields and light.

4. The detector shall provide advance indication of the analog value of the products of combustion to the FACP indicating that maintenance is required in order to insure normal operation. The detector sensitivity shall be adjustable per device (within UL limits) and be set at the FACP for continuous or variable based on time of day. There shall be a minimum of six (6) selectable sensitivity levels. The individual detector sensitivity setting shall be adjusted to meet the building/space characteristics and operation.

5. Detectors shall be designed for twistlock mounting to a separate base assembly. Provide manufacturer's recommended back box suitable for surface mounting where required.

6. The detector base shall have terminals for making all connections; no soldering shall be required. It shall be possible to secure the detector to the base with a concealed socket headscrew to prevent unauthorized tampering.

7. Smoke detectors shall be UL 268 listed and FM approved.

8. All smoke detectors shall be field checked and set to meet the prevailing conditions of the premise and any Owner requests. All such work shall be performed by an authorized representative of the manufacturer trained in such procedures.

9. Photo-obscuration type smoke detection shall be used for smoke detection unless indicated otherwise indicated.

C. Projected Beam Photo Electric Smoke Detectors:

1. Microprocessor based beam type smoke detector consisting of a separate transmitter and receiver units. Units shall have individual system addresses and provide an analog signal based on the beam obscuration. Unit shall have a sensing range suitable for the intended location with capability up to 60 ft. x 320 ft. of detection area. Where an analog signal is not available provide an addressable initiation module for system interface.

2. Transmitter shall produce a crystal controlled infrared beam.

3. Shall have an adjustable time delay (up to 30 seconds) for momentary beam blockage. Alarm sensitivity shall be adjustable from 20 to 60%.

4. Shall initiate trouble alarm when dust obscures beam by 50%. Unit shall compensate for a gradual buildup of dust.

5. Installation with convenient beam alignment adjustments.

6. Provide with manufacturer surface mounting backbox for surface mounted locations.

7. Housing color to match the surrounding colors.

8. Operating voltage 18-32 VDC. Provide a 24 VDC power circuit from the FACP. Connect unit to the system addressable circuit.

9. Provide with remote indicator and testing station for each unit. Station shall indicate system condition (alarm, normal, trouble), have the ability to remotely test the system and have time delay/sensitivity adjustments. Mount station in local utility space and label for the specific unit.

10. Acceptable Manufacturer:

    a. System manufacturer.

    b. Another manufacturer listed with the system and meeting these specifications.

D. Heat Detector:

1. The heat detector shall be a thermal sensor and shall constantly monitor the space temperature and constantly report this to the system. The unit shall be analog addressable.

2. The sensor shall use dual solid state thermistors and shall monitor the ambient temperature from 32 degrees F, to 155 degrees F and provide a fast response to rapid increase in temperature. The sensor shall send data to the FACP representing the analog value of the ambient temperature. The FACP shall be suitable to monitor for set temperature (selectable by detector for 135 or 155 degrees F) and rate of rise (selectable by detector for 15 or 20 degrees F per minute). Individual detector thermal settings shall be adjusted for the building/space characteristics and operation but shall initially be set to 135 degrees F set temperature and 15 degrees F per minute rate of rise.

3. Detectors shall be designed for twistlock mounting to a separate base assembly. Provide back box suitable for surface mounting where required.

4. The detector base shall have terminals for making all connections; no soldering shall be required. It shall be possible to secure the detector in the base with a concealed socket headscrew to prevent unauthorized tampering.

5. Smoke detectors shall be UL 268 listed and FM approved.

6. All thermal sensors shall be field checked and set to meet the prevailing conditions of the premise. All such work shall be performed by an authorized representative of the manufacturer trained in such procedures.

E. Combination Smoke And Heat Detector:

1. Single detector shall have both heat and smoke sensing capability as described in the photoelectric smoke detector and heat detector paragraphs above. Unit shall provide two individual analog sensing levels to the FACP including one for smoke and one for heat.

2. Detector shall utilize the same base unit as the smoke and heat detectors.

F. Addressable Initiation Module/Monitor Module:

1. The addressable initiation module shall be used to connect supervised conventional initiating device or zone of supervised conventional initiating devices (water flow switches, tamper switches, manual pull stations, (4) wire smoke detectors, conventional (4) wire duct detectors, fire pump alarms, dry chemical fire extinguisher control panels, etc.) to one of the system's addressable circuits.

2. The module shall provide address setting means using rotary decimal switches and also store an internal identifying code which the control panel shall use to identify the type of device.

3. The module shall contain an integral LED that flashes each time the unit is polled.

G. Manual Pull Stations:

1. Non-coded pull-down type, double action (push then pull down) manual addressable units with front keyed test/reset. Units shall be semi-flush where installed in construction with hollow or block walls. Where construction does not allow semi-flush mounting then unit shall be surface mounted utilizing the manufacturers back box. Each unit shall have a distinct address. Units shall be key reset.

2. Units installed outdoors or in potentially wet locations shall be rated for such conditions.

3. Bright red finish with white lettering "FIRE ALARM".

4. Provide tamperproof clear lexan protective shield with horn and batteries to produce 85 Db minimum sound pressure level at 10 ft. when shield is raised. Shield shall have activation/deactivation switch with lockout screw, and 400 lb. breaking strength retaining cable.

H. Duct-Type Smoke Detector:

1. Detector shall be a photoelectric type that shall be activated by the presence of combustion products.

2. The detector head shall be a plug-in unit. The unit shall contain no moving parts. One chamber shall be for fire detection and the second chamber shall function as a reference, to stabilize the detector for changes in environmental temperature, humidity and pressure. It shall be possible to electrically check detectors sensitivity, using a sensitivity test set, or equivalent, and readjust the detectors sensitivity as required.

3. The detector base shall have terminals for making all connections; no soldering shall be required. It shall be possible to secure the detector in the base with a concealed socket-head screw to prevent unauthorized tampering.

4. Smoke detectors shall be listed by Underwriter's Laboratories, Inc. and approved by Factory Mutual Insurance Company.

5. Provide complete with sampling tubes. Size sampling tubes for 80% of the width of the duct. Locate in ductwork for the indicated system and in accordance with the manufacturer's recommendations.

6. Provide auxiliary contacts and separate 24 VDC power to relay required for smoke damper operation.

7. Provide a remote indicating light/key test switch for each duct detector and mount in a local utility room with a sign indicating the system and location of the duct detector (i.e. AHU-2, Second Floor East End).

8. Provide addressable base.

I. Carbon Monoxide (CO) Detector:

1. Detector shall sense the level of CO concentration within a space and provide analog addressable signal to the system and be UL 2075 listed. Unit shall have a minimum life span of 10 years without replacement/recalibration.

2. Provide with audible notification base unit for local unique notification. Alarm and notification initiation shall be from the control panel.

3. Detector shall connect to the system addressable circuiting.

4. Alarm level shall be adjusted at the control panel. Upon an alarm the local notification shall sound and a trouble alarm initiated.

J. Single Station Carbon Monoxide (CO) Detector:

1. Detector shall sense the level of CO concentration within a space, provide local notification and be UL 2034 listed. Unit shall have a minimum life span of 10 years without replacement/recalibration.

2. Provide with audible notification base unit for local unique notification. Audible shall be 85dB minimum output at 10 ft.

3. Unit shall be sealed and operate with 10 year battery.

K. Single Station Combination Smoke/Carbon Monoxide Detector:

1. Detector shall be photoelectronic type and have carbon monoxide (CO) sensing. Upon activation, the detector shall sound its integral alarm horn in accordance with ANSI S34.1 and operate its associated alarm circuit and illuminate the built-in alarm light. Integral alarm horn shall be rated 85 dB at 10 ft. Built-in alarm light shall be 177 candela, 60 flashes/minute strobe. Provide LED power-on/alarm indicator.

2.8 NOTIFICATION APPLIANCES

A. Speakers:

1. Refer to audio evaluation article for additional requirements.

2. Basic grille type with powder coated red finish paint.

3. Speaker shall be rated 94 dBA (anechoic chamber) at 10 feet. Output shall be selectable steady tone or coded. Provide dampening devices to reduce unit output by 5dBA for a minimum of 40% of the system speaker units and install as needed to meet the Owner's needs.

4. Units shall be semi-flush where installed in construction with hollow or block walls. Where construction does not allow semi-flush mounting then unit shall be surface mounted utilizing the manufacturers back box.

5. Units installed outdoors or in potentially wet locations shall be rated for such conditions.

6. Provide directional projector where noted on the Drawings.

7. Provide backbox and grille for fully recessed installations; 4 in. deep box maximum.

8. Speaker for carbon monoxide alarm notification shall meet the requirements above but have a white finish color and have a temporal Code 4 alarm.

B. Strobe Unit:

1. 24 volts DC with built-in Xenon Flasher; two watts maximum. Pulse duration shall be 0.2 seconds with maximum duty cycle of 40%. Illumination intensity shall be field selectable for 15, 30, 75 or 110 candela. Output setting shall be 15 candela in corridors, 75 candela in general areas, 110 candela in sleeping areas or as indicated. Flash rate minimum 1 Hz, maximum 2 Hz. Units within building shall flash in synchronization.

2. Protruding pyramid shaped lexan lens with reflector and the word "FIRE" imprinted on the lens.

3. Rated life shall be a minimum of 500 hours of continuous operation.

4. Units installed outdoors or in potentially wet locations shall be rated for such conditions.

5. Units shall be semi-flush where installed in construction with hollow or block walls. Where construction does not allow semi-flush mounting then unit shall be surface mounted utilizing the manufacturers back box. Wall or ceiling mounted as noted on the Drawings.

6. Provide surface backbox for surface installation; 4 in. deep maximum.

7. Strobe for carbon monoxide alarm notification shall meet the requirements above but have a white finish color and have the word "ALARM" imprinted on the device.

C. Combination Speaker-Strobe Units:

1. Unit shall be a combination of the speaker and strobe units specified above in a single manufactured unit.

D. Addressable Notification Appliances:

1. Notification appliances specified herein shall be addressable and individually programmed for use as dictated by the Owner. Notification shall be programmed by floor, office space, common space, specialty use space and others as directed. Appliances shall only annunciate upon the directed conditions and order.

2.9 ADDRESSABLE CONTROL MODULE

A. The addressable control module shall have an individual system address, be supervised and control an output dry contact from indication from the FACP. This can be used to control or have an input to elevator controls, notification appliances, door holder circuits, fans systems, etc. as indicated. Modules shall be connected to the addressable loop(s).

B. The unit shall control an output relay (dry contact form C). The module shall mount in a 4 in. square, 2-1/8 in. deep electrical box.

C. The module shall contain an integral LED that shall flash each time the module is polled.

D. The module shall provide address setting means using rotary decimal switches and also store an internal identifying code which the control panel shall use to identify the type of device. Each unit shall have a separate address and be connected to the system addressable signaling circuit.

2.10 REMOTE ANNUNCIATOR

A. Wall mount within a surface box. Maximum depth of 4 in., stainless steel trim. Nominal dimensions of 4 in. x 12 in.

B. Annunciation shall be by two line by 40 character LCD display to provide system information and alarm/trouble description.

C. Unit power and control shall be from the FACP. Unit circuiting shall be supervised.

D. Provide trouble signal with audible buzzer, silencing switch and system reset. All pushbuttons shall be inoperable without keyswitch activated. Pushbuttons for alarm acknowledge, silence and alarm reset shall be standard on the front with a description. Shall include a minimum of four auxiliary switches/pushbuttons to be programmed as coordinated with the owner (possible options are door holder release override, manual alarm initiation, elevator capture bypass, etc.).

E. Tamper-resistant front panel screws.

F. Provide a 24 in. x 36 in. framed directory showing the building outline of each floor and referencing device descriptions. All lettering shall be minimum 1/2 in. high. Mount next to remote annunciator.

2.11 MAGNETIC DOOR HOLDERS

A. Rated 24VDC from a dedicated supervised power supply.

B. Holders shall be wall or floor mounted adjacent to the doors as dictated by the building conditions. Floor mounted units shall only be used where wall mounted are not possible.

C. Door holders shall be aluminum construction, have 25 pound holding force and shall have all necessary mounting hardware. Provide door plate for each and extender chain (chromed and 1 in. links) where needed.

2.12 MUNICIPAL TIE EQUIPMENT - RFD MASTER RADIO SYSTEM

A. Provide complete system consisting of sending equipment to interface with existing master box equipment.

B. Transmission shall be sent over existing 4-channel master radio network arranged by the Fire Department.

C. Associated equipment shall be contained within the Fire Alarm Central Processing Unit enclosure. Provide surge suppression to protect the two (2) systems.

D. Sending equipment shall transmit line trouble as well as fire alarm condition signal.

E. Provide all required work to complete communication tie to local Fire Department 911 Center, RFD Master, Radio Network System.

2.13 DIGITAL COMMUNICATOR

A. The digital fire communicator shall be installed in the FACP or mounted in a separate enclosure. The communicator shall be powered by 24 VDC from the FACP and shall report four (4) conditions - (2) alarm, (1) trouble and (1) supervisory. The unit shall have a built in auxiliary relay output which is programmable for alarm or trouble conditions, and shall be capable of sending a distinctive AC power failure report.

B. Install all wiring in accordance with manufacturer's recommendations. All wiring shall be completely tested as directed by the manufacturer, and a written test report submitted to them for approval. Their approval shall be obtained before connecting any devices. The system manufacturer, by their approval of the test report, shall assume all responsibility for all installed wiring.

C. The communicator shall have the following features: visual and audible trouble indications; supervised or unsupervised input channels, dual phone line interface with line seizure; local and remote programming and automatic 24-hour test.

D. The communicator shall be UL 864 listed and meet the requirements of NFPA 72 Chapter 4 for supervising station fire alarm systems.

2.14 NOTIFICATION APPLIANCE CIRCUIT EXTENDER (NAC)

A. Unit shall provide additional notification appliance circuit capability for new or existing system and be utilized for horns and strobe units.

B. Connections to the unit shall include power, notification appliance circuit output circuits and addressable control input or notification circuit input. The power circuit shall be from an emergency source if available in the building.

C. Notification appliance circuit capability shall be four Class B or Class A, 2A, 24VDC minimum. Selectable for synchronized or not.

D. Power supply shall be rated for 8A minimum at 24VDC for circuit power use and battery charging. Battery and charger shall be as specified within this section.

E. Unit shall provide output circuit/operation/battery/power/status monitoring and trouble signal to FACP as needed.

F. Operation: upon a signal through the addressable control input or the notification appliance circuit indicating a system alarm.

G. Use: Units can be utilized where indicated or where building is greater than 60,000square feet or over six stories in height. There shall be a minimum of one unit for each floor.

2.15 CENTRAL STATION MONITORING

A. Provide all work required to communicate system status to Fire Department.

2.16 BATTERY AND CHARGER

A. Standby power shall be provided through 24 volt DC battery and automatic charger.

B. Provide sealed lead-calcium batteries, ampere-hour capacity which will allow system to operate 24 hours under supervisory condition and at the end of this period to operate all alarm signals for fifteen 15 consecutive minutes.

C. Provide cell reversal protection.

D. Life expectancy shall be five (5) years minimum.

E. Charger shall be self-regulating, solid state, type, automatic with capability to fully charge the discharged battery within five (5) hours.

F. Locate charger within the FACP enclosure. Locate batteries in a separate vented enclosure directly adjacent to the FACP [or the FACP enclosure].

2.17 WIRE GUARDS

A. Where specified herein or shown on the drawings provided a suitable wire guard for protection of indicated devices/equipment. Units shall be custom as needed for the application.

B. Wire guard shall be a minimum #6 wire gage of zinc plated steel, overall clear coating and welded at joints. For any unit needing access it shall have an integral hinge and locking means.

C. As a minimum provide a wire guard for equipment where indicated and in gymnasiums.

D. Wires shall have 2 inch maximum spacing.

E. Acceptable Manufacturers:

1. Design Make: American Time and Signal.

2. Game Well FCI

3. Approved equal.

2.18 PULL STATION ALARM COVER

A. Provide a protective alarm cover over manual pull stations in public places. Unit shall allow easy access to the manual pull station and also provide an audible alarm when operated.

B. Unit shall provide a 95dB alarm at 1 foot and be powered from a 9VDC battery.

C. Unit shall be suitable for use in the intended location and pull station.

D. Acceptable manufacturer:

1. System manufacturer.

2. STI Stopper II.

PART 3 - EXECUTION

3.1 INSTALLATION, EQUIPMENT

A. All installations shall be accomplished in a professional manner by qualified personnel regularly engaged in and experienced in this type of Work. Fire alarm installation shall be directed by a person who possesses a state license for installation of fire alarm systems. All equipment and components shall be installed in accordance with the manufacturer's recommendations.

B. System junction boxes and surface mounted device boxes shall be painted red.

C. All notification circuits shall originate from the FACP. Signal expander units shall not be used.

D. Provide all wiring to sprinkler flow switches, pressure switches, and alarm check valves, installed by others. Maintain supervisory circuitry to the switches. Use liquidtight conduit for the last 2 ft. - 0 in. of raceway at the switch.

E. Provide all wiring to post indicator valves, OS&Y valves and dry pipe sprinkler system maintenance air pressure switches, provided by others. Wire into the supervisory alarm portion of the fire alarm system.

F. Provide all wiring to the smoke dampers installed by others. Provide an addressable control module for each. Wire to the damper junction box with flexible conduit and wire; provide box or boxes as required. Install according to NEC. Smoke dampers shall close when its associated smoke duct detector is in alarm, upon direction from the FACP or if the associated fan unit is not operating.

G. Provide all power supplies and wiring to smoke relief hatches and fire barriers provided by others. Smoke relief hatch or fire barrier shall operate only when its associated smoke detector is in alarm.

H. Provide all wiring to duct smoke detectors. Duct smoke detectors shall be mounted on the ventilating ductwork by others. All mounting arrangements, holes cut into ductwork, sealing of openings along with ceiling and access doors for the duct type detectors shall be provided by others. Provide duct detectors along with sampling tubes with end caps. Sequence smoke damper operation thirty seconds after its associated fan has been shut down.

I. Provide all wiring required for fan shutdown. Wire from the addressable control module for each fan to be shut down and provide wiring from the module to the fan control unit (starter, adjustable speed drive, etc.) Dry contact shall be wired ahead of all control functions for starters. Provide intermediate relay for control circuits beyond the rating of the control module.

J. Coordinate the municipal tie with the local Fire Department and comply with Fire Department requirements and regulations.

K. Install all door holders in accordance with installation detail on the drawings and coordinate with the General Construction trade. A maximum of fifty (50) door holders shall be wired to each power circuit.

L. Provide 120 volt AC supervisory relays in the Fire Alarm Control Panel enclosure for each magnetic door holder power circuit to insure their associated circuit breakers are in the "ON" position. In the event a circuit breaker is in the "OFF" position, its associated supervisory relay shall transmit a trouble signal.

M. Provide all elevator capture control wiring. Installation shall be in accordance with manufacturer's recommendations. Pay all costs to modify existing elevator controllers for elevator capture and alternate level capture.

N. Elevator machine room and shaft heat detectors shall be mounted within two feet of the sprinkler head where applicable.

O. Detection and initiating equipment shall be listed by NRTL and approved by FM.

P. All surface mounted devices shall be mounted on a special box furnished by fire alarm equipment manufacturer. Total assembly shall be secure, smooth contour and have no protrusions.

Q. Where detectors are installed on wood or masonry surfaces, attach brackets directly to the surface with tamperproof fasteners. Where detectors are installed on suspended ceilings, provide additional supports in the ceiling, such as channel support system, angle iron or additional runner bars. Fasten the additional supports rigidly to the ceiling runner bar system. Attach bracket to the supports with tamperproof fasteners. Install metal spacers between the bracket and supports so that the ceiling tiles will not be a part of the support system.

R. Install wall mounted audio/visual signal devices at 80 in. AFF to center line. Where ceiling types are called for, verify ceiling type and mounting height in the field. Provide pendant-mounted devices as required for specified mounting height.

S. An auxiliary fire alarm relay used to control an emergency control device that provides control functions described in this specification shall be located within 3 ft. of the emergency control device and all wiring shall be supervised.

T. All smoke detectors shall be field checked and set to meet the prevailing conditions of the premise. All such Work shall be performed by an authorized representative of the manufacturer trained in such procedures.

3.2 SYSTEM CIRCUITING

A. All wiring shall conform to the NEC, and to NFPA-72, National Fire Alarm Code.

B. Install all wiring in accordance with manufacturer's recommendations taking into account loading, intended location, circuit length, spare capacity and voltage drop.

C. All wiring shall be copper and installed in a dedicated/segregated raceway system.

D. Power circuits:

1. Provide the required quantity of 20 ampere, 120 volt circuits to the system with a minimum of one (1) for the FACP, one (1) for door release, one (1) for ECCP.

2. All 120 volt wiring shall be installed in separate raceway system.

E. Provide minimum #18 AWG twisted shielded pair for addressable signal line circuits. Notification appliance circuits shall be#14AWG minimum.

F. Provide minimum #18 AWG twisted pair for speakers and telephones.

G. Addressable signal line and Speaker circuits shall be shielded, unless shielding is not required by manufacturer. Maintain separation from nearby power interference.

H. Addressable signal line circuits shall be NFPA 72 - 2010 Class B.

I. Notification appliance circuits shall be NFPA 72 - 2010 Class B.

J. NFPA pathway survivability:

1. LEVEL 0: NO PROVISIONS.

2. LEVEL 1: BUILDING SPRINKLER PROTECTED AND METAL CIRCUIT RACEWAY.

3. LEVEL 2: 2 HOUR FIRE RATED PROTECTION FOR CIRCUITING.

4. LEVEL 3: 2 HOUR FIRE RATED PROTECTION FOR CIRCUITING AND BUILDING SPRINKLER PROTECTED.

K. Provide a 24VDC power circuit, #16 twisted pair minimum, with each initiation addressable circuit for the entire length.

L. Notification circuits shall be segregated as indicated on the drawings and by individual floors as a minimum. Circuits shall also be dedicated to audible or visual appliances but not both.

3.3 PROGRAMMING

A. Include in bid the cost to cover all system programming, including items particular to this project (such as custom zone descriptions, time delay settings, sensitivity settings, etc.) such that entire system is 100% complete and operating to the Owner's satisfaction. Coordinate all system programming with the Owner. Also, provide programming of the system a minimum of once during the warranty period to provide changes requested by the Owner.

3.4 SPARE EQUIPMENT

A. Provide spare equipment with installation included. Field verify quantities prior to ordering. At the end of the project, if the equipment is not needed to be installed, deliver the equipment to an Owner designated location in the original packaging. Submit a credit proposal for the deleted labor.

B. Equipment to include:

1. Smoke detectors: 5% of each type used with a minimum of ten (10).

2. Heat detectors: 5% of each type used with a minimum of ten (10)

3. Addressable control modules: 2% of each type used with a minimum of two (2).

4. Addressable initiation modules: 2% of each type used with a minimum of two (2).

5. Strobes: 5% of each type used with a minimum of five (5).

6. Speakers: 5% of each type used with a minimum of five (5).

7. Speakers/Strobes: 5% of each type used with a minimum of ten (10).

8. Fire Alarm Fan Shutdowns: 5% of each type used with a minimum of fifteen (15).

9. Smoke Damper locations: 10% of each type used with a minimum of ten (10).

10. Duct-Mounted Smoke Detectors: 5% of each type used with a minimum of ten (10).

11. Tamper Switches: 2% of each type used with a minimum of two (2).

12. Flow Switches: 2% of each type used with a minimum of two (2).

13. Refer to fire alarm riser diagrams for spare parts, wiring and work.

3.5 TESTING AND INSTRUCTION

A. The complete fire alarm system shall be fully tested after the installation is complete. Testing shall include all devices, FACP, annunciator panel, other panels, features and functions. Testing shall be witnessed by the owners representative and be in accordance with the NFPA and herein. Provide a testing report to the authority having jurisdiction and the Engineer as a submittal.

B. Provide a minimum of four (4) hours of instruction to the operating personnel designated by the Owner's Representative with regard to use and operation of the system. Provide up to three programming modifications.

C. Provide three (3) sets of keys to all panels, manual stations, etc., to the Owner's Representative.

D. Provide a copy of the system programming to the Owner on a CD/DVD disk or flash drive.

E. Provide to the Owner system Operation Manuals as specified, that shall include as a minimum:

1. Bill of Material.

2. Catalog descriptive literature for all equipment. This shall include a description of the unit, ratings, functions, capability, materials and compatibility with other components.

3. Riser Wiring Diagram showing all equipment, devices, device addresses, connections, control connections, remote notification connection(s), wire quantities and sizes.

4. Floor plan indicating equipment and device locations, addresses, power circuit information with power panel location, notification circuiting, initiation circuiting and control circuiting. Contact the Engineer for a copy of the project floor plans.

5. Typical Terminal Wiring Diagram for each type of device.

6. Terminal wiring Diagram for all Fire Alarm equipment.

7. Calculations including:

   a. Battery sizing calculations indicating total number of power devices, load associated with each type device and recommended battery capacity (AH).

   b. Voltage drop calculations with actual equipment loads used to derive battery back-up ampere-hour rating and individual circuit voltage drop (indicate the wire size to be used and the associated voltage drop with the allowed voltage drop) for each circuit.

8. Instruction report starting when instruction was given and who was in attendance, signed by Owner's Representative.

9. A written test report from an authorized representative of the equipment manufacturer that each device and overall system operation has been 100% tested and approved.

10. Certificate of Completion as described in NFPA-72.

11. A two (2) year warranty in accordance with the Basic Requirements of these Specifications shall be provided for this system.

END OF SECTION 283102

SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. It is the intent of this section to limit the area of clearing and grubbing to the minimum area possible to allow for the proper installation of the work and to preserve all plantings, trees, shrubs, grass, and natural vegetation to the maximum extent possible.
2. Provide stripping and stockpiling of topsoil.
3. Prune existing trees and plants affected by the execution of the work.
4. Provide clearing and grubbing of all trees, plants, undergrowth, shrubs, brush, other vegetation and debris within the limits indicated on the Contract Drawings and as required to complete the work.
5. Protect existing trees and plants scheduled to remain.
6. Remove all fence, sidewalk, granite curb, concrete curb, asphalt pavement, concrete pavement, utility structures, pipes, conduits, site lighting, utility poles and other items as indicated on the Contract Drawings or as needed to complete the work.
7. Remove all site amenities as designated on the Drawings or as needed to complete the work including but not limited to: signs, guide rails, etc.
8. Disconnect, cap or seal, and remove and/or abandon site utilities in place. Provide bypassing of flows as needed to complete and protect the work.
9. Properly dispose of all removed materials not designated to be reused or delivered to the Owner.
10. Fill and properly compact voids left from clearing and grubbing and buried utility removal activities with backfill materials to meet the finished treatments. (Refer to Part 3 “Clearing and Grubbing)
11. Building and foundation demolition are covered under other specification sections.

B. Related Sections:
1. Division 31 Section **“Earth Moving”**
2. Division 31 Section **“Erosion and Sediment Control”**
3. Division 32 Section **“Maintenance and Protection of Traffic”**

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, materials toxic to plant growth, or other nonsoil materials. These soils typically need to be screened and amended before satisfying the requirements of topsoil for landscaping purposes.

D. Plant-Protection Zone: Area surrounding planting beds, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated.

F. Caliper: Diameter of a trunk measured by a diameter tape at 6 inches (150 mm) above the ground for trees up to, and including, 4-inch (100-mm) size; and 12 inches (300 mm) above the ground for trees larger than 4-inch (100-mm) size.

G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 SUBMITTALS

A. Submit name and qualifications of certified Arborist and tree service firm to be utilized.

B. Tree Pruning Schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction. Data shall include:

1. Species and size of tree.
2. Location on site plan. Include unique identifier for each.
3. Reason for pruning.
4. Description of pruning to be performed.
5. Description of maintenance following pruning.

C. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.

D. Certification: From arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.

E. Existing Conditions: Documentation of existing trees and plantings, indicated to remain and adjoining construction and/or site improvements which establishes preconstruction conditions that might be misconstrued as damage caused by site clearing or other construction related activities.

1. Use sufficiently detailed photographs or videotape.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

F. Label or pruning paint data proposed for use.

G. Antirust coating data proposed for use.

H. Contractor's schedule indicating dates upon which Contractor and Owner's Designated Representative will traverse the site to allow Contractor to indicate the trees and plantings which he has determined to be necessary to remove, trimmed, or replanted and to obtain Owner's Designated Representative's approval.

I. Detailed plan on handling of bypass flows during construction including equipment and methods proposed, timeline, crews and contingency plan. This plan will be reviewed by the Architect/Engineer and no bypass operations will be permitted without an approved plan.

J. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

A. Arborist Qualifications: Certified Arborist as certified by ISA.

B. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this project and that will assign an experienced, qualified arborist to project site during execution of the work.

1. Review methods and procedures related to temporary tree and plant protection including, but not limited to, the following:

    a. Construction schedule. Verify availability of materials, personnel, and equipment needed to make progress and avoid delays.
    b. Enforcing requirements for protection zones.
    c. Arborist's responsibilities.
    d. Field quality control.

C. Confine clearing and grubbing operations to within the limits shown on the Contract Drawings or as otherwise designated by the Architect/Engineer. General limits include:

1. All areas where work is required to be done, but, to the minimum extent possible to properly install the work.

2. Within the grading limits shown on the Drawings.
3. Within existing public rights-of-way or easement.
4. Within contract limits.

D. No trees, plants, shrubs, flowers or vegetation shall be removed or trimmed without prior permission of the Architect/Engineer or Owner's Designated Representative, except where otherwise specified or directed.

E. Pruning of trees shall be completed by a trained arborist.

F. Provide at least one person who shall be present at all times during clearing and grubbing operations who shall be thoroughly familiar with the following:

1. The types of trees and plantings encountered.
2. The proper procedures and methods for preserving trees.
3. The proper procedures and methods for felling, trimming, pruning, and caring for trees and plants and their roots.

Such person(s), firm(s), or subcontractor(s) must be totally familiar with this type of work, must be regularly engaged in similar work and shall be responsible for directing all work affecting trees, plantings, and vegetation.

G. Comply with all applicable local, state, and federal requirements regarding materials, methods of work, and disposal of excess and waste materials.

H. Erosion control measures in accordance with Division 31 Section "Erosion and Sediment Control" shall be followed.

I. Obtain and pay for all required inspections, permits, and fees. Provide notices required by governmental authorities.

1.7 PROJECT CONDITIONS

A. Burning or burial of materials at the site is not permitted.

B. Explosives are not permitted for clearing and grubbing operations.

C. Minimize interference with adjoining roads, streets, walks, parking areas and other adjacent occupied or used facilities during site-clearing operations. Refer to Division 32 Section "Maintenance and Protection of Traffic" for traffic maintenance information.

D. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property, if any, will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Owner's Designated Representative.

E. No grubbing shall be allowed along the side slopes of the embankments.

F. All clearing and grubbing within 5-feet of the embankments shall be performed by pulling debris, sediment or any other materials away from the embankment slope to help protect the downhill areas. No materials within this area shall be pushed down the embankment slope.

G. Notify Dig Safely New York (UFPO) prior to commencing any excavation. Locate and identify existing underground and overhead services and utilities within contract limit work areas. Provide adequate means of protection of utilities and services, which are not designated to be removed. Repair utilities damaged during site work operations at Contractor's expense.

H. The Project Site Owner is not a member of Dig Safely New York. The Contractor alone shall be responsible to locate all utilities and services outside the public rights-of-way. The Contractor shall complete test pits as needed to confirm underground utilities and services. The cost of all test pits shall be included in the price bid. Provide adequate means of protection of utilities and services, which are not designated to be removed. Repair utilities damaged during site work operations at Contractor's expense.

I. Arrange for disconnection, disconnect, and seal or cap all utilities and services designated to be removed before start of site work operations. Perform all work in accordance with the requirements of the applicable utility company or agency involved. The Contractor shall pay all costs for all utility related work including coordination with and charges from the utility company for work they may require in order to accomplish the work shown or implied.

J. Should uncharted or incorrectly charted underground piping or other utilities and services be encountered during site work operations, notify the applicable utility company or utility owner immediately to obtain utility company/owner in maintaining active services in operation. The Contractor shall bear the cost of any and all repair work.

K. Locate, protect, and maintain benchmarks, monuments, control points, and project engineering reference points. Reestablish disturbed or destroyed items at Contractor's expense.

L. The control of dust, noise, erosion, and sediment originating from construction operations is considered a critical responsibility of the Contractor. The Owner's Designated Representative will be the final judge of the adequacy of the Contractor's dust, noise, erosion, and sedimentation control. Work may be suspended by the Owner's Designated Representative until adequate dust, noise, erosion, and sedimentation control is attained.

M. Protect existing buildings, paving, and other services or facilities on site and adjacent to the site from damage caused by site work operations. Cost of repair and restoration of damaged items at Contractor's expense.

N. The location and size of trees, plantings, vegetation, as well as location, size and material of construction of drives, sidewalks, curbs, fences, existing utilities and other living and non-living items, as shown on the Drawings, have been determined by actual surveys at the time surveys were made. Since that time, additional items may have been built, modified, improved or planted, some items may have been removed or replaced, and the condition of things may have changed.

O. The contract cost shall also include restoration of all disturbed or damaged areas with in-kind materials at the time of construction, whether shown on the Contract Drawings or not, unless otherwise indicated in the Contract Documents.

P. Protect and maintain streetlights, parking and sidewalk lighting, emergency phones, utility poles and services, curb boxes, valves, utility structure/piping castings, and other services, except items designated for removal.

Q. The Contractor shall take precautions to protect from harm the work of other contractors on site, existing facilities, as well as adjacent property. The Contractor shall be responsible for all damage or injury done to pipes, structures, pavement, site amenities, utility features, property or person as a result of work performed to complete this contract. The Contractor at his own expense shall repair or replace such property or item to the satisfaction of the property owner, utility owner, public agency having jurisdiction and/or Architect/Engineer and Owner's Designated Representative.

R. When it is necessary to haul materials over public or private streets, roads, drives, parking areas, walkways or other pavements, the Contractor shall provide suitable tight vehicles so as to prevent deposits on these pavements. In all cases, where any materials are dropped from the vehicles, the Contractor shall clean up the same as often as directed and keep the crosswalks, streets, roads, drives, parking areas, walkways, and drainage ways (e.g. swales, ditches, gutters, catch basins, manholes, piping, etc.) clean and free from dirt, mud, stone, and other hauled materials.

S. Responsibility for cleaning private and public; roads, drives, parking areas or walkways, of any material carried onto these roads or other pavements by trucks or other equipment, completing work in support of this project, shall be the Contractor's and cost shall be included in price bid.

T. The following practices are prohibited within tree- and plant-protection zones:

1. Storage or stockpiling of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging, unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
8. Do not direct vehicle or equipment exhaust towards protection zones.
9. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.
10. Do not store materials potentially harmful to tree roots. Potentially harmful materials include, but are not limited to: petroleum products; cement; lime; paints; detergents; acids; and, cleaning agents.

U. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

1.8 STORAGE AND HANDLING

A. Stockpiling of earth spoil or excess earth material on the site or storage of excavated materials for reuse shall be done in a manner which will not hinder the progress of the work; cause any nuisance; or cause spillage or tracking of materials from the transporting vehicle onto public or private roadways and pavements, or cause an inconvenience to adjacent property owners or the active campus facility.

B. Obstruction of roads, driveways, parking areas, sidewalks, or interference with drainage along curbs, ditches, or drainage channels with stored material is not permitted.

C. Store fences, signs, granite curb and other items at approved locations for subsequent reinstallation.

D. Promptly remove materials not specified to be stored or reused.

1.9 SCHEDULING

A. Avoid interference with the use of, and passage to and from, adjacent properties, buildings, facilities, driveways, walks, drainage systems, and roads etc.

B. Do not commence site clearing operations until temporary erosion- and sedimentation-control and tree- and plant-protection measures are in place.

C. Pavements which are required to be removed, including streets, roadways, driveways, parking areas, and walkways, may be saw cut in advance, but do not remove until the work is ready to be installed.

D. Do not remove signs, guide rails, and all other control, safety and warning devices until just prior to the installation of the work.

E. Do not remove fences until the property owners affected are notified at least four days in advance of such removal. Unless written permission from a fence owner is received, do not remove a fence more than 48 hours in advance of the installation of the work affected by the fence.

F. It is the intent of this section that all items affecting traffic, safety, lives, and the containment of humans and animals and all items essential to the protection of property or the operation of a business be left in place as long as possible and replaced as soon as possible when such items must be removed. Weekend shutdowns should be considered in scheduling these operations.

1.10 PROTECTION AND COORDINATION

A. Persons and Property:

1. Carefully protect and guard all trees, shrubs, and vegetation to remain.
2. Take every precaution to avoid damage to utilities, buildings, structures, facilities, and other property. All curbs, gutters, pavements, structures, utility lines, and other features along the street rights-of-way, adjacent property and the existing campus facility shall be protected.
3. Barricades/Enclosures: Properly protect persons and property at all times against harm or damage of any kind during construction and site improvement operations. Provide substantial barricades/enclosures around all openings as soon as they are uncovered, to block access and afford protection to workmen, facility employees, and the general public.
4. Signals: Provide lanterns or other signalization, as may be required by law or directed by the Owner’s Designated Representative in the vicinity of any open excavations or unsafe areas, and be certain that such devices are operable at all times during hours of darkness, or when the work area is left unattended.
5. Shoring/Bracing: Provide necessary shoring and bracing for support of buildings scheduled for demolition and for protection of adjacent structures and facilities caused by demolition operations. Cost of repair shall be paid by the Contractor and at additional cost to the Owner.
6. Maintain all barricades and signals for the duration of the Contract.

B. Utilities:

1. Preserve Active Lines: Preserve in operating condition, all active utilities indicated on the Contract Drawings to remain. This applies to all utilities, which traverse the project site, or exist in the immediate vicinity of the site, including, but not limited to, mains, conduits, manholes, handholes, catch basins, valve boxes, poles, guy anchors, and appurtenances. Damage to any utility line or related appurtenances resulting from work under this Contract shall be repaired or replaced by the Contractor to the satisfaction of the Architect/Engineer, Owner, utility company, utility owner and/or local authority. All costs associated with this repair shall be paid by the Contractor at no additional cost to the Owner.
2. Damaged Utility Lines: If active utility lines are broken or damaged during any site improvement operations, take all necessary steps immediately to avoid endangering persons or property, and notify the Owner's Designated Representative, Architect/Engineer, the affected utility company, and the municipal engineer's office to obtain a decision regarding this treatment and/or assistance in the repair of the damaged line.
3. Prior Notification: Notify all utility companies, utility owners, municipal engineer's office, and/or the respective water and sewer department, prior to the commencement of any operations on the site. Confirm locations with all utility companies/owners involved, of all live or active lines within, or immediately adjacent to, the contract limit lines of this project.
4. Water Damage: In the event that water, storm sewer, sanitary, or other utility lines are broken, or that springs, ground water, or other sources of water are encountered, take all necessary steps immediately to divert water away from construction, site improvement operations and storage areas to prevent erosion, undermining or other damage. If permanent corrective measures other than those indicated on the Contract Drawings become necessary, request a written decision from the Architect/Engineer.

C. Adjacent Properties:

1. Protection: Protect all adjacent properties and structures and use every means possible to prevent erosion, flooding, undermining excessive excavation or other damage during any construction or site improvement operations. Repair all damage in a manner specified by, and to the satisfaction of the Owner's Designated Representative and the Architect/Engineer. The Contractor shall pay the cost of any repairs necessary at no additional cost to the Owner.

D. Restoration:

1. Injured or damaged trees shall be repaired in accordance with accepted nursery industry standards and as acceptable to the Architect/Engineer.
2. Contractor shall bear the cost of repair and replacement of trees scheduled to remain that are damaged or removed by construction operations.
3. All trees, shrubs or plantings, which are taken-up for subsequent reuse, and die, shall be replaced with first class balled and burlapped nursery grown representatives of the same species and caliper at the expense of the Contractor.
4. Damage to existing curbs, gutters, pavements, structures, utility lines, or other features should be replaced or repaired to the satisfaction of the Architect/Engineer, Owner's Designated Representative, and/or utility owner, at no additional cost to the Owner.
5. Fill, grade, and compact disturbed areas to the grades and lines as shown on the Contract Drawings. Grade compacted surface to meet adjacent grades and provide proper surface

drainage. Provide uniform levels and slopes. All work shall be completed in accordance with specification Division 31 Section “Earth Moving”.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Asphalt base paint specially formulated for horticultural application to cut or damaged plant tissue.

B. Satisfactory Soil and Granular Material: Requirements for satisfactory soil and granular materials are specified in Division 31 Section "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.
2. Provide imported granular materials.
3. Provide imported topsoil.

C. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating.

1. Use coating with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:

1. Type: Shredded hardwood.
2. Size Range: 3 inches maximum, 1/2 inch minimum.
3. Color: Natural.

E. Tree- and Plant- Protection Zone Fencing:

1. The Contractor is to furnish all labor, materials, equipment, and supplies and perform all operations required to complete this work.

2. Protection zone fencing shall be temporary orange construction fence, a minimum of 4-feet in height, mounted to 2-inch x 4-inch wood or steel fence posts, set a maximum of 10 feet o.c. Fence enclosure shall reach 1.5 times the diameter of the drip line, a minimum radius from face of tree trunk as shown in the Contract Plans, or as determined by the arborist, whichever is greater.

PART 3 - EXECUTION

3.1 PREPARATION

A. Monuments: Locate, protect and maintain benchmarks, monuments, batter boards, survey control points and other reference points from disturbance during construction. Protect all reference points against movement, injury, and displacement and replace those, which become disturbed as

the result of any operations of this Contract. Monuments, benchmarks, and other reference features shall be carefully protected by Contractor. Should any be disturbed or damaged by any cause, the Contractor shall have same replaced to original location, elevation and condition by a NYS Licensed Land Surveyor at the cost and expense of the Contractor.

B. Verify all limiting boundaries such as permanent and temporary easements, property lines, rights-of-way and grading limits have been accurately located and clearly marked. Where appropriate, verify that pipeline routings and other work limits have been accurately located and clearly marked.

C. Locate and clearly identify trees, shrubs, and other vegetation to be removed or relocated. Wrap a 1-inch blue vinyl tie tape flag around each tree trunk at 54+/- inches above the ground.

D. Carefully plan and execute operations so as to avoid damage to trees, shrubs, plants, etc.

E. Verify that temporary erosion- and sedimentation-control measures are in place.

F. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner's Designated Representative.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Work shall be completed in accordance with Division 31 Section "Erosion and Sediment Control".

B. Comply with all federal, state, and local laws, ordinances, rules, and regulations.

C. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

D. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

E. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

F. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. Prior to the start of any site operations, fence all trees and groups of trees, shrubs or planting beds which may interfere with site operations and are not designated to be removed. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation. Maintain fencing during full construction period. Remove temporary fencing when no longer needed or when acceptable to the Architect/Engineer.

B. Protect trees against cutting, breaking, bruising of bark. Where, in the opinion of the Architect/Engineer, the Contractor does not exercise reasonable care, the Architect/Engineer may require trunks to be wrapped with protective fencing.

C. Tie back flexible limbs that may be damaged by passage or activity of equipment beneath trees. Where limbs cannot be tied back and equipment cannot avoid limbs or branches, prune back limbs, only after approval of the Architect/Engineer.

D. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

E. If recommended by the Arborist, mulch areas inside tree-protection zones and other areas indicated. Apply 4-inch average thickness of organic mulch. Do not place mulch within 6-inches of tree trunks.

F. Protect Tree- and Plant- Protection Zones. Refer to Part 1 “Project Conditions” for additional information.

G. Maintain protection zones free of weeds and trash. Mow grass as needed to maintain a 2-to 4-inch grass height.

H. Trenching near Trees: Obtain arborist approval for work required in root zones and protection zones. Where utility trenches are required within protection zones, hand excavate under or around tree roots or tunnel under the roots by drilling, auger boring, or pipe jacking. Tunnel past established trees for a minimum distance of 7 feet each side of the trunk. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning.

I. Redirect roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches back from new construction and as required for root pruning.

J. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

K. Prune roots that are affected by temporary and permanent construction.

1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
2. Cut Ends: Coat cut ends of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other coating formulated for use on damaged plant tissues and that is acceptable to arborist.
3. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
4. Cover exposed roots with burlap and water regularly.

5. Backfill as soon as possible according to requirements in Division 31 Section "Earth Moving."

L. Root Pruning at Edge of Protection Zone: Prune roots 12 inches outside of the protection zone, by cleanly cutting all roots to the depth of the required excavation.

M. Root Pruning within Protection Zone: Clear and excavate by hand to the depth of the required excavation to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

N. The Contractor will be held responsible for damage to trees as a result of not following the procedures outlined herein, not exercising reasonable care or by negligence.

O. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect/Engineer or Owner's Designated Representative.

P. Dead or Dying Trees:

1. All trees, which, upon completion of the project, are found to be in a dead or dying condition (more than 50% dead or in an unhealthy condition) as the result of the failure to adhere to the above precautionary measures, shall be removed to 12 inches below finished grade and replaced, in a designated location, with a tree of like size and species at the expense of the Contractor. The tree shall be guaranteed for a period of 12 months or the project's guarantee period, whichever is longer.

Q. Damaged Trees:

1. Trees damaged in any manner, but deemed savable, may be repaired to the satisfaction of the Architect/Engineer, by an approved tree surgery company.
2. Should the repaired tree(s) die within 12 months of final acceptance of the project, the tree(s) shall be removed and replaced as above.

R. Relocation of Trees/Shrubs/Plants:

1. Dig trees/shrubs/plants during appropriate season and plant immediately in the designated location. Should it be necessary, due to the sequence of work, to delay planting in the new permanent location, dig and store tree/shrubs/plants in accordance with accepted standard practices. Trees may be dug with a tree spade, but must be planted immediately in the permanent or an approved temporary location.

3.4 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Notify applicable utility company or utility owner and obtain approval for shutting off and terminating existing utility services.
2. Perform work in accordance with applicable utility company requirements.
3. Identify utility service terminations on project record documents. Place markers to indicate location of disconnected utility service below grade.

4. Notify Owner's Designated Representative in writing when disconnecting and sealing/capping of each utility service is complete.

B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. The Contractor shall coordinate at least two weeks in advance with the Architect/Engineer, the Campus, and Owner's Designated Representative to schedule temporary service shut downs needed to complete the work.
2. Notify Owner's Designated Representative and Owner in writing not less than 48-hours in advance to confirm proposed utility interruptions.
3. Any one disruption shall not exceed 4-hours unless mutually agreed to by the Owner, Owner's Designated Representative, Architect/Engineer and Contractor.
4. Temporary service shutdown durations, time of day, and day of the week will be restricted by the Owner. Temporary power, water or sanitary shut downs will not be permitted during normal weekday business hours for the facility/campus. The Contractor shall include in the price bid all costs for labor, equipment and materials necessary to complete the connections when the facility/campus is not in operation (e.g. weekends, holidays, or if approved by the facility/campus weekdays between 5:00 p.m. and 6:00 a.m.). The date, time and duration of any service shutdown shall be mutually agreed upon between the Contractor, Owner's Designated Representative, the Campus, and Architect/Engineer, prior to start of work.
5. Do not proceed with utility interruptions without Owner's Designated Representative written permission.

C. Excavate for and remove underground utilities indicated to be removed.

D. Provide bypassing of flows as needed.

3.5 CLEARING AND GRUBBING

A. All trees shall be "topped" and "limbed" before felling unless otherwise approved.

B. The Contractor shall schedule and conduct his operations to minimize erosion of soils and to prevent silting and muddying of streams, rivers, wetlands, impoundments and land adjacent to or affected by the work. Erosion control measures shall be implemented and the area of soil exposed by construction at any one time shall be kept to a minimum. Final restoration shall be carried out as soon as possible following completion of clearing and grubbing operations.

C. Contractor shall protect all existing site utilities, appurtenance and amenities to remain.

D. All operations shall be done in a manner so that present growth will blend with the limits of construction and a natural appearance will be attained.

E. Clearing consists of cutting and properly disposing of all trees (designated to be removed) and other vegetation, down timber, snags, stubs, brush, shrubs, bushes, as well as boulders, rubbish, debris, and other objectionable matter and materials occurring within areas to be cleared.

F. In wooded areas, trees may be removed and/or trimmed as required, for the proper installation of the work. Gross and unnecessary removal of trees is not permitted.

G. Grubbing consists of the removal and proper disposal of all stumps, roots, duff, grass, turf, sod, debris, vegetation, foundations, buried structures and pipes, as well as other objectionable matter and materials occurring within the areas to cleared and grubbed.

H. Remove stumps and roots to their full depth within 5-feet of underground structures, utility lines, footings and concrete or paved surfaces. Remove stumps and roots to a clear depth of 3-feet below subgrade in other locations.

I. Use hand method for grubbing within protection zones of trees to remain.

J. Stumps of trees removed shall be grubbed, ground or cut.

K. All stump holes shall be backfilled and properly compacted to the satisfaction of the Owner's Designated Representative and/or Architect/Engineer. Backfill materials shall include: granular materials meeting NYSDOT Item 304.14 in areas under and within 5 feet of structures or buildings; granular materials meeting NYSDOT Item 304.12 in areas under and within 5 feet of pavements (asphalt, concrete or similar) and utility structures; and, Select Earth in all other areas. Backfilling shall be completed within one (1) week after start of work on the tree. Any open excavation as a result of this work, shall be properly protected to avoid harm to public, facility employees, work, equipment, or others.

3.6 FELLING OR PRUNING TREES

A. If it is impractical to fell trees as a whole, remove them in sections according to standard practices of professional tree removal. Fall trees to the center of the area being cleared to minimize damage to trees that are to be left standing.

B. Fall trees away from the slope embankments; stream banks, wetlands, swamps or other water courses; buildings; public or private roadways or sidewalks; and, trees/shrubs to remain.

C. Fall trees in a manner to minimize damage to existing pavements or structures.

D. Immediately after felling a tree, remove branches, cut trunk and limbs, and remove all materials from the site. All merchantable timber and wood, which is removed, shall become the property of the Contractor.

E. All trees to remain shall not come in contact with any machine or appliance that will in any manner injure, sear, or kill them.

F. All trees left standing, which have been trimmed or become scarred by Contractor's operations, shall be promptly repaired by properly cutting, smoothing, and painting.

G. Trees to be trimmed shall be evenly cut to achieve neat severance with the least possible damage to trees.

H. Prune branches that are affected by temporary and permanent construction. Prune branches as follows:

1. Prune trees to remain to compensate for root loss caused by damaging or cutting root system. Provide subsequent maintenance during Contract period as recommended by arborist.
2. Pruning Standards: Prune trees according to ANSI A300 (Part 1) and the following:
   a. Type of Pruning: Cleaning.
   b. Specialty Pruning: Restoration.
3. Cut branches with sharp pruning instruments; do not break or chop.
4. Do not apply pruning paint to wounds.
5. Chip removed branches and dispose of off-site.

I. Where roots are cut or damaged, apply wet burlap to prevent drying out.

3.7 TOPSOIL STRIPPING

A. Prior to any excavation or embankment or as directed by the Architect/Engineer, topsoil shall be removed. Topsoil work, such as stripping, stockpiling and similar work shall not be carried out when soil is wet so that tilth of soil will be destroyed.

B. Remove sod and grass before stripping topsoil.

C. Topsoil shall be stripped full depth in building areas, and all areas to be regraded, resurfaced or paved within the contract limit work area. Stripped topsoil shall be stockpiled in a location on site acceptable to the Owner's Designated Representative or Architect/Engineer.

D. Strip topsoil in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, stones, and other objects more than 2 inches in diameter; trash, waste, branches, brush, debris, weeds, roots, and other waste materials.

E. Stockpile cleaned topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water. Provide and maintain erosion control measures around stockpiles including, but not limited to, silt fence.

1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within protection zones.

F. Stockpiled topsoil will be used in finish grading for preparation of lawns and planting beds. No topsoil shall be removed from the site without the prior approval of the Architect/Engineer. All topsoil used in grading shall be screened to remove any materials larger than 2-inches in diameter.

G. Where trees are indicated to be left standing, stop topsoil stripping a sufficient distance to prevent damage to main root system.

H. If the Contractor fails to strip and stockpile all available topsoil within the limits of areas disturbed by his work, the Contractor shall at no cost to the Owner, import adequate topsoil to cover the disturbed areas to a minimum depth of 4-inches.

I. If topsoil does not exist, in sufficient quantity, on the site, the Contractor shall deliver, place and spread a sufficient quantity of acceptable topsoil necessary to achieve a depth of 4 inches over the entire area of the site indicated on the contract drawings to receive lawns and planting. Secure all topsoil from an approved source and submit a mechanical and chemical analysis to the Architect/Engineer for any topsoil, which is to be delivered.

J. If excess quantities of topsoil exist, the Contractor shall notify the Architect/Engineer immediately. The Architect/Engineer will determine whether the Contractor shall screen and spread the excess topsoil on-site in designated areas, leave the excess topsoil properly stockpiled on-site, and/or remove and dispose of the excess topsoil from the site. Contractor's price bid shall include the costs to complete any one or a combination of these alternatives.

3.8 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove all below-grade wood, organic material, and metal construction within demolition or removal area.

C. Remove slabs, paving, curbs, gutters, and aggregate base as indicated. Remove to the minimum extent possible to complete the work while utilizing existing joints.

1. Prior to full depth removal, saw cut asphalt and concrete paved surfaces. Use a saw, which will cut a neat, straight joint line along line of existing pavements to remain. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.
3. Carefully remove walks and curbs to the minimum extent possible. Store and protect for reuse if so designated.

D. All fences, signs, and other obstructions encountered shall be carefully taken-up and stored for subsequent replacement.

E. Do not disturb property markers unless absolutely necessary. If it becomes necessary to disturb or remove a property marker, have a NYS licensed land surveyor provide four (4) ties to the marker. The licensed land surveyor shall replace the marker as soon as possible.

F. Remove and turn over to the Owner all items indicated to be salvaged.

G. Remove, store, protect, and reinstall all items indicated for relocation.

H. Remove and dispose off-site underground structures and piping indicated for removal on the Contract Drawings.

3.9 REGRADING AT OR ADJACENT TO PROTECTION ZONES

A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

B. Lowering Grade within Protection Zone: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by arborist unless otherwise indicated.

1. Root Pruning: Prune tree roots exposed by lowering the grade. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots as required for root pruning.

C. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

D. Minor Fill within Protection Zone: Where existing grade is 2 inches or less below elevation of finish grade, fill with topsoil. Place topsoil in a single uncompacted layer and hand grade to required finish elevations.

3.10 BACKFILLING

A. The Contractor shall be responsible for providing all necessary fill materials to backfill the resultant hole from removal of all plant materials.

B. Water in sufficient quantity may be required to assure compaction.

C. Earth and granular materials for backfill, shall be in accordance with Division 31 Section “Earth Moving”. Refer to Part 3 “Clearing and Grubbing” of this specification for additional information.

D. All excavations shall be backfilled to the original surface of the ground or as otherwise specified, or directed. Provide proper surface drainage and provide uniform levels and slopes. Backfilling shall be done with suitable excavated materials approved by the Architect/Engineer, and satisfactorily compacted.

E. The Architect/Engineer shall be the sole judge of what constitutes unsuitable material for backfill.

3.11 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them in accordance with requirements of all federal, state, local laws and ordinances off Owner's property. Remove cleared materials from the site as the work progresses.

B. Remove cleared materials from the site as the work progresses. All wood and brush shall be disposed of within 15 days after cutting or felling unless otherwise approved by the Architect/Engineer.

C. On site burning of combustible cleared materials is not permitted. On site burial of cleared materials is not permitted.

D. Leave site in a neat and orderly condition.

3.12 DUST & NOISE CONTROL

A. Complete dust and noise control in accordance with Division 31 Section “Earth Moving”.

3.13 DEWATERING

A. Complete dewatering in accordance with Division 31 Section “Earth Moving”.

3.14 MAINTENANCE TRAFFIC

A. Complete maintenance and protection of traffic in accordance with Division 32 Section “Maintenance and Protection of Traffic”.

END OF SECTION 311000

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Earth excavation
2. Cutting and filling of subgrade
3. Earthen embankments
4. Preparation of subgrade, including excavation and backfill, for buildings, structures, and foundations.
5. Excavating and backfilling trenches for utilities and pits for buried utility structures.
6. Preparing subgrades, including excavation and backfill, for slabs-on-grade, walks, pavements, turf and grasses, and plants
7. Excavation and removal of unsuitable bearing material
8. Soils and backfill materials consolidation and compaction.
9. Grading outside building lines
10. Furnishing and placing earth and granular materials
11. Drainage course for concrete slabs-on-grade.
12. Subsurface drainage backfill for walls and foundation/footing trenches.
13. Subbase course for concrete walks and pavements.
14. Subbase course for asphalt paving.
15. Removing from site excess and/or unsuitable fill
16. All other associated earthwork as necessary to perform the work under this Contract in conformance with the alignments, grades and detailed sections provided.

B. Related Sections:

1. Division 03 Section "Cast in Place Concrete"
2. Division 31 Section "Site Clearing"
3. Division 31 Section “Erosion and Sedimentation Control”
4. Division 32 Section "Turf and Grasses"

C. Special Requirements
1. Upon excavation, the subgrade shall be inspected by a qualified and independent testing representative obtained by the Owner. Subgrade shall be approved by the Owner’s representative before any new construction begins. Results of the tests must be reviewed and approved by the Architect/Engineer.

2. All excavation, fill or backfill placement, and utility construction shall be performed in the dry. The contractor shall be prepared to dewater as necessary. Subsurfaces shall be kept free of water, subjected to minimum amount of construction traffic, exposed no longer than necessary, and not permitted to freeze.
3. Site-Specific geotechnical information – Also see the Geotechnical Reports

1.3 DEFINITIONS

A. Backfill: Aggregate or earthen material or controlled low-strength material used to fill a trench excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

C. Borrow Soil: Satisfactory soil imported from off-site (or on-site if permitted) for use as fill or backfill.

D. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

E. Embankment Foundation: Surface area upon which an embankment or fill is constructed.

F. Excavation: Removal of material encountered to subgrade elevations, lines, and dimensions required and the subsequent disposal of materials removed.

1. Additional Excavation: When excavation has reached required subgrade elevations, notify the Owner's Designated Representative, who will make an inspection of the conditions. If Architect/Engineer determines that bearing materials at required subgrade elevations are unsuitable, continue excavation until suitable bearing materials are encountered and replace excavated material as directed by Architect/Engineer.
2. Unauthorized Excavation: Consists of removal of materials beyond required subgrade elevations or dimensions without specific direction of the Architect/Engineer or Owner's Designated Representative. Unauthorized excavation, as well as remedial work directed by the Architect/Engineer or Owner's Designated Representative, shall be at Contractor's expense. Fill of unauthorized excavations shall be as follows:
    a. Under footings or foundation bases, fill of unauthorized excavations under footing or foundation bases shall be accomplished by extending lean concrete or well-graded crushed aggregate fill to bring elevations to proper position, when acceptable to Architect/Engineer.
    b. In locations other than those above, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by the Owner's Designated Representative.
3. Unclassified Excavation: Unclassified excavation shall consist of the excavation and disposal of all materials or obstructions, of any description, encountered during construction, unless otherwise specified.

G. Fill: Aggregate and/or earthen soil materials used to raise existing grades.

H. Loam: Soil mixture consisting of the following proportions:

Sand	30 - 50%
Silt	30 - 50%
Clay	0 - 20%

I. Rock: Solid hard material located in ledges, bedded deposits and unstratified masses, and all natural conglomerate deposits so firmly cemented as to present all the characteristics of solid rock, which must be removed by blasting or pneumatic hammers. Rock does not include shale, slate, soft sandstone, hardpan, masonry or concrete rubble, boulders less than 2 cubic yards, such other rock material which is decomposed, stratified, weathered or shattered, or any material capable of being removed by a well maintained Caterpillar 225 power shovel, or equivalent.

J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, utility structures, pole bases, or other man-made stationary features constructed above or below the ground surface.

K. Subbase Course: Aggregate layer placed between the subgrade and asphalt pavement, concrete pavement, hardscape or stabilized topsoil area.

L. Subgrade or Subgrade Surface: Uppermost undisturbed surface of an excavation or the top surface of a compacted fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

M. Suitable Material: Materials whose composition is satisfactory for use in embankment, backfill, or fill construction. Determinations of whether a specific material is suitable for a specific application shall be made by the Owner’s Designated Representative or Architect/Engineer.

N. Topsoil: Refer to Division 31 Section "Site Clearing".

O. Unstable Material: (if encountered) Unstable material shall mean debris and all wet, soft, or loose material, which does not provide sufficient bearing capacity to satisfactorily support pipes, structures or other work placed thereon.

P. Unsuitable Material: Unsuitable material shall mean excavated material, which in the opinion of the Owner’s Designated Representative or Architect/Engineer, does not meet specification requirements for backfilling, embankment, or filling purposes and includes unstable material.

1. Unsuitable material shall fall into two specific categories. The first shall be that material which would be unsuitable under any circumstances including unstable materials. This category includes materials containing humus, spongy material, roots, stumps, muck, peat, and any other objectionable material. This material shall be disposed of in an approved off-site spoil area.
2. The second category shall consist of material, which is unsatisfactory for backfill because of its moisture content at the time of excavation. This material shall be stockpiled in approved areas on the Project site. This stockpiled material, when satisfactory for backfill, as determined by the Architect/Engineer, shall be used in other areas lacking backfill.
3. Excavated materials, which become unsuitable as a direct result of the Contractor's work shall result in rejection of the unsuitable material by the Architect/Engineer.

4. The Owner's Designated Representative or Architect/Engineer shall be the sole judge of what constitutes unsuitable material and into which category it falls.

Q. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

A. Product Data: For each type of the following manufactured products required:
1. Geotextiles.
2. Silt Fence
3. Low-strength material, including design mixture.
4. Warning tapes.

B. Material Test Reports: Contractor shall submit test results for laboratory gradation, moisture content (Proctor Tests), and maximum density tests certified by an approved testing laboratory or other requirements on the various imported soil and granular items, from each approved material source, prior to their use on the project:
1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 1557.

C. Provide material certifications for imported materials.

D. Submit list indicating locations where various soil earthen and granular materials will be utilized.

E. List of compaction plans of proposed compaction equipment and description.

F. Copies of measurements and computed volumes of unsuitable material removed shall be submitted to the Architect/Engineer.

G. Details of proposed sheeting, if required, shall be submitted by the Contractor to the Architect/Engineer for review and no sheeting shall be installed until written acceptance from the Architect/Engineer. Sheeting design shall be stamped by NYS licensed professional engineer.

H. Submit Qualification Data: For qualified independent testing agency.

I. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.5 QUALITY ASSURANCE

A. All finished grades shall be as shown on the Drawings or as specified by the Architect/Engineer. Contractor shall verify that survey benchmark and intended elevations for the work are as indicated. Contractor shall verify existing site conditions.

B. Contractor's independent testing agency shall be approved by the Architect/Engineer.

C. Erosion control measures in accordance with Division 31 Section "Erosion and Sediment Control", the Project SWPPP and the NYSDEC SPDES General Permit for Stormwater Discharges from Construction Activity (GP-0-20-001 shall be followed).

D. When placing fill and backfill, all compaction and soil moisture requirements as delineated in this specification shall be followed. Lift thickness, and the compactive capabilities of the equipment used, shall be continually monitored by the Contractor to obtain the compaction efforts required.

E. Provide on-site at least one person who shall supervise the soil compaction operations, and who shall be thoroughly familiar with the various types of compaction equipment, proper compacting techniques and methods, and soils behavior, and who shall direct the compaction operations.

F. It is the responsibility of the Contractor to select, furnish and properly maintain equipment, which will compact the fill uniformly to the required density.

G. The Architect/Engineer will be the sole judge of the conformance of materials, workmanship, and compaction with the requirements of the Contract Documents.

H. Work referencing NYSDOT (New York State Department of Transportation) shall be in compliance with the latest edition of the New York State Department of Transportation Standard Specifications (NYSS) as well as the latest applicable New York State Department of Transportation Standard Sheets.

I. Special Inspections: Owner will engage a qualified special inspector to perform the Special Inspections as outlined in Divisions 1.

1.6 COMPACTION TESTING AND REPORTS

A. Owner will engage and pay for a qualified and independent testing and inspecting agency to complete field compaction density testing for all soils and granular materials utilized in the Work. All materials not meeting proper compaction requirements shall be removed and replaced. Costs to the Owner for additional testing of replacement materials shall be the responsibility of the Contractor.

B. Owner will engage and pay for a qualified and independent testing and inspecting agency to take samples and perform tests to determine optimum moisture content, and maximum density testing of various on-site soils to be utilized in the Work. Reports will be provided to the Contractor and engineer/architect.

C. The Owner reserves the right to request testing of all Contractor imported materials to verify conformance with approved materials. All soils and granular materials not meeting the proper gradation requirements nor previously approved laboratory maximum density tests as submitted by the Contractor shall be removed. Costs to the Owner for testing of materials, which are found not in conformance with approved materials, shall be the responsibility of the Contractor.

1.7 PROJECT CONDITIONS

A. When work is in public rights-of-way, the Contractor shall make necessary arrangement for permits, as required, at no extra cost to the Owner.

B. The Contractor shall be required to ascertain the complete extent of all permits required governing dewatering operations, and shall be bound by their conditions and provisions.

C. Provide and maintain emergency ingress/egress to the site at all times. Provide and maintain pedestrian and vehicle access to active facility, including but not limited to designated doors, sidewalks, and parking areas.

D. If trench widths and depths are exceeded, concrete cradles or other special installation procedures may be required and shall be provided where directed by Architect/Engineer. All additional costs, including the cost of redesigns, shall be borne by Contractor.

E. Moisten or dry backfill materials to the proper moisture content as determined in accordance with ASTM D1557, Method C in order to obtain proper compaction.

F. Utilities shown on the Contract Drawings are for the convenience of the Contractor, exact locations are not guaranteed. The Contractor shall verify existing utilities with the proper authorities.

G. Notify Dig Safely New York (UFPO) prior to commencing any excavation. Locate and identify existing underground and overhead services and utilities within contract limit work areas. Provide adequate means of protection of utilities and services, which are not designated to be removed. Repair utilities damaged during site work operations at Contractor’s expense.

H. The project site Owner is not a member of Dig Safely New York. The Contractor alone shall be responsible to locate all utilities and services outside the public rights-of-way. The Contractor shall complete test pits as needed to confirm underground utilities and services. The cost of all test pits shall be included in the price bid. Provide adequate means of protection of utilities and services, which are not designated to be removed. Repair utilities damaged during site work operations at Contractor’s expense.

I. Minimize interference with adjoining roads, streets, walks, parking areas and other adjacent occupied or used facilities during earth moving operations. Refer to Division 32 Section “Maintenance and Protection of Traffic” for traffic maintenance information.

J. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Owner’s Designated Representative.

K. Locate, protect, and maintain benchmarks, monuments, control points, and project engineering reference points. Reestablish disturbed or destroyed items at Contractor’s expense.

L. The control of dust, noise, erosion, and sediment originating from construction operations is considered a critical responsibility of the Contractor. The Construction Manager will be the final judge of the adequacy of the Contractor’s dust, noise, erosion, and sedimentation control. Work may be suspended by the Construction Manager until adequate dust, noise, erosion, and sedimentation control is attained.

M. Protect structures, utilities, sidewalks, pavements, buildings, and other services or facilities on site and adjacent to the site from damage caused by earth moving operations or other work in

support of Contractor operations. Cost of repair and restoration of damaged items shall be at Contractor's expense.

N. The Contractor shall take precautions to protect from harm the work of other contractors on site, existing facilities, as well as adjacent property. The Contractor shall be responsible for all damage or injury done to pipes, structures, utilities, pavement, buildings, property or person as a result of work performed to complete this contract. The Contractor at his own expense shall repair or replace such property or item to the satisfaction of the property owner, utility owner, public agency having jurisdiction, Architect/Engineer and Construction Manager.

O. When it is necessary to haul materials over the streets or pavements, the Contractor shall provide suitable tight vehicles so as to prevent deposits on the streets or pavements. In all cases, where any materials are dropped from the vehicles, the Contractor shall clean up the same as often as directed and keep the crosswalks, streets, pavements and drainage ways clean and free from dirt, mud, stone, and other hauled materials.

P. Contractor shall be responsible for cleaning private and public; roads, parking areas or walkways, of any material carried onto these roads or pavements by trucks or other equipment completing work in support of this project. Associated costs shall be included in price bid.

Q. The following practices are prohibited within tree- and/or plant-protection zones:

1. Storage of or stockpiling of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Impoundment of water.
5. Excavation or other digging unless otherwise indicated.
6. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
7. Do not direct vehicle or equipment exhaust towards protection zones.
8. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.
9. Do not store materials potentially harmful to tree roots. Potentially harmful materials include, but are not limited to petroleum products, cement, lime, paints, detergents, acids and cleaning agents.

R. The Owner and Architect/Engineer do not guarantee that all required excavation can be executed by use of machinery. In some cases, it may be necessary to revise proposed alignments, which may preclude the use of machinery. In this event, the Contractor shall be required to perform this work by any method at the same price(s) bid in the Proposal, with no additional compensation due to the inability to use machinery.

S. The existing ground elevations as shown on the Drawings are believed to be reasonably correct. The Contractor shall satisfy himself, however, by actual examination of the sites of the work, as to the existing elevations and the amount of work required under this section. No claim shall be made by the Contractor for additional compensation for conditions other than that shown.

T. The Contractor shall remove any waste material or other debris that has accumulated as a result of the work of this section and dispose in conformance with applicable legal requirements and in a manner acceptable to the Construction Manager or Architect/Engineer.

U. Soil reports and boring logs: Refer to **Attachment Geotechnical Report (if applicable)**

1.8 TRIAL EXCAVATIONS (if required)

A. After the Contract is awarded, and prior to fabrication of steel and other framing members, the Contractor shall perform trial excavations, as directed by the Architect/Engineer, to verify certain existing conditions which may affect the proper dimensioning and fit of steel or other framing members.

B. Contractor shall construct test pit excavations to determine the locations of underground utilities or structures as shown on the plans and/or as ordered by the Construction Manager or Architect/Engineer. Underground utilities and/or structures shall be located and tied off for future stake out. The test pit shall be properly backfilled and compacted. Surface restoration shall be performed as required and as ordered by the Construction Manager or Architect/Engineer.

1.9 STORAGE AND HANDLING

A. Stockpiling of earth spoil or excess earth material on the site or storage of excavated materials for reuse shall be done in a manner which will not hinder the progress of the work; cause any nuisance; or cause spillage or tracking of materials from the transporting vehicle onto public or private roadways, parking areas, sidewalks or pavements, or cause an inconvenience to adjacent property owners or tenants, general public, other contractors, or facility operations.

B. Obstruction of roads, driveways, parking areas, sidewalks, or interference with drainage along curbs, gutters, ditches, or drainage channels with stored material is not permitted.

C. On-site topsoil suitable for final placement and grading shall be excavated and stockpiled on-site for future use in accordance with Division 31 Section “Site Clearing”. Imported topsoil shall be stockpiled on-site in a separate location from on-site topsoil. Each stockpile shall be well-shaped and graded in order to shed water and to avoid contamination by other granular or earth materials temporarily stockpiled on-site. Provide and maintain erosion control (silt fence) around stockpiles.

1.10 SCHEDULING

A. If required to complete the work properly, the Contractor shall obtain grading releases from property owners near trenching or other grading operations at least ten (10) days before commencement of the work.

B. Do not commence site earth moving operations until temporary erosion- and sedimentation-control and tree- and plant-protection measures are in place.

C. Allow time to rework, screen and moisture condition on-site and/or imported soils for placement.

D. Except by permission of the Architect/Engineer, not more than 200 feet of trench shall be opened at any one time. Not more than 100 feet of trench may be opened in advance of the completed pipe laying operations; and not more than one street crossing may be obstructed by the same trench at any one time.

E. Schedule the work to allow ample time for laboratory tests and to permit the collecting of samples and the performing of field density tests during the backfilling and compaction operations.

F. All subgrades shall be approved by Architect/Engineer or Construction Manager before pipes, structures, and facilities are installed or concrete is placed. Results of the tests must be reviewed and approved by the Architect/Engineer.

G. Do not backfill against concrete elements until bearing surfaces have reached design strength or are properly braced and backfilling operations are approved.

H. Compaction shall not take place in freezing weather or when materials to be compacted are frozen, too wet or moist, or too dry.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. **Common Earth:** (for use under nonpaved areas located at least 5-feet outside building/structure limits only) - Sand, loam, gravel, or similar materials free from debris, frozen materials, organic materials, or other deleterious material, and containing some rock fragments, stones, and pebbles, not exceeding 4 inches in their largest dimension and meeting the following requirements:

1. Plasticity index of not more than 7 - ASTM D424.
2. Minimum laboratory dry weight at optimum moisture content of 110 pounds per cubic foot.

Provide imported Common Earth fill materials as required to complete the work. Contractor shall obtain rights and pay all cost for imported materials.

Proposed Common Earth fill (imported or site excavated) material shall be inspected, tested, and laboratory report issued prior to use in the work.

B. **Select Earth:** Sand, gravel, and similar material which shall be free from silt, clay, loam, organic material, roots, debris, waste, frozen material, or other deleterious materials, and shall only contain small amounts (less than 10 percent) of stone, pebbles, or lumps over one inch in greatest dimension, but none over 2 inches in greatest dimension.

Imported select earth materials shall meet requirements of the NYSDOT Standard Specification Section 203-2.02C except that no material shall exceed 2-inches in their largest dimension.

C. **Imported Topsoil:** Imported topsoil shall meet the requirements of NYSDOT Specification Section 713-01, except provide 6 percent minimum organic material. The Contractor shall be responsible for amending imported topsoil with approved materials and by approved methods to meet these requirements and in accordance with Division 32, Section “Turf and Grasses”, at no additional cost to the Owner. The material shall be stockpiled, tested and approved by Owner’s Designated Representative prior to use on the project. Obtain topsoil from naturally well-drained sites where topsoil occurs at least 4-inches deep; do not obtain from bogs or marshes.

D. Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

E. Acceptance of all types of soil materials shall be based on the above requirements, and the Owner's Designated Representative or Architect/Engineer shall make final acceptance. Such acceptance or rejection of materials is binding upon the Contractor.

2.2 GRANULAR MATERIALS

A. **Cushion Sand:** The material shall meet the requirements of NYSDOT Standard Specification Section 703-06, Cushion Sand.

B. **Bedding Sand:** Sand shall consist of clean, hard, durable, uncoated particles, free from lumps of clay and all deleterious substances. When dry, the sand shall meet the following gradation requirements:

Sieve Size	Percent Passing by Weight
1/4 inch	100
No. 50	0-35
No. 100	0-10

The sand may be determined to be unacceptable if it contains loam or silt in excess of 10 percent of the total volume.

C. **Crushed Stone:** Material shall be clean, sound, crushed stone of uniform quality. It shall be a 50-50 mixture of NYSDOT primary size designation #1 and #2 stone as per NYSDOT Standard Specifications, Section 703-02, Material Designation 703-0201. Mixture shall meet the following gradation requirements:

Sieve Size	Percent Passing by Weight
1-1/2 inch	100
1 inch	95-100
½ inch	45- 57.5
1/4 inch	0 - 7.5

D. **Subbase Material (Crusher Run):** Shall meet the requirements of NYSDOT Standard Specification Section 304-2, Type 2 within the Right-of-Way. NYSDOT Standard Specification 304.15, optional type can be used within the property.

E. **Engineered Fill (run-of-bank gravel):** Material consisting of hard, durable particles and shall meet the requirements of NYSDOT Standard Specification Section 304-2.02, Type 4. Maximum particle size 2-inches, less than 40% by weight passing the No. 40 sieve and less than 10% by weight passing the No. 200 Sieve.

F. **Select Granular Fill:** The material shall meet the requirements of NYSDOT Standard Specification Section 203-2.06, for Select Granular Fill.

G. **Underdrain Filter Material:** Shall meet the requirements of NYSDOT Standard Specification Section 605-2.02, Type II Underdrain Filter Material.

H. **Underdrain Sand Filter Material**: (Use with Type 1 Corrugated HDPE Underdrain only) Shall be coarse and medium sand meeting the following size range:

Sieve Size	% Passing
#10	97-100%
#18	85-100%
#60	0-20%
#100	0-3%

I. **Pea Gravel:** Shall be screened, washed bank-run gravel meeting the gradation requirements of ASTM D448 (size varies – No. 6 or 1/8”-3/8”).

J. **Light and Medium Stone Fill:** The material shall meet the requirements of NYSDOT Standard Specification Section 620-2.02 for light and medium stone fill.

K. Acceptance of all types of fill shall be based on the above requirements, and the Architect/Engineer shall make final acceptance. Such acceptance or rejection of materials is binding upon the Contractor

2.3 RECYCLED ASPHALT

A. Recycled asphalt (obtained from milling of existing asphalt pavement on the site) to be re-used as a partial replacement of the subbase course material should be approved by a qualified geotechnical representative, and shall consist of a well graded material having a maximum particle size of 3 inches, less than 40% by weight passing the No. 40 sieve and less than 10% by weight passing the N0. 200 sieve. We anticipate that specifying a maximum particle size of 3 inches for the recycled asphalt will help the contractor in grading operations and in meeting the compaction requirements.

2.4 LOW STRENGTH MATERIALS

A. **Controlled Low Strength Material (CLSM):** Self compacting, flowable concrete material shall conform to ACI 229R with a compressive strength of 400 psi or as otherwise indicated on the plans or specifications.

B. **Controlled Density Fill (CDF):** "K-Krete" or approved equivalent with a compressive strength of 50 to 100 psi.

2.5 GEOTEXTILES

A. **Pavement Stabilization Geotextile Fabric:** The geotextile fabric for pavement stabilization shall be Mirafi 500X as manufactured by Mirafi, AMOCO 2002, Synthetic Industries 200ST or approved equal. The geotextile fabric shall be woven fabric of only continuous chain polymeric filaments or yarns of polyester. The fabric shall be inert to commonly encountered chemicals, hydrocarbons, mildew, and rot resistant. The fabric shall be UV stabilized.

Fabric Properties – Mirafi 500x	Acceptable Value	Test Method
Grab Tensile Strength, kN (lbs)	0.9 (200)	ASTM D4632

Elongation at Failure, % MD/ CD	15/ 10	ASTM D4632
Mullen Burst Strength, kPa (psi)	2756 (400)	ASTM D3786
Trapezoidal Tear Strength, kN (lbs)	0.33 (75)	ASTM D4533
Puncture Strength, kN (lbs)	0.40 (90)	ASTM D4833
Apparent Opening Size (AOS)	50	US Std. Sieve
	0.30 mm	ASTM D4751
Permittivity, sec^{-1}	0.05	ASTM D4491
Flow Rate, $l/min/m^2$ (gal/min/sf)	200 (5.0)	ASTM D4491
UV Resistance after 500 hrs, % strength	70	ASTM D4355
	Acceptable	
Fabric Properties – Mirafi 140N	Value	Test Method
Tensile Strength, at ultimate kN/m (lbs/ft)	MD 36.5 (2500)	ASTM D6637
	XD 65.7 (4500)	
Tensile Strength, at 5% strain kN/m (lbs/ft)	MD 14.6 (1000)	ASTM D6637
	XD 65.7 (4500)	
Grid Aperture Size mm (in)	MD 25.4 (1.0)	
	XD 25.4 (1.0)	
Mass/Unit Area g/m^2 (oz/yd^2)	386 (11.4)	ASTM D5261
UV Resistance after 500 hrs, % strength	70	ASTM D4355

B. **Geogrid:** The geogrid fabric for reinforcement shall be a polyester multifilimant yarn wonven in tension and finished with a PVC coating, such as Mirafi BXG-12 as manufactured by Mirafi, or approved equal.

2.6 ACCESSORIES

A. **Warning Tape:** Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility in bold readable lettering; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.

B. **Detectable Warning Tape:** Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility in bold readable lettering, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30-inches deep; colored as follows: (Detectable warning tape shall be a minimum of 12-inches wide for utilities where Drawings indicate tape shall be buried greater than 30-inches.)

1. Red: Electric.
2. Yellow: oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

C. **Tracer Wire*:***Wire shall be 10 AWG stainless steel tracer wire. The wire shall be extended into tracer wire boxes with adequate excess wire to extend 2 feet above grade.

D. **Tracer Wire Boxes:** Tracer wire boxes in lawn areas shall be 4-inch shaft cathodic protection test boxes Model P445 DT Test as manufactured by Bingham & Taylor or approved equal. Provide cast iron rim and pentagon nut lid. Lid shall be blank with no lettering. Body of box shall be ABS plastic.
   1. Box shall be 3-foot in length with standard base.
   2. Provide each box with a terminal block containing four terminals.
   3. The box shall not transmit shock or stress to the tracer wires and shall be plumb with the box cover flush with the surface of the finished grade.

2.7 COMPACTION

A. Utilize the proper compaction methods and equipment to suit the soils and conditions encountered. Mechanical, vibratory, pneumatic tampers or other method as approved by the Architect/Engineer shall be required.

B. Provide water in sufficient quantity as needed to assure compaction.

2.8 DEWATERING, DUST AND NOISE CONTROL

A. Provide all equipment and materials necessary to perform dewatering and dust control operations in a safe and satisfactory manner. Conform to the New York State Standards and Specifications for Erosion and Sediment Control, and Division 31 Section “Erosion and Sediment Control” for proper operations.

B. Standing water and/or saturated, unstable soil conditions will not be tolerated in areas to receive foundations, utilities, or asphalt or concrete pavements.

C. Provide noise suppression enclosures, if required and as determined by the Architect/Engineer. Enclosures, if required shall meet minimum requirements of 3/8-inch plywood enclosure lined with 2-inch rigid insulation.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain erosion and sedimentation controls during earth moving operations.

B. Before placing subsequent materials remove temporary protection installed to protect subgrades and foundation soils from freezing temperatures and frost.

C. Prior to start of work, the Contractor's surveyor shall verify that all boundaries of temporary and permanent easements and property lines are clearly marked in the field so that the work will not violate these boundaries.

D. The Contractor and his surveyor shall verify the locations and character of structures, underground lines, and subsurface conditions and verify that the described work will not adversely affect them.

E. The Contractor's Surveyor shall verify that grade stakes have been properly and accurately set.

F. The Contractor shall be responsible for providing all necessary fill materials.

3.2 METHODS OF CONTROL FOR EXCAVATIONS AND GRADING

A. The Contractor shall employ at the site a NYS licensed surveyor responsible for the proper layout of utilities, structures, and drainage. He shall maintain adequate stakeout control for inspection of the work and to accurately complete construction.

B. The alignment and depth of subgrades of all pipe trenches shall be determined by overhead grade lines or laser at Contractor's option, installed and maintained by his surveyor.

C. In the event that rock is encountered, the Contractor will take cross sections of the rock uncovered. No removal shall begin until adequate time has been given the Owner's Designated Representative or Architect/Engineer for inspection and to verify the measurement of rock material.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 EARTH MOVING, GENERAL

A. The work shall be performed by methods acceptable to the Owner's Designated Representative or Architect/Engineer.

B. Excavation shall include the satisfactory removal and disposal of all materials encountered, regardless of the nature of the materials, or the manner in which they were excavated, except materials classified as rock excavation.

C. Excavate to subgrade elevations. Do not excavate rock until it has been classified and cross sectioned.

D. All pipe lines or existing structures encountered during the excavation operation and designated to remain shall be properly supported/protected to prevent damage.

E. Erosion and sedimentation control measures meeting the requirements of Division 31 Section "Erosion and Sediment Control" shall be used around all earthen material stockpiles.

F. Provide and maintain adequate temporary crossovers for pedestrian and vehicular traffic, including temporary gravel drives, steel plates, guardrails, lamps, flags; remove same when necessity for such protection ceases. All traffic maintenance shall be done in a manner satisfactory to the Owner's Designated Representative or Architect/Engineer.

G. Provide and maintain suitable temporary crossings over open trenches where necessary to maintain access for other Contractors, the Architect/Engineer or general public (if applicable).

H. The Contractor shall have available a supply of steel plates with minimum dimensions of 4 feet x 8 feet x 1 inch, or thicker, as required by jurisdictional authorities and to maintain emergency access and egress to the site. The plates shall be used to bridge open trenches crossing roadways, or driveways as directed by the Architect/Engineer. When used, they shall be secured against the possibility of shifting or dropping into the excavation. During winter months, these plates shall not be left in the roadway or driveway overnight unless specifically required by the Architect/Engineer. If required to be left overnight "Road Plate Ahead" warning signage shall be used.

I. When excavating in or adjacent to the traveled portion of highways, driveways, or parking areas take whatever measures are necessary to protect the road/drive/parking surfaces from becoming undermined.

J. Protect trees indicated to remain in accordance with Division 31 Section "Site Clearing".

K. All traffic maintenance shall be done in a manner satisfactory to the Architect/Engineer.

3.5 SOIL STABILIZATION

A. Sloped sides of excavations shall comply with local codes, ordinances, and requirements of agencies having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfilling and/or filling.

B. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross braces, etc. in good serviceable condition. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Extend shoring and bracing as excavation progresses.

C. Daily inspections of excavations shall be made by an authorized competent representative of the Contractor performing the excavation work.

3.6 DRAINAGE/DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

1. Surface and ground water shall be intercepted and removed before entering excavations. All necessary measures shall be taken. Earth dikes, ditches or other devices, if required, shall be constructed to prevent such flows.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

2. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations.

3. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

C. The Contractor shall at all times provide and maintain proper and satisfactory means and devices (i.e. ditches, temporary pipes, pumps, and/or other temporary construction) for the removal of all water entering the excavations. Water shall be removed as fast as it may collect, in such manner that shall not interfere with the execution of the work or in the proper placing of pipe, structures or other work.

D. The Contractor shall make his own determination as to required dewatering operations necessary to complete the work. Contractor shall have available at all times sufficient equipment, machinery, piping, and appurtenances for pumping water to keep excavations free from water during construction.

E. Where the presence of fine grained subsurface materials and high groundwater table may cause the upward flow of water into the excavation with a resulting quick or unstable condition, the Contractor shall install and operate a well point system to prevent the upward flow of water during construction.

F. All water removed from the trenches or excavations by pumping, bailing, siphoning, well-points, or other means shall be disposed of in such a manner so as to avoid damage to the work, work of other Contractors, surface and ground water, persons or property. Unless otherwise permitted by the Architect/Engineer, groundwater encountered within the limits of excavation shall be depressed to an elevation not less than 12 inches below the bottom thereof before pipe laying, concreting or masonry is started, and shall be so maintained until concrete and joint material have attained adequate strength.

G. The Contractor shall not discharge water from dewatering operations directly into any line or intermittent stream, channel, wetlands or surface water. The Contractor shall not discharge water from dewatering operations directly into the storm or sanitary sewer system without prior approval of the Architect/Engineer. If the quality of the trench water is not better than or equal to that of the receiving stream, the Contractor shall perform all work necessary to improve the quality of the removed water in accordance with all requirements of the agencies having jurisdiction. This work shall include, but not be limited to, filtration, settling, and screenings meeting the requirements of the New York State Standards and Specifications for Erosion and Sediment Control to reduce the amount of sediment contained in the water to allowable levels, as acceptable to the Architect/Engineer, prior to disposal.

H. All costs to ensure proper drainage, dewatering and discharge from dewatering operations shall be at the Contractor's expense.

I. The Contractor shall be responsible for repairing, at his own expense, any ruts, gullies, sloughage, slides, and cleaning or repairing any catch basins or storm drainage lines which display signs of silt build-up during the course of construction until the contract is complete.

J. Provide adequate protection from the effects of possible uplift due to storm or groundwater where buoyancy might lift installed work or cause joint or structure failure during construction.

K. Protect the interior of installed work from the entering and accumulation of liquids, ice, and snow. Immediately remove and dispose any accumulation, which may occur.

L. Adjust, repair, replace, or clean all work, surfaces, and property, which may have been damaged as a result of any dewatering operation.

3.7 EARTH FILL

A. Unless otherwise specified, shown on the Contract Drawings, or directed by the Owner's Designated Representative or Architect/Engineer, trench and utility backfill material and earth fill located 5 feet outside pavement, building or structure limits shall be Common Earth while, earth fill to subgrade (where earth fill is permitted) located under or within 5 feet of buildings, structures or pavements shall be Select Earth.

B. To the extent it is available, Common Earth and Select Earth fill material shall consist of approved on-site materials excavated and removed to accommodate new construction. On-site soils modifications including screening and soils conditioning to meet gradation and compaction requirements will be required. When there are insufficient approved suitable materials on-site, import additional material from off-site at no additional cost to the Owner. The Contractor shall obtain all permits necessary to furnish off-site borrow.

C. The excavated material to be used for trench or structure backfilling or earth fill shall be stored and properly protected by the Contractor so that it will remain suitable for the intended reuse. Excavated materials, which become unsuitable as a direct result of the Contractor's work or lack of protections shall result in rejection of the unsuitable material by the Architect/Engineer.

D. No payment will be made for stockpiling, rehandling, transporting, removing, or disposing of any materials, which become contaminated or unsuitable and are subsequently rejected by the Architect/Engineer. No payment will be made for additional imported materials required to make up the deficiency in backfill or fill resulting from these rejected materials.

E. No extra payment shall be made for any excavating, stockpiling, rehandling, transporting, or disposing of any unsuitable material, the cost shall be included in the price bid. Any deficiency in backfill or fill shall be made up in spoil, if suitable and appropriate for application or by imported material acceptable to the Owner's Designated Representative or Architect/Engineer. No payment shall be made for making up any deficiency; the cost of such shall be included in the price bid.

3.8 SOIL CONDITIONING

A. Provide all wetting, drying, mixing and screening equipment and materials necessary to condition on-site soils to optimum moisture for compaction and required gradation.

B. Allow time to rework, screen and moisture condition on-site soils for placement.

C. If in the opinion of the Owner's Designated Representative or Architect/Engineer, the Contractor does not take reasonable care to protect and prepare suitable on-site soils for project use, the Contractor shall provide suitable imported materials at no additional cost to the Owner. Suitable imported materials shall include granular materials meeting NYSDOT Item 304.14 in areas under

and within 5 feet of structures or buildings; granular materials meeting NYSDOT Item 304.12 in areas under and within 5 feet of pavements and utility structures; and, Select Earth in all other areas. Excess unsuitable materials replaced by imported materials shall be removed at no additional cost to the Owner. Refer to Part 1 "Summary – Special Requirements" and the geotechnical report for additional information regarding reuse of on-site soils.

D. Moisture Control: Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   1. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material. Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations.

E. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to permit compaction to specified density.

F. Stockpile or spread soil material that has been removed because it is too wet to permit compaction. Assist drying by discing, harrowing, or pulverizing until moisture content is reduced to a satisfactory value.

3.9 MANNER OF EXECUTION

A. Materials for reuse on the project shall be stockpiled in an approved designated area adjacent to the work site. Suitable excavated material to be used for trench backfill or earthen fill shall be properly segregated by the Contractor to avoid mixture with topsoil or other unsuitable materials. Contamination of the excavated material as a direct result of the Contractor's work shall result in rejection of the contaminated material by the Owner's Designated Representative or Architect/Engineer.

B. The excavated material to be used for trench backfill or earthen fill shall be stored so that it will cause a minimum of inconvenience to public travel, active facility, adjacent owners or tenants and other contractors or subcontractors. Excavated material shall not be stored in the roadway, parking areas or sidewalks at any time.

C. Conduct operations in a manner, which will keep the work free of standing and flowing water and dispose the water so as not to damage or create a nuisance to the work, the public, surface, groundwater, and adjacent properties.

D. The accumulation of liquids, ice and snow in excavation, trenches, areas to be graded, and adjacent areas during construction is not permitted.

E. Keep graded surfaces well drained, but avoid erosion. Do not place earth or granular fill on wet grade, in water, or over frost, ice or snow. Excavations shall be maintained free of water.

F. Pipe trenching, building foundations, and structural undercuts: Under normal conditions, the excavation shall be vertical open cut from the ground surface. Tunneling beneath trees and certain surface structures may be required.

G. Bottom of excavations shall be finish graded by hand methods to receive bedding. The stone bedding shall be placed, compacted, and trimmed by hand to ensure the grade as necessary or as detailed.

H. Trench sheeting and bracing shall be placed as required to meet local, state and federal safety regulations.

I. The Architect/Engineer reserves the right to order sheathing and bracing left in place where removal may create damage or impair integrity of the work.

The right of the Architect/Engineer to order sheathing and bracing left in place shall not be construed as creating any obligation on his part to issue such orders. His failure to exercise his right to do so shall not relieve the Contractor of any liability for damages to persons or property occurring from or upon the work of constructing the sewer, water main, or appurtenances occasioned by negligence or otherwise, growing out of a failure on the part of the Contractor to leave in place in the trench sufficient sheathing and bracing to prevent the caving or moving of the ground, or disturbance of the completed work or any of the subsurface structures.

J. As required, the Contractor may add sufficient water during compaction to assure a complete consolidation of the material. This work shall be at no additional cost to the Owner. Where, in the opinion of the Owner's Designated Representative or Architect/Engineer, adequate consolidation is not being obtained, additional density tests may be ordered at the expense of the Contractor.

K. The Contractor shall make up any settlement of trenches or embankments with suitable material and stabilize at no additional cost to the Owner. This work shall be performed promptly and as directed by the Owner's Designated Representative

3.10 GRADING

A. General: Excavate, transport, place, compact and uniformly grade areas within the project limit (including excavated and filled sections and adjacent transition areas) to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
3. The degree of finish shall be that is ordinarily obtainable from either a blade, grader or scraper operations.
4. Subgrade surfaces shall drain, be compacted, and well graded.

B. Temporary Ditches, Swales: Install temporary or permanent diversion ditches and/or temporary pumps and take other steps as may be required to effectively eliminate potential water damage in accordance with the Division 31 Section "Erosion and Sediment Control" or instructions received from the Architect/Engineer.

C. The Contractor shall be responsible to subtract from finished grades shown on the plans the depths indicated on the Contract Drawings to ensure that the proper subgrade elevations are established. Any questions regarding subgrade elevations shall be answered by the Architect/Engineer. The Architect/Engineer's decision shall mandate.

D. Site Rough Grading:

1. Unauthorized Excavation: Do not perform excavation work for any purposes other than those indicated on the Contract Drawings, unless so directed by the Architect/Engineer.
2. Slope grades to direct water away from buildings and to prevent ponding.
3. Finish subgrades to required elevations within the following tolerances:
   a. Turf, Planted Areas or Unpaved Areas: Plus or minus 1 inch.
   b. Walks: Plus or minus 1 inch.
   c. Pavements and slabs: Plus or minus 1/2 inch.

E. Grading under and within 10 feet of Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

F. Slopes: All swales shall be finished to drain readily. Unless otherwise indicated on the Contract Drawings, the surface of the subgrade in areas to receive lawns shall have a minimum slope of 2% unless otherwise agreed upon by the Architect/Engineer. All areas shall have positive drainage.

Round tops and bottoms of all slopes and drainage swales. Adjust slopes at intersections of cuts and fills and warp to flow into each other or into the natural ground surface without noticeable break. Establish earth at tops and bottoms of rock ledges in accordance with instructions received from the Architect/Engineers and in a manner that will prevent erosion.

G. Following stripping, the subgrade shall be compacted sufficiently to develop required compaction to a depth of at least 12 inches. Within building, pavement and retaining wall limits, no fill shall be placed until the subgrade has been proofrolled and approved by the Architect/Engineer. If subgrade ruts, waves or quakes during proofrolling, recompact or replace the unacceptable areas and proofroll again. Repeat process until satisfactory results are obtained as approved by the Architect/Engineer.

H. The Contractor shall dispose of excess excavated material in accordance with Part 3-Disposal.

3.11 EXCAVATIONS BELOW SUBGRADE

A. In case earth materials encountered at subgrades are unsuitable, the Contractor shall immediately notify the Architect/Engineer and shall excavate from the limiting subgrades shown or specified, to such new lines and grades, as will be ordered. Excavation below subgrade shall be done only upon express orders of the Owner's Designated Representative or Architect/Engineer.

B. At subgrade in pavement areas any loose, soft, wet, frozen, organic, or otherwise unsuitable material shall be removed.

C. Whenever excavations are carried beyond or below the lines and grade shown on the Plans, or as given or directed by the Owner's Designated Representative or Architect/Engineer, all such over-excavation shall be backfilled with special backfill such as: engineered fill; concrete or other materials as directed by the Owner's Designated Representative or Architect/Engineer.

1. Fill over-excavations under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Whether over-excavation was directed by the Owner's Designated Representative or Architect/Engineer or unauthorized, backfill shall be 2,500 psi concrete.

2. Fill authorized or unauthorized over-excavations below other construction, pipe, or conduit as directed by Owner's Designated Representative.
3. In pavement areas fill over-excavations with Engineered Fill.

D. Special backfill materials ordered by the Architect/Engineer as a result of unauthorized over-excavation by the Contractor without prior approval shall be provided by the Contractor at no additional cost to the Owner.

E. Payment for authorized over-excavation and subsequent backfill materials shall be on a unit price basis agreed between the Owner and the Contractor prior to the required work.

F. All material which slides, fails, or caves into the established limits of excavations due to any cause whatsoever, shall be removed and disposed of at the Contractor's own expense and no extra compensation shall be paid the Contractor for any materials ordered for backfilling the void areas left by the slide, fall, or cave-in. It is the Contractor's responsibility to make all excavations safe for ongoing construction.

3.12 UNSTABLE SOILS REMOVAL METHODS (if required)

A. Methods of Removal: Prior to the start of excavation operations, divert water away from work area and create dry conditions. Through the use of dragline, clamshell, or other necessary equipment, excavate and legally dispose of all unacceptable material.

B. Precautionary Measures: Divert the run-off of mud and water during the course of removal of wet and unstable material to avoid adversely effecting adjacent construction or site improvement operations. Barricade, rope off, or otherwise protect workmen, active facility, and the public from open excavations, waterholes, and other hazards resulting from the work of this operation.

C. Damage: The Contractor shall correct any damage to structures, foundations, site improvement work or adjacent property resulting from the work of this operation.

D. Degree of Removal Required: Remove all unstable material to the point of sound stable earth or as directed by the Architect/Engineer.

3.13 ROCK EXCAVATION (if required)

A. Degree of Removal required: Rock, if encountered shall be removed to depths (pay lines) as follows:

1. In Building Areas
    a. 2-foot outside of concrete work for which forms are required, except footings.
    b. 1-foot outside perimeter or concrete forms of footings.
    c. Outside dimensions of concrete work where no forms or exterior waterproofing treatments are required.
    d. Under slabs on grade: to subgrade or 8-inches below bottom of concrete slab whichever is greater.
2. Under Areas to Receive Pavement - To the surface of the respective subgrade for such areas. Boulders or isolated pockets of rock shall be removed to 12-inches below the pavement subgrade and the resultant excavation backfilled with pavement subbase-course material.
3. Under Lawn and Planted Areas - To 24-inches below finished grade. Boulders or protruding

rock outcropping where in the manner determined by the Architect/Engineer may be left undisturbed, provided a directive to this effect is transmitted to the Contractor.

4. In pipe trenches for pipes 18-inch diameter and smaller: 6-inches below bottom of pipe and 2-feet wider than outside diameter of pipe, one (1) foot each side of pipe, but not less than 3-foot minimum trench width.
5. In pipe trenches for pipes larger than 18-inch diameter refer to Contract Drawing details for additional rock removal requirements.
6. In all other cases to 6-inches below subgrade.
7. No payments will be made for excavation beyond pay lines.

B. No blasting is allowed.

C. The Contractor is responsible for measurement of rock material in place. (Also refer to Part 3 – Methods of Control of Excavation and Grading.)

D. Payment for rock removal shall be on a unit price basis agreed between the Owner and the Contractor prior to rock removal.

3.14 EXCAVATION FOR STRUCTURES

A. Excavations for structures and facilities shall be of sufficient size to give suitable room for proper construction procedures and no larger, or as shown on the Contract Drawings.

B. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections. Provide clearance sufficient for formwork. Banks and sides shall be at angle of repose of recline or sheathed, sheeted, shored and braced as required for safety, and conforming to all applicable laws, rules, regulations and codes. Remove shoring prior to backfilling, unless otherwise directed by Architect/Engineer.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades and remove loose materials and debris from excavation so that all footings rest on solid rock or approved undisturbed bearing soil, to leave solid base to receive other work.
2. If unsuitable bearing soil is encountered at depth indicated on Contract Drawings for foundation, the Contractor shall notify the Architect/Engineer and shall not proceed further until direction is given.
3. Pile Foundations: Stop excavations 12 inches above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
4. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

C. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Cut and protect roots according to requirements in Division 31 Section "Site Clearing", Part 3 -Tree and Plant Protection.

D. Ensure that movement of equipment in excavation does not cause working or pumping of underlying soil, which is not to be excavated. Should equipment cause the soil to work or pump, use other methods of excavation to maintain the design bearing capacity of the soil.

3.15 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.16 EXCAVATION FOR UTILITY TRENCHES

A. General

1. Trenches shall be excavated as shown on the Contract Drawings.
2. Before any trenching operation starts, the line of work shall be cleared and all existing underground pipe lines and structures located. Test pits shall be opened where necessary to properly establish the location.
3. When trenches crossing other pipe lines occur, machine excavation shall stop at least 2 feet away from the location of any pipe. The pipe line shall than be uncovered by manual excavation before proceeding with machine work.
4. Trenches shall be kept free of water by pumping or providing well points.
5. Trench sheeting and bracing shall be placed as required to meet local, state and federal safety regulations.
6. All pipe lines encountered during the trenching operation shall be properly supported to prevent damage.

B. Excavate trenches to indicated gradients, lines, depths, and elevations.

C. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches minimum each side of pipe or conduit or as indicated on the various utility trenching and bedding details on the Contract Drawings.

D. **Trench Bottoms:** (Where bedding course is not required.) Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
4. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course. Refer to Part 3 – Rock Excavation

E. **Trench Bottoms**: (Where bedding course is required [e.g. facility water main, storm and sanitary sewers; and, pipes or conduits constructed under footings or foundations)

1. For pipes and conduits 18-inches or smaller in nominal diameter, excavate trenches minimum of 6-inches deeper, than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
2. For pipes 21- to 36-inches in nominal diameter excavate trenches minimum of 9-inches deeper, than bottom of pipe and conduit elevations to allow for bedding course.
3. Excavate trenches in rock or other unyielding bearing material to depths indicated above depending on pipe or conduit size to allow for bedding course. Refer to Part 3 – Rock Excavation.

F. **Trenches in Tree- and Plant-Protection Zones**:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
3. Cut and protect roots according to requirements in Division 31 Section “Site Clearing”, Part 3-Tree and Plant Protection.

3.17 SUBGRADE INSPECTION

A. Notify Owner’s Designated Representative when excavations have reached required subgrade.

B. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 10 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Proof-rolling shall be witnessed by the Architect/Engineer or his designated representative.
2. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph.
3. Excavate any loose, wet, frozen, or soft spots; unsatisfactory soils; and areas of excessive pumping or rutting, as determined by Architect/Engineer and replace with compacted backfill or fill as directed. Refer to Part 3- Excavations Below Subgrade.
4. If subgrade ruts, waves or quakes during proof rolling, recompact or replace unacceptable area and proof roll again.
5. Repeat process until suitable results are obtained as approved by the Architect/Engineer or his designated representative

C. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect/Engineer and/or Owner's Designated Representative, without additional compensation.

3.18 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust. All stockpiled materials shall be stored in locations so as not to endanger the work, and so that easy access may be had at all times to all parts of the excavation. Stored materials shall be kept neatly piled and trimmed, so as to cause as little inconvenience as possible to other Contractors on site, to adjoining property owners and to the active facility.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

B. Topsoil suitable for final grading shall be removed and stored on-site separately from other excavated material.

C. Place, grade and shape stockpiles for proper drainage. Provide proper erosion control measures around stockpiles.

3.19 BACKFILL

A. All excavations shall be backfilled to the original surface of the ground or to the lines and grades as shown on the Contract Drawings or as otherwise specified, or directed. Backfilling shall be done with suitable excavated materials as shown on the Contract Drawings or approved by the Architect/Engineer, and satisfactorily compacted.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

C. Place and compact backfill in excavations promptly, as work permits but not before completing the following:

1. Acceptance of construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Inspection, testing, approval, and recording of locations and inverts for underground utilities has been performed and documented.
3. Removal of concrete formwork.
4. Removal of temporary shoring and bracing, and sheeting and backfilling of voids with satisfactory materials.
5. Removal of trash and debris from excavation.
6. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

D. Excavated material considered by the Owner's Designated Representative or Architect/Engineer to be unsuitable for backfilling shall not be used, and shall be disposed in accordance with Part 3-Disposal of Excess and Waste Materials.

3.20 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill and compact trenches excavated under footings and within 18-inches of bottom of footings with 1000 psi CLSM to elevation of bottom of footings plus 3 inches.

1. Backfill trenches with 1000 psi CLSM where trench excavations pass horizontally within 18-inches of column or wall footings and that are carried below bottom of such footings or that pass under wall footings. Place CLSM to level of bottom of adjacent footing plus 3 inches.

D. Trenches where Concrete Encasement shown: Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Division 03 Section "Cast-in-Place Concrete."

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Place and compact initial backfill as shown on details.

1. For soil and granular initial backfill: Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

2. For Controlled Low-Strength Material: Where CLSM indicated, place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.

G. Place and compact final backfill to final subgrade elevation.

H. Install warning tape/detectable warning tape at elevations as shown on the Contract Drawings. Where not shown on the Contract Drawings install warning tape, centered and 12 inches above utility.

I. All pipes shall be protected from lateral displacement and possible damage resulting from backfill operations through, impact or unbalanced loading, by maintaining the pipe adequately embedded as detailed on the Plans. Except where detailed or due to subsoil conditions that require the use of concrete cradle encasement, all pipe embedment shall be placed so as to ensure adequate lateral and vertical stability of the installed pipe during pipe jointing and backfill operations. A sufficient amount of the specified pipe backfill material to hold the pipe in rigid alignment shall be uniformly deposited and thoroughly compacted below, on each side, as well as above each pipe laid in accordance with the limits as shown on the Contract Drawings.

J. Pipe initial backfill shall be granular material or as indicated on the Contract Drawings. Pipe initial backfill materials placed any point below an elevation of 12 inches above the top of the pipe barrel shall be placed and compacted in layers not to exceed 6 inch lifts and shall be done simultaneously and uniformly on both sides of the pipe to the limits as shown on the Contract Drawings. All such materials shall be graded in the trench with hand tools in such a manner that

they will be placed uniformly alongside the pipe. Each layer shall be thoroughly compacted to prevent settlement.

K. Trench final backfill when placed under pavements, utilities, buildings and other structures shall be Engineered Fill, Subbase Material or as indicated on the Contract Drawings and shall extend from the top of pipe initial backfill material to the bottom of the subbase. These materials shall be compacted in layers not to exceed 6 inch lifts. Each layer shall be thoroughly compacted to prevent settlement.

L. Trench final backfill outside of pavements, utilities, buildings, and other structures shall consist of common earth backfill or as otherwise shown on the Contract Drawings and shall extend from the top of pipe initial backfill material to the bottom of the topsoil. These backfill materials shall be compacted in layers not to exceed 12-inch lifts after compaction. Each layer shall be thoroughly compacted to prevent settlement.

M. Where trenches are constructed in, near, or across roadway ditches or other watercourses, the backfill shall be protected from surface erosion.

N. Trucks or other heavy equipment shall not be operated over pipelines until a minimum of 24 inches of backfill above the crown of the pipe has been placed and properly compacted.

O. Where pedestrian, bicycle or vehicle traffic is impacted; all trenches within paved areas shall be immediately restored to existing grade with temporary subbase material to allow traffic flow to continue until final restoration is complete.

P. Trench backfill for waterway crossings, if any, shall include 18 inches of medium stone fill rock lining meeting the requirements of this Section.

Q. Do not backfill trenches until tests and inspections have been made and backfilling is authorized by the Architect/Engineer. Use care in backfilling to avoid damage or displacement of pipe systems.

3.21 BACKFILLING OR PLACING FILL AROUND STRUCTURES

A. Location of Fill Types: (Where not otherwise shown on the Contract Drawings)

Type 1 (Select Earth Fill) - In all areas outside of building area to within 6" of finished grade, except at asphalt, concrete or brick pavements; curbing; concrete slabs; or graveled areas; where it is to be brought to an elevation appropriate to allow all subbase, asphalt, concrete or brick materials to be placed to grade as shown on the Contract Drawings.

Type 2 (Engineered Fill) - In all fill areas within the building up to the subgrade limits.

Type 3 (Subbase NYSDOT 304-2, Type 2) – Subbase under slabs. Depth as indicated on the Contract Drawings.

B. Backfilling around structures shall not be commenced until directed by the Owner’s Designated Representative.

C. Prior to backfilling, a minimum of seven (7) days cure time shall elapse from the placing of cast-in-place concrete. The Contractor shall comply with any special requirements noted on the Contract Drawings. In no case shall backfill materials be allowed to fall directly on a structure or to damage the structure or its protective coatings.

D. Backfill around structures shall be deposited in horizontal layers not more than 6- to 8-inches in thickness and shall be compacted by tamping to prevent settlement. Backfill shall be no more than 4 inches thick when hand-operated equipment is used. Backfill shall be brought up evenly on all sides of structures so as not to subject the structure to unequal loadings. Do not backfill against unsupported walls or structures.

E. Evenly distribute stones in fill, none over 3-inch diameter within top 12-inches of subgrade. Remove rocks and compact each layer of fill before applying next layer. Slope to prevent ponding of water and to provide positive drainage away from building(s) and roadways. Dewater as required to prevent water from setting in excavated and graded areas. No backfilling will be allowed in areas full of water.

F. At all times the Contractor shall maintain and operate proper and adequate surface and subsurface drainage methods to the satisfaction of the Owner's Designated Representative in order to keep the construction site dry and in such condition that placement and compaction of fill may proceed unhindered by saturation of the area. During construction, the surface of the fill area shall be left in such condition that precipitation and/or surface water will run off.

G. Place underslab base material (Type 3 Fill as noted above) after all underslab mechanical lines, electrical conduits, etc. have been installed. Protect lines, etc. as required.

H. When a compacted course is indicated to be 6" thick or less, place material in a single layer. When indicated to be more than 6" thick, place material in equal layers, except no single layer more than 6" or less than 3" in thickness when compacted

3.22 EMBANKMENT CONSTRUCTION (if required)

A. Prior to the placement of materials in fill sections, remove all debris and other deleterious material and stabilize all existing surfaces.

B. Ground surfaces sloped steeper than 1 vertical on 4 horizontal shall be plowed, scarified, stepped, or broken up to permit bonding of the embankment with the existing surface.

C. Prior to placement of fill, the embankment foundation shall be thoroughly inspected by the Architect/Engineer. The embankment foundation shall be proof rolled by a roller or loaded ten wheeler (not less than 10-tons) to the satisfaction of the Architect/Engineer. Proofrolling shall be witnessed by the Architect/Engineer or his designated representative. Any loose, soft, wet, frozen, organic, or otherwise unsuitable material shall be removed and replaced with Engineered Fill. If embankment foundation ruts, waves or quakes during proof rolling, recompact or replace unacceptable area and proof roll again. Repeat process until suitable results are obtained as approved by the Architect/Engineer or his designated representative.

D. Uniformly place and spread fill in successive horizontal layers not more than 8-inches in compacted depth for material compacted by heavy compaction equipment, and not more than 4-inches in loose depth for materials compacted by hand operated tampers. Complete compaction to proper density and complete compaction testing prior to placing additional backfill material.

E. The embankment shall be constructed with suitable on-site materials amended as needed to meet application. When on-site material supplies are exhausted, additional suitable imported material shall be used to complete the embankment. The Architect/Engineer shall be the sole judge of what constitutes suitable and unsuitable material.

3.23 SUBSURFACE DRAINAGE

A. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 12 inches.

1. Compact each filter material layer to 85 percent of maximum density with a minimum of two passes of a plate-type vibratory compactor.

B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 12 inches.

1. Compact each filter material layer to 85 percent of maximum density with a minimum of two passes of a plate-type vibratory compactor.
2. Place and compact impervious fill over drainage backfill in 6-inch thick compacted layers to final subgrade.

3.24 PREPARATION OF PAVEMENT SUBGRADES

A. Shape the entire subgrade to the required line, grade, and cross slope. Remove any protruding stones larger in diameter than 5 inches and fill the resulting depressions with Subbase Material.

B. Proof-roll the subgrade in accordance with Part 3 Subgrade Inspection. Proofrolling shall be witnessed by the Architect/Engineer or his designated representative. Any loose, soft, wet, frozen, organic, or otherwise unsuitable material shall be removed and replaced with Engineered Fill. If subgrade surface ruts, waves or quakes during proof rolling, recompact or replace unacceptable area and proof roll again. Repeat process until suitable results are obtained as approved by the Architect/Engineer or his designated representative.

C. Roll the subgrade surface with a roller weighing not less than 10 tons and achieve the required compaction densities. If during construction, the Contractor allows the subgrade to become wet and rutted, Contractor shall re-shape, aerate, and recompact subgrade, as required. Compact the entire width of the area to receive pavement and shoulders. Where subgrade failures occur due to rolling, thoroughly roll and compact these areas until no further consolidation is apparent.

D. When pavements cannot be placed immediately after the preparation of the subgrade, the entire, subgrade area shall be restricted to construction traffic until subbase materials can be placed.

E. After rolling, the finished subgrade shall not vary from the established grade and cross slope by more than the tolerance indicated in Part 3-Grading.

F. Do not disturb the finished subgrade by traffic or other operations and protect and maintain in a satisfactory condition until the overlaying granular materials are placed.

G. Any deteriorated subgrade areas that occur during construction are to be removed and repaired by Contractor prior to placement of subbase at no additional cost to Owner.

3.25 STABILIZATION FABRIC (if required)

A. The stabilization fabric shall be placed over subgrade only after the subgrade has been reviewed and limits for fabric established by the Architect/Engineer.

B. The fabric shall be unrolled over the designated subgrade area with a 24-inch overlap at fabric ends and allowing 18-inch overlap on sides. Prior to placement of subbase materials the fabric shall be pulled tight leaving no waves in the fabric.

C. Subbase materials shall be placed on the fabric in such a manner that equipment does not come in contact with the fabric, the fabric remains in tension and no damage to the filter cloth from equipment or subbase materials occurs. All fabric placed shall be covered with fill the same day.

D. Fabric, which becomes damaged prior to covering, shall be removed over its full width and replaced with new fabric, overlapping as stated above.

E. Maintain a minimum of 8 inches loose thickness of aggregate above stabilization fabric subject to traffic.

3.26 SUBBASE COURSES UNDER PAVEMENTS AND WALKS

A. The Contractor shall notify the Architect/Engineer at least three days before any subbase material is scheduled to be placed.

B. Place subbase course on subgrades free of mud, frost, snow, or ice.

C. Subbase shall be placed to the thickness and limits as shown on the Contract Drawings.

D. On prepared subgrade, place subbase course under pavements and walks as follows:

1. Install separation or stabilization geotextile (where required) on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Shape subbase course to required crown elevations and cross-slope grades.
3. Place subbase course 6 inches or less in compacted thickness in a single layer.
4. Place subbase course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
5. Each course shall be compacted with a vibratory compactor capable of producing a minimum dynamic vibration force of 27,000 pounds.
6. Compact subbase course at optimum moisture content to required grades, lines, cross sections, and thickness. Meet compaction requirements in accordance with this specification.

E. Compaction for driveways or roadways shall proceed in the longitudinal direction to traffic flow and be performed in accordance with NYSS Section 304. Compaction for parking areas shall commence on one side of an area and gradually proceed to the opposite side. When rolling has been completed in one direction, the rolling shall commence in a direction 90 degrees from the first rolling. Bus loops, if any shall be considered as a driveway and shall only be rolled longitudinally.

F. After completion of rolling, no traffic shall be permitted over the compacted course and no hauling other than necessary for bringing material for next course will be allowed. Each

compacted course shall be tested with a straight edge 16 feet in length and any depressions greater than 1/4 inch in depth shall be re-graded until the depressions are corrected. The finished surface shall be smooth compact and dry.

G. All voids in the top subbase course shall be removed by re-grading and compacting to the satisfaction of the Architect/Engineer.

H. Thickness tests and compaction tests shall be conducted on the subbase courses. The Contractor shall hand dig holes, not less than 3" in diameter through the subbase, at locations designated by the Architect/Engineer. The Architect/Engineer shall measure the thickness and if any deficiencies are found, they shall be corrected. These tests may be conducted on an average of one test every 200 feet.

3.27 DRAINAGE COURSE UNDER CONCRETE BUILDING SLABS-ON-GRADE

A. Place subbase course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade as indicated, according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches or less in compacted thickness in a single layer.
3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum density according to ASTM D 1557.
5. Place vapor barrier Specified in Division 03 Section "Cast-in-Place Concrete".

3.28 COMPACTION OF SOIL (EARTH & GRANULAR) BACKFILLS AND FILLS

A. Performance:

1. Compaction densities shown are percentages of the maximum density obtainable at optimum moisture content as determined by ASTM D1557, Method C.
2. Uniformly spread each layer. Moisten or dry each layer of material to achieve optimum moisture content. Unless otherwise specified or directed by Architect/Engineer, compact each layer of material to the following required densities:

Location	Percentage of Modified Proctor Test Density
Under concrete slab, foundations, and footings	95%*
Backfill at Structures	95%
Undercut Backfill	95%
General Fill adjacent to and outside of Buildings	93%
Structural Engineered Fill at Bldgs	95%

Embankments	95%
Pavement Areas (asphalt and concrete and brick)	95%
Impervious Barriers	95%
Trench Backfill Under Traffic Areas (Including sidewalks) Non-Traffic areas	 95% 90%
Other Landscaped Areas	90%
*100% for granular material if specified	

B. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

C. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

3.29 FIELD QUALITY CONTROL AND TESTING

A. Contractor shall provide free access to Work and shall provide assistance and cooperation with appointed testing firm during testing. Coordinate operations to allow ample time for the required sampling and testing.

B. Soil density and optimum moisture content tests for each source of <u>imported</u> material shall be conducted by the Contractor's independent, Architect/Engineer approved laboratory and shall be re-tested upon each significant change of material. Costs shall be included in the price bid.

C. Samples from each source of material shall be made available to the Architect/Engineer for approval and testing purposes one week prior to its use.

D. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

E. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during soils and granular material placement. Field density and moisture testing shall conform to the requirements of ASTM D1556 (sand core) or D2922 and ASTM D3017 (nuclear density). Soils shall be described in accordance with ASTM D2488, Visual-Manual Procedure.

F. The following tests **will** be performed:
   1. Perform a laboratory maximum density test for each type of **on-site** soil proposed for use or encountered in the work. Determine optimum moisture content in accordance with ASTM D1557, Method C.

G. The following tests **may** be performed:

1. Perform a laboratory maximum density test for each type of Contractor imported soil or granular material proposed for use to verify Contractor submitted information. Determine optimum moisture content in accordance with ASTM D1557, Method C.

H. Architect/Engineer will designate the time, date, and exact location of all field compaction density tests. Field density tests may be ordered by the Architect/Engineer at his discretion and at a minimum in accordance with the following average frequencies per lift:

1. General: One test for each type of fill and at each change in material or supplier.
2. Backfill for Foundations, Retaining Walls and Utility Trenches: At least one test for each layer of compacted fill and base material at intervals of approximately 50 feet along structure walls (foundation or retaining) and utility trench backfill on alternating lifts.
3. Embankments, Pavement Areas (asphalt, concrete, brick): At least one test on each 2,000 sq. ft. or less of mass fill placed under roadways, pavements (asphalt, stone or concrete) and sidewalks but not less than three tests for each partial lift.
4. Under Structures, Foundations, Slabs, Retaining Walls and Footings: At least one test on each 2,000 sq. ft. or less of mass fill placed under structures, foundations, floor slabs, retaining walls and footings with at least three tests for each partial lift.
5. Under Building Pads: Perform at least one test of subgrade for every 2,000 sq. ft. of building pad, but in no case fewer than three tests of subgrade. In addition, for each layer of compacted fill or backfill, if any, perform one field test for every 1,000 sq. ft. of overlaying building slab, but in no case fewer than three tests per lift. Compaction tests for areas under building slabs shall be completed not more than 24-hours prior to placement of concrete.
6. Landscaped Areas: One test per 300 cubic yards of compacted fill or backfill but not less than two per lift.

I. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

J. Compacted soils not meeting compaction densities shall be re-excavated, re-compacted, and re-tested until all requirements are met. All costs of re-testing shall be borne by the Contractor.

K. Materials not meeting gradation requirements shall be removed from the project site and replaced with appropriate materials. All costs of re-testing shall be borne by the Contractor.

L. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by On-site Geotechnical Engineer.

3.30 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Remove waste materials, including unacceptable/unsuitable excavated material, trash, and debris, and legally dispose off-site.

B. Remove excess excavated material and other materials not specified to be stored, or reused. Dispose off-site at a disposal site approved for the materials.

C. Burning or burial of excess or waste materials at the site is not permitted. Such materials shall be disposed of off-site in conformance with applicable local, state and federal legal requirements.

D. Excess excavated materials may temporarily be stockpiled on-site at a location approved by the Architect/Engineer,-OR Owner's Designated Representative.

E. All costs related to stockpiling, rehandling, transporting, removing and disposal of excess (including suitable and unsuitable) and waste materials shall be paid by the Contractor. Costs shall be included in the price bid.

F. Transport surplus satisfactory soil to designated storage areas on Owner's property**.** Stockpile or spread and rough grade soil as directed by Owner's Designated Representative or the Architect/Engineer. Provide erosion control measures.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off-site.

3.31 MAINTENANCE AND PROTECTION OF WORK

A. Protecting Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris. Protect subgrades and foundation soils from freezing temperatures and frosts when atmospheric temperature is lower than 35 degrees F.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Owner's Designated Representative; reshape and recompact.

C. Settling: Where settling is measurable or observable at excavated areas during construction, remove finished surface (pavement, lawn, or other finish areas), add backfill material, compact, and replace/reconstruct surface treatment.

1. Restore appearance, quality, and condition of finished surface to match adjacent work, and eliminate evidence of restoration to greatest extent possible, at the Contractor's expense.

D. Any backfill or fill materials that settle and/or erode during the general project warranty period shall be repaired by the Contractor upon receipt of written notice from the Owner's Designated Representative, at no expense to the Owner.

1. Remove finished surface (pavement, lawn, or other finish areas), add backfill material, compact, and replace/reconstruct surface treatment.
2. Restore appearance, quality, and condition of finished surface to match adjacent work, and eliminate evidence of restoration to greatest extent possible, at the Contractor's expense.

E. Replace or repair any pipe, structure, or other work, which has been displaced or damaged during construction and general project warranty period at no expense to Owner.

F. Repair to proper grade any settlement of slab, pavement, utility structure, lawn, etc. adversely affected by settlement within general project warranty period at no expense to Owner.

END OF SECTION 312000

SECTION 312319 - DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes construction dewatering.

1.2 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Contractor is responsible for the Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Pre-installation Conference: Contractor is to conduct conference at project site.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 INSTALLATION PROVIDED BY THE CONTRACTOR

A. Provide temporary grading to facilitate dewatering and control of surface water.

B. Monitor dewatering systems continuously.

C. Protect and maintain temporary erosion and sedimentation controls, which are specified in Contract Documents during dewatering operations.

D. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Space well points or wells at intervals required to provide sufficient dewatering.
2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

E. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

F. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

G. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

H. Provide standby equipment on site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches (900 mm) below overlying construction.

END OF SECTION 312319

SECTION 312500 - EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Work covered in this section includes the control of erosion, siltation, and sedimentation.

B. This work shall consist of temporary and permanent control measures as shown on the plans or as ordered by the Architect/Engineer during the life of the contract to control soil erosion, siltation, sedimentation and prevent water pollution through use of berms, dikes, dams, sediment basins, fiber mats, netting, gravel, mulches, grasses, slope drains and other erosion control devices or methods..

C. Plans show the suggested minimum measures required. Areas of erosion and sedimentation control measures defined on the plans are not all-inclusive. The Contractor is responsible for utilizing erosion and sedimentation control techniques in all areas of construction where disturbance to existing conditions is required.

D. All appropriate erosion and sediment control measures shall be in place and functional a minimum of five (5) business days before commencement of construction of any segment of the project that requires such measures.

E. Contractor shall complete installation and repair of erosion control measures as indicated by the Owner’s and the Construction Manager in a timely manner.

F. Contractor shall protect all storm and sanitary sewers, ditches, swales, etc and the stormwater management facilities from siltation and sedimentation resulting from work completed under this contract.

G. Related Sections:
   1. Division 03 Section **“Cast-in-Place Concrete”**
   2. Divisions 21, 22, 23, 26, 27, 28, and 33 Sections for installing underground facility utilities and buried utility structures.
   3. Division 31 Section **“Site Clearing”**
   4. Division 31 Section **“Earth Moving”**
   5. Division 32 Section **“Turf and Grasses”**

1.3 SUBMITTALS

A. Submit erosion and sediment control sequence schedule based on Contractor's intended sequencing for review and approval by Architect/Engineer prior to start of construction.

B. Submit actual erosion control measures and excavation dewatering discharge plan based on Contractor intended sequencing for review and approval by Architect/Engineer prior to start of construction. This plan shall also define the maximum disturbed areas per project phase and show required cuts and fills. Refer to Part 3 - Schedule of Work for additional data to be submitted.

C. Contractor shall provide record plans of the stormwater management facilities, water quality control unit and all storm piping. Record plans shall provide as a minimum: elevations of all rims and inverts; pipe and structure size and materials of construction; and, elevations and limits of stone at infiltration practices.

1.4 QUALITY ASSURANCE

A. Work shall be completed in accordance with New York State Standards and Specifications for Erosion and Sediment Control.

B. Provide at least one person who shall be present at all times during erosion control operations and who shall be thoroughly familiar with the types of materials being installed and the best methods for their installation and who shall direct all work performed under this section.

C. Material manufacturers and vendors shall be reputable, qualified firms regularly engaged in producing the required types of materials.

D. Utilize construction methods/techniques, which will limit exposed earthen areas and minimize the effect of earth disturbance activities on soil erosion. There shall not be more than five (5) acres of disturbed soil at any one time without prior written approval from the Town as the Municipal Separate Storm Sewer Systems (MS4).

E. Direct all sediment-laden water to an appropriate sediment control device prior to off-site discharge.

F. The Contractor shall maintain all erosion and sediment control measures in good working condition and in accordance with the Contract Documents. The Contractor shall inspect the erosion and sediment control measures, weekly and after each runoff event, to maintain their effectiveness.

1.5 AUTHORITY OF WORK

A. The Architect/Engineer and/or Owner's Designated Representative may limit the area of clearing and grubbing, excavation, borrow, embankment and/or utility operations in progress, commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding, and other such permanent or temporary control measures current in accordance with the accepted schedule.

B. The Architect/Engineer and/or Owner's Designated Representative has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, the surface area of erodible earth material exposed by excavation, borrow, and fill operations, and to direct the Contractor to provide immediate permanent or temporary pollution control measures to minimize damage to adjacent property and to minimize contamination of adjacent streams or other watercourses, lakes, ponds or other areas of water impoundment.

C. In addition, other agencies having jurisdiction over waterway crossings or site erosion control, such as the Corps of Engineers and the NYSDEC, have the authority to make observations at the site to evaluate the construction practices with regard to the approved permits. Any deviation from the requirements of the approved permits will require the approval of the Architect/Engineer, as well as any agencies having jurisdiction.

1.6 PROJECT REQUIREMENTS

A. Take every reasonable precaution and do whatever is necessary to avoid any erosion and to prevent silting of rivers, streams, ponds, impoundments, drainage ditches, and swales.

B. Protect and maintain all areas disturbed by the work, such that erosion is adequately controlled and silt and sediments are not allowed to flow into or onto: any watercourse; adjacent properties; adjacent campus facilities; roadways, parking areas, walkways or other pavements; or, storm or sanitary sewers.

C. Work shall be scheduled to sequence work in such a manner so that the exposed, unprotected surface area of any earth material that is subject to erosion by wind or water will be kept at a minimum.

D. The exposure of uncompleted cut slopes, embankments, trench excavations, and site graded areas shall be kept as short as possible. Initiate seeding and other erosion control measures on each segment as soon as reasonably possible. Temporary and/or permanent stabilization measures shall be implemented within seven days in areas where soil disturbance activities have ceased.

E. Should it become necessary to suspend construction for any length of time, shape all excavated and graded areas in such a manner that runoff will be intercepted and diverted to points where minimal erosion will occur. Provide and maintain temporary erosion and sediment control measures, such as berms, dikes, slope drains, silt stops, and sedimentation basins, until permanent drainage facilities and erosion control features have been completed and are operative.

F. Fine material placed or exposed during the work shall be so handled and treated as to minimize the possibility of its reaching any surface waters. Use diversion channels, dikes, sediment traps, or any other effective control measures.

G. Provide silt stops wherever erosion control measures may not be totally capable of controlling erosion, such as in drainage channels and where slopes may exist.

H. Before water is allowed to flow in any ditch, swale, or channel, install the permanent erosion control measures in the waterway so that the waterway will be safe against erosion.

I. Contractor shall devote particular attention to all (existing and new) drainage facilities, keeping them fully operational at all times. Contractor shall at a minimum inspect and repair siltation controls. Provide inlet protection at existing and new drainage structures.

J. Take special precautions in the use of construction equipment to minimize erosion. Do not leave wheel tracks where erosion might begin. Prevent direct discharge from dewatering pumps and surface runoff from the construction sites to storm sewers, culverts, streams or ditches. Intercept and conduct surface runoff and discharge from dewatering pumps to siltation ponds before discharging to natural drainage channels.

K. Siltation deposits in storm sewers, surface waters, streams or wetlands resulting from the discharge of water from the project site shall be removed to restore profiles and conditions to that existing prior to the commencement of the work.

L. The Contractor shall keep access routes and parking areas used for the work clean of debris and other obstructions resulting from the work.

M. The Contractor shall keep traveled ways free of foreign objects such as spilled earth, rock, timber, and other items that may fall from transporting vehicles. Materials spilled by or dropped from the undercarriage of any carrying vehicle used in the Contractor's hauling operations along or across any public or private traveled way shall be removed immediately.

N. Disturbance of lands and waters outside the limits of construction is prohibited, except as may be found necessary and approved by the Architect/Engineer.

O. The requirements of this section also apply to project-related construction activities away from the project site, such as at borrow pits, off-site storage areas, and haul and work roads.

P. Mulching shall follow the seeding operation by not more than 24 hours.

Q. Should any protective measures employed indicate any deficiencies or erosion taking place, immediately provide additional materials or employ different techniques to correct the situation and to prevent subsequent erosion.

R. Continue erosion control measures until the permanent measures have been sufficiently established and are capable of controlling erosion on their own.

S. Comply with all federal, state, and local laws, ordinances, rules, and regulations.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

A. Materials shall conform to the design plans or specifications outlined in the New York State Standards and Specifications for Erosion and Sediment Control.

B. All materials shall be subject to the approval of the Architect/Engineer and be reasonably clean and free of noxious weeds and deleterious materials.

C. Grass shall be a quick growing species suitable to the geographical area as specified in the Contract Documents.

D. Fertilizer and soil conditioners shall be standard commercial grade acceptable to the Architect/Engineer.

E. Trench plug materials shall consist of native soil installed within “sandbags.”

2.2 HAY AND STRAW MULCH

A. General: Hay and straw mulches shall be reasonably free from swamp grass, weeds, twigs, debris, and other deleterious material, and free from rot, mold, primary noxious weed seeds, and rough or woody materials. Mulches containing mature seed of species which would volunteer and be detrimental to the permanent seeding, or would result in overseeding, or would produce growth which is aesthetically unpleasing, is not permitted.

B. Hay Mulch: Properly aired native hay, Sudan grass hay, broomsedge hay, legume hay, or similar hay or grass mowings. When air-dried in the loose state, the contents of the representative bale shall lose not more than fifteen (15) percent of the resulting air-dry weight of the bale. Apply at the rate of 2 to 3 tons/acre, or at 1.5 tons/acre when a net or a mulch stabilizer is used with the mulch.

C. Straw Mulch: Threshed plant residue of oats, wheat, barley, rye, or rice from which grain has been removed. Apply at the rate of 2 to 3 tons/acre or at 1.5 tons/acre when a net or a mulch stabilizer is used with the mulch.

D. Mulch Stabilizers: "Curasol" applied at the rate of 40 gallons/acre, Dow "Mulch Binder" applied at the rate of 45 gallons/acre, or asphalt binder, AASHTO M140, Type SS-1 or RS-1 as applicable, applied at the rate of 400 gallons/acre.

E. Temporary Type Mulch Nets: Paper yard, approximately 0.05" in diameter, woven in to a net with approximate openings of 7/8" by 1/2" and weighing about 0.20 lbs./sy.

F. Permanent Type Mulch Nets: "Vexar" or "Erosion-Net" plastic or nylon mesh netting with approximate openings of 3/8" by 3/4".

2.3 MATTING/BLANKETS (if required)

A. Nomenclature: The various materials under this paragraph are sometimes referred to as "matting" and "blankets". These words are interchangeably used throughout this section, but the meanings shall be the same.

B. Jute Matting: Undyed and unbleached jute yarn woven into a uniform open, plain weave mesh, furnished in rolled strips conforming to the following physical requirements:

Width: 48", ±1"
78 warp ends per width of cloth

41 weft ends per yard
Weight: 1.22-1.80 lbs./LY, ±5%

C. Excelsior Matting: Uniform web of interlocking wood excelsior fibers with a backing of mulchnet fabric on one side only. The mulchnet shall be woven of either twisted paper chord or cotton cord. Excelsior matting shall be furnished in rolled strips and shall conform to the following physical requirements:

Width: 36", ±1"
Weight: 0.80 lbs./SY, ±5%

D. Erosion Control Mulching Blanket: "Hold/Gro" by Gulf States Paper Corp. or approved equal.

E. Staples: No. 11 (or heavier) plain iron wire made from at least 12" lengths of wire bent to form "U" of 1" to 2" width. Use longer staples for loose soils or where otherwise required.

F. Erosion Control Blanket: Shall be S150 as manufactured by North American Green or approved equal.

2.4 HYDROMULCHES (if required)

A. Hydromulches are not permitted where the slope of the ground surface exceeds 10 percent.

B. Wood fiber mulch with tackifier shall meet NYSDOT material designations 713-11 and 713-12. Materials shall be equal to "Genaqua 743" or "Terra Tack III". Apply wood fibers at the rate of 500 lbs./acre and tackifier at the rate of 40-45 gallons/acre and in accordance with manufacturers recommendations.

C. Paper mulch equal to "Spra-mulch" by Rumose Products Co., applied at the rate of 1,200 lbs./acre.

2.5 SEED AND SOD FOR EROSION CONTROL

A. Seed for temporary control: Blend - Mix Type 'A' Rate: 5 to 6 pounds per 1,000 SF

Common Names	Parts	Purity	Germination
Adelphi Kentucky Bluegrass	30%	90%	87%
Baron Kentucky Bluegrass	30%	90%	87%
Pennlawn Fescue	30%	90%	82%
Pleasure Perennial Ryegrass	10%	90%	90%

B. For permanent control: See Division 32 Section "Turf and Grasses"

2.6 SILT FENCES

A. Filter cloth shall be as manufactured by Mirafi 100X, Stabilenka T104N, Indian Valley 3611 Construction Grade or approved equal and shall meet the following requirements:

1. Silt Fence Fabric:

Fabric Properties	Minimum Acceptable Value	Test Method
Grab Tensile Strength (lbs)	90	ASTM D1682
Elongation at Failure (%)	50	ASTM D1682
Mullen Burst Strength (lbs)	190	ASTM D3786
Puncture Strength (lbs)	40	ASTM D3786
Slurry Flow Rate (gal/min/sf)	0.3	
Equivalent Opening Size	40-80	US Std. Sieve SW-02215
Ultraviolet Radiation Stability (%)	90	ASTM G-26

B. Other materials shall be as defined on the silt fence detail shown on the Contract Documents.

C. Pre-assembled silt fence, which is complete with U.V., stabilized filter fabric (minimum 36-inch) high-strength polypropylene netting and pre-attached hardwood stakes may also be used. The preassembled reinforced silt fence shall be Silt-LOK 36-100RX as manufactured by JDR Enterprises, Inc., Mirafi Envirofence, Belton Industries or approved equal.

2.7 STABILIZED CONSTRUCTION ENTRANCE

A. Crushed Stone in accordance with Division 31 Section “Earth Moving”.

B. Filter cloth New York State Standards and Specifications for Erosion and Sediment Control for heavy duty haul roads, rough graded, as listed below. Acceptable materials are Trevira Spunbound 1135, Mirafi 600X or equal. The filter cloth shall be woven fabric of only continuous chain polymeric filaments or yarns of polyester. The fabric shall be inert to commonly encountered chemicals, hydrocarbons, mildew; rot resistant and conform to the fabric properties listed below:

Fabric Properties		Test Method
Grab Tensile Strength (lbs)	220	ASTM D1682
Elongation at Failure (%)	60	ASTM D1682
Mullen Burst Strength (lbs)	430	ASTM D3786
Puncture Strength (lbs)	125	ASTM D751 modified
Equivalent Opening Size	40-80	US St Sieve CW-00215

2.8 INLET PROTECTION

A. Provide filter fabric drop inlet protection, as shown on the contract details.

PART 3 - EXECUTION

3.1 GENERAL

A. In the event of conflict between these specification requirements and pollution control laws, rules or regulations of other Federal, State, or local agencies, the more restrictive laws, rules or regulations shall apply.

B. All appropriate erosion and sedimentation control measures including silt fences and temporary sediment traps shall be in place prior to the excavation of ground vegetation of any segment of the project that requires such measures. All measures shall be maintained throughout the period of construction until vegetation is established to the satisfaction of the Owner's Designated Representative.

C. Maintenance of said measures shall include periodic removal and disposal of sediment, inspection and repair of damaged facilities, and replacement of any materials required to facilitate revegetation of disturbed areas.

D. Any areas of temporary storage for spoil materials shall be protected by silt fences as directed by the Architect/Engineer and/or Owner's Designated Representative.

E. Temporary measures such as silt fences and sediment traps shall be removed at the end of construction when vegetation is established to the satisfaction of the Owner's Designated Representative. Removal of any erosion and sedimentation control measures shall not begin without approval of the Architect/Engineer.

3.2 HAY AND STRAW MULCHING

A. Install hay or straw mulch immediately after each area has been properly prepared. When permanent seed or seed for erosion control is sown prior to placing the mulch, place mulch on seeded areas within 24 hours after seeding. Architect/Engineer may authorize the blowing of chopped mulch provided that 95 percent of the mulch fibers will be 6" or more in length and that it can be applied in such a manner that there will be a minimum amount of matting that would retard the growth of plants. Hay mulch should cover the ground enough to shade it, but the mulch should not be so thick that a person standing cannot see the ground through the mulch. Remove matted mulch or branches.

B. Where mild winds may blow the mulch, or when ground slopes exceed 15 percent, or when otherwise required to maintain the mulch firmly in place, apply a system of pegs and strings, a chemical stabilizer, or temporary type netting to the mulch. Unless otherwise directed, remove the strings and netting prior to the acceptance of the work.

C. Where high winds exist, or heavy rainstorms are likely, or where ground surfaces are steep, or where other conditions require, apply temporary type netting over the mulch and take whatever measures are necessary to maintain the mulch firmly in place.

D. Unless otherwise specified, the use of permanent type netting is not permitted without the prior approval of the Architect/Engineer.

3.3 MATTING/BLANKETS - GENERAL (if required)

A. The use of mulch with matting is not permitted, however, a 4" to 6" overlap of mulch over the edge of matting is permissible.

B. Prepare surfaces of ditches and slopes to conform to the grades, contours and cross sections shown on the Drawings and finish to a smooth and even condition with all debris, roots, stone, and lumps raked out and removed. Loosen the soil surface to permit bedding of the matting. Unless otherwise noted, seed prior to the placement of the matting.

C. Unroll matting parallel to the direction of flow of water and loosely drape, without folds or stretching, so that continuous ground contact is maintained.

D. The ditches and swales, and on slopes, each upslope and each downslope end of each piece of matting shall be placed in a 6" trench, stapled at 12" on center, backfilled, and tamped. Similarly, bury edges of matting along the edges of catch basins and other structures. Architect/Engineer may require that any other edge, exposed to more than normal flow of water, be buried in a similar fashion.

E. Tightly secure matting to the soil by staples driven approximately vertically into the ground, flush with the surface of the matting. In driving the staples, take care not to form depressions or bulges in the surface of the matting.

F. Decrease the specified spacing of staples when varying factors, such as the season of the year or the amount of water encountered or anticipated, requires additional anchoring.

G. Refer to the following paragraphs for additional requirements on the placement and stapling of matting.

H. Erosion Control Blanket shall be installed per manufactured recommendations. Plant with Swale Seed mix.

3.4 JUTE MATTING (if required)

A. Where strips are laid parallel or meet, as in a tee, they shall be overlapped at least 4". Overlap ends at least 6" shingle fashion.

B. Space check slots, built at right angles to the direction of flow of water, so that one check slot or one end occurs within each 50 feet of length of slope. Construct check slots by placing a tight fold of matting at least six (6) inches vertically into the ground. These shall be tamped the same as the upslope ends.

C. Press jute matting onto the ground with a light lawn roller or other satisfactory means.

D. On slopes flatter than 1:4, place staples not more than 3 feet apart in three rows, for each strip, with one row along each edge and one row alternately spaced down the center. On grades 1:4 or steeper, place staples in the same three rows, but spaced 2 feet. On lapping edges, double the number of staples, with the spacing halved. Ends of matting and all required check slots shall have

staples placed every foot. Matting placed adjacent to boulders or other obstructions shall be stapled with no spaces between the staples.

E. Spread additional seed over jute matting, particularly those locations disturbed by the building of slots.

3.5 EROSION CONTROL MULCHING BLANKET (if required)

A. Where one roll ends and a second roll begins, the upslope piece shall be brought over the end of the downslope roll so that there is a 12-inch overlap, placed in a 4-inch deep trench, stapled at 12 inches on center, backfilled, and tamped.

A. On slopes where two or more widths of blanket are applied, the two edges shall be overlapped 4 inches and stapled at 12-inch intervals along the exposed edge of the lap joint.

B. Staple the body of the blanket in a grid pattern with staples 3 feet on center, each way.

3.6 SEED FOR EROSION CONTROL

A. Sow seed when soils are moderately dry and when wind does not exceed five miles per hour or as directed by the Architect/Engineer.

B. Areas, which will be re-graded or otherwise disturbed later during construction, may be ordered to be seeded with rye grass to obtain temporary control. The seed shall be sown at the rate of approximately one pound per 1,000 square feet, on the pure live seed basis.

3.7 SILT FENCES

A. Provide silt fences, as required, for the temporary control of erosion and to stop silt and sediment from reaching surface waters, adjacent properties, or entering catch basins, or damaging the work.

B. Erect silt fences and bury bottom edge in accordance with the manufacturer's recommended installation instructions. Provide a sufficient length of fence to accommodate runoff without causing any flooding and to adequately store any silt, sediment, and debris reaching it.

C. Maintain and leave silt fences in place until permanent erosion control measures have stopped all erosion and siltation.

D. Along sloped areas, silt fences shall be placed at spacing not to exceed slope length shown below.

Slope Steepness	Maximum Slope Length, Ft.
2H : 1V	25
3H : 1V	50
4H : 1V	75
5H : 1V or flatter	100

E. Silt fence shall be placed along property boundaries where the grade is such that runoff may occur to adjacent property owners.

3.8 STABILIZED CONSTRUCTION ENTRANCES

A. Stabilized pads of aggregate underlain with filter cloth shall be constructed as shown on the Contract Drawings.

B. Filter cloth shall be placed over the entire area to be covered with aggregate prior to placing of the stone.

3.9 SCHEDULE OF WORK

A. Included with the proposed construction schedule, the Contractor shall submit to the Architect/Engineer for acceptance, his schedules for accomplishment of temporary and permanent erosion control work, as are applicable for clearing and grubbing; grading; installation of utilities, stormwater management facilities, building foundations, ramps and pavements; and, restoration. In addition, the Contractor shall also submit for acceptance at the same time, his proposed plan for disposal of surplus excavated materials. No work shall be started until the erosion control schedules and methods of operations have been accepted by the Architect/Engineer. If climactic changes occur during construction, the Contractor may be required to submit a revised schedule for acceptance as directed by the Architect/Engineer.

A. Where conditions warrant, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent erosion control features can follow immediately thereafter as the project conditions permit; otherwise temporary erosion control measures will be required between successive construction stages.

3.10 MAINTENANCE

A. If any staples become loosened or raised, or if any matting becomes loose, torn, or undermined, or if any temporary erosion and sediment control measures are disturbed, repair them immediately.

B. If the seed is washed out before germination, repair any damage, re-fertilize, and reseed.

C. Maintain mulched and matted areas, silt stops, and other temporary control measures until the permanent control measures are established and no further erosion is likely.

D. All sediment spilled, dropped, or washed onto the driveways, roadways, parking areas, walkways or public rights-of-way shall be removed immediately.

E. Maintain ditches and swales at all times so that they effectively drain. Refill, reshape, and re-compact where ruts or erosion occurs.

F. Maintain filter fabric placed at inlet grates. Clean and replace as necessary to protect the storm sewers from siltation and sediments.

G. Maintain areas temporarily seeded including repair of all damages, re-seeding, and re-fertilizing.

H. Flush and clean all storm sewers, structures and sumps. Capture and remove sediments prior to release into other downstream systems.

END OF SECTION 312500

SECTION 320105 - MAINTENANCE AND PROTECTION OF TRAFFIC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This work consists of safely delineating and containing the project work area, maintaining traffic and access as required, including maintaining and protecting the public from damage to person and property within the limits of and for the duration of the contract.

B. Providing new permanent traffic and posts.

C. The cost to provide, install, relocate, maintain, cover and remove all construction traffic control measures and devices including personnel necessary to regulate and protect traffic for the duration of the contract shall be included in the price bid. The costs to repair the existing pavements utilized as detour routes, shall be include in the price bid.

D. Provide temporary fencing.

E. The costs to provide, install, relocate, maintain, and remove temporary fencing for the duration of the contract shall be included in the price bid.

1.3 QUALITY ASSURANCE

A. Work of this section shall be performed in accordance with the requirements of the New York State Department of Transportation (NYSDOT). Traffic control devices in New York on all streets, highways, bikeways, and private roads open to public travel are currently regulated by two documents: the **National Manual on Uniform Traffic Control Devices for Streets and Highways** (MUTCD) and **17 NYCRR Chapter V** (New York Supplement).
The current editions of these documents are:

   a. MUTCD (2023 Edition – and any related updates)

   b. NYS Supplement (2010 Edition – and any related updates)

B. Provide necessary traffic control measures and devices as required to meet the conditions and requirements of the Contract Documents and the requirements of any authorities having jurisdiction.

C. Chain Link Fence Manufacturer: company specializing in commercial quality chain link fencing with five (5) years experience. Submit evidence of these projects in writing to the Owner's

Designated Representative, including name and telephone number of person for each reference.

D. Chain Link Fence Installer's Qualification: Firms with a minimum of five (5) years experience installing similar fencing.

E. Layout Personnel: Layout of fence line shall be performed by qualified surveyors or representatives of the fence supplier.

F. All fence and gate materials and installation shall be furnished and installed by a single firm.

1.4 SUBMITTALS

A. Shop drawings for the material, hardware, and manner of installation shall be submitted for each sign.

B. Submit plan for proposed detouring and closure plans for approval.

C. Submit manufacturer's certification that signs conform to MUTCD (or NYS Supplement) as required.

D. Submit product data in the form of manufacturer's technical data, and specifications for each fence system and each gate system including, fence and gate layout, grid, spacing of components, fence posts, gate posts, fabric, gates, hardware, fittings, anchorage and other accessories.

E. Submit shop drawings showing location of fence, gates, each post, and details of post installation, hardware, and accessories.

F. Submit manufacturer's installation instructions and procedures, including standard details of fence installation.

G. Submit warranty information for staging fence.

1.5 JOB CONDITIONS

A. The Contractor is placed on notice that maintenance and protection of traffic over or around a roadway, drive, sidewalk, parking area, etc., during construction is considered as important as the construction itself. Therefore, at all times, conduct operations in a manner to ensure the convenience of all travelers, facility operations and the abutting property owners and their safety.

B. The Architect/Engineer has the authority to suspend all work until all requirements are met.

C. Coordinate with the Architect/Engineer and Owner's Designated Representative to schedule lane closures, road and/or drive closures, sidewalk closures, parking space closures, detour route installations and any other vehicular traffic, pedestrian, and/or parking related impacts.

D. Provide and maintain, at all times, safe and adequate ingress and egress to active fire hydrants.

E. Provide and maintain temporary lighting facilities as necessary to ensure safe, continuous, temporary pedestrian routes when activities affect an existing pedestrian route.

F. Maintain existing pavements in repair, which are utilized for project detours.

G. Store all material so they can be easily inspected and so they will not be damaged prior to installation.

PART 2 – PRODUCTS

2.1 TRAFFIC CONTROL MEASURES AND DEVICES

A. Provide, install, move and maintain construction signs, drums, delineators, flags, barricades and lighting for barricades as shown on the plans or as directed by the Architect/Engineer. All traffic control measures and devices shall conform to the requirements of the NYSS and MUTCD.

B. All traffic control devices shall be reflectorized conforming to the NYSS and MUTCD.

C. Flaggers: Provide the necessary traffic control equipment and flaggers for adequate traffic control on the traveled way. Sign paddles, in lieu of flags, may be required by the Architect/Engineer.

2.2 TEMPORARY FENCING

A. Provide temporary fencing and gates around project work limits as shown on the plans. Fence as indicated in Division 1 Temporary Facilities. Adjust fence locations as needed or as directed during construction.

1. Swing Gate hardware: Minimum two 180-degree gate hinges per leaf and lockable hardware for padlock. Provide padlock and two sets of keys to Owner's Designated Representative for each gate.

B. Post Driven Fence - Provide temporary galvanized steel, chain-link fabric fence around staging area. Height of fence as shown on the plans. As a minimum, fence shall include:

1. Line Posts: 2.38" O.D. steel pipe, spaced at 10' maximum on center. Posts shall have safety caps.
2. Corner, terminal and gate posts: 2.88" O.D. steel pipe.
3. Top rail: 1.63" O.D. steel pipe
4. Bottom rail, brace rail, and gate bracing: 1.66" O.D. plain end, sleeve coupled steel pipe.
5. Swing Gate frame: 2" O.D. steel pipe for fittings and truss rod fabrication.
6. Fabric: 2 inch diamond mesh steel wire, interwoven, 9 gauge, top and bottom knuckled salvage.
7. Caps: Cast steel or malleable iron, galvanized, sized to post dimension, set screw retained.
8. Fittings: Sleeves, bands, slips, rings, rail ends, tension bars, fasteners and fittings: steel, galvanized.
9. Swing Gate hardware: Minimum two 180-degree gate hinges per leaf and lockable hardware for padlock. Provide padlock and two sets of keys to Owner's Designated Representative for each gate.

C. Moveable Panelized Fence with portable bases – Provide temporary galvanized steel, chain-link fabric fence where shown on plans. Height of fence as shown on the plans. As a minimum, fence shall include:

1. Framework including posts; top, bottom and horizontal/vertical mid rails: 1.38" O.D. steel pipe. All framework to be galvanized. Panel overall widths 10’ maximum.
2. Fabric: 2 inch diamond mesh steel wire, interwoven, 11.5 gauge, top and bottom knuckled salvage.
3. Portable bases: 1.38" O.D. galvanized steel pipe with minimum 6-inch uprights. Minimum plan size 18”x24” for 6-H and minimum 18”x36” for 8-H fence. Bases shall be substantial enough to support the fence and gate systems in a stable, upright and plumb position.
4. Fittings: Sleeves, bands, slips, clamps, fasteners and fittings: steel, galvanized.
5. Sand bags: Minimum 2-50 pound bags at each base plate.
6. Swing Gate hardware: Minimum two 180-degree gate hinges per leaf and lockable hardware for padlock. Provide padlock and two sets of keys to Owner’s Designated Representative for each gate.

2.3 PERMANENT TRAFFIC SIGNS

A. Signs shall be aluminum sign panels as defined in the MUTCD and in conformance with Section 730-01 of NYSS.

B. Size, number of signs, MUTCD/Order No., and mounting location shall be as shown on the Contract Drawings.

C. Provide breakaway galvanized steel posts as shown on the plans. Provide sufficient number of posts per sign panel.

D. Where shown on the plans posts shall be set in round bollards.

PART 3 – EXECUTION

3.1 MAINTAIN TRAFFIC - GENERAL

A. Maintain traffic on all adjacent public streets and drives at all times and install and maintain barricades, signs, flags, and lights as required by law, or directed by local officials, or by the Architect/Engineer or Owner’s Designated Representative.

B. Minimize interference with adjoining roads, streets, walks, parking areas, and other adjacent occupied or used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without written permission from Owner’s Designated Representative and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways as required by Owner’s Designated Representative or authorities having jurisdiction.
3. Coordinate with the Owner’s Designated Representative and Facility Owner to minimize disruption to the normal operation of the active facility.
4. Maintain ingress/egress for emergency vehicles at all times.

5. Flaggers, guards, barricades, lights, services, and other items needed for the protection of persons and property shall be furnished and maintained by the Contractor. Costs for these items shall be included in the prices bid for the Contract.
6. Contractor shall obtain written approval from the local highway superintendent and pay all fees for work required in the public right-of-way.

C. Relocation of Signs: Within the public right-of-way, private roads, parking areas or project limits; signs designated for relocation shall be removed and relocated in conformance with the requirements of NYSDOT Section 647, latest edition. Care shall be taken in removing sign panels to prevent damage. Any damage shall be repaired or replaced to the satisfaction of the Owner's Designated Representative, Architect/Engineer at the Contractor's expense. Existing signs shall be mounted on new posts or bollards at the location shown on the drawing, or as otherwise directed by the Owner's Designated Representative or Architect/Engineer. Mounting of signs shall be in conformance with NYSDOT Section 645-3.

3.2 IMPLEMENTATION OF TEMPORARY TRAFFIC CONTROL

A. The existing roadways, drives and parking lots shall be kept free of foreign objects such as spilled earth, rock, timber and other items that may fall from transporting vehicles both within and outside the project limits.

B. Whenever it becomes necessary to maintain traffic on one lane, or provide alternating one-way traffic, provide adequate traffic controls on the section of roadway on which vehicle operation is maintained. Employ a sufficient number of competent flaggers to control one lane traffic continuously. In the event the length of the one lane operation is extremely short and conditions are favorable for safe operation, the Architect/Engineer may, in writing, authorize the Contractor to dispense with flaggers. Provide a sufficient number of competent flaggers in areas where construction equipment is operating in potential conflict with public traffic, regardless of the volume of traffic or the sight distance. Wear orange hard hats and approved safety vests, and direct traffic in conformance with the NYS MUTCD. Sign paddles, in lieu of flags, may be required by the Architect/Engineer.

C. All signs shall be kept clean and mounted at the required height on adequate supports and placed in proper position and alignment so as to give maximum visibility both night and day.

D. Move, remove, relocate or change immediately any signs that do not indicate actual conditions.

E. Drop-offs greater than 3-1/2 inches will not be allowed overnight. Provide temporary fill with 1 on 4 or flatter cross slope.

F. Overnight, all excavations are to be backfilled or steel plated to protect motorists from the excavations.

G. Remove temporary equipment and facilities when no longer required, and restore area to original or specified conditions upon removal.

H. Haul Routes - The Contract shall consult with governing authorities and establish thoroughfares, which shall be used as haul routes and site access. The Contractor shall confine construction traffic to designated haul routes. The Contractor will be required to provide traffic control at

critical points of haul routes to expedite traffic flow and minimize interference with normal public traffic. Where required by governing authorities, the Contractor shall prepare and submit traffic control plans for approval by both the Architect/Engineer and the governing authority prior to commencement of the work.

3.3 TEMPORARY PANELIZED FENCING

A. Install framework, fabric, accessories, and gates in accordance with ANSI/ASTM F567 and manufacturer's recommendations.

B. Install, relocate, and maintain temporary fencing for the duration of the contract.

C. Fence and gates shall be kept plumb and good condition throughout the contract duration.

D. Provide and maintain sand bags to keep fence stable and in alignment.

E. Remove temporary equipment and facilities when no longer required, and restore area to original or specified conditions upon removal.

3.4 TEMPORARY POST DRIVEN FENCING

A. Install fencing and gates complete as shown on the plans.

B. Install framework, fabric, accessories, and gates in accordance with ANSI/ASTM F567 and manufacture's recommendations.

C. Space line posts at intervals not exceeding 10'. Set or drive posts into ground a minimum of one-third the total height or as otherwise shown on the drawings without concrete footings. Where a post is located on existing pavement or concrete to remain, provide appropriate means of post support acceptable to Owner's Designated Representative.

D. Locate terminal posts at the beginning and end of each continuous length of fence, at abrupt changes in line or grade, and additionally at intervals not to exceed 500 feet, or closer as required by the fence manufacturer. Install posts in proper alignment.

E. Set all posts plumb.

F. Provide top rail through line post tops and splice with 7" long rail sleeves.

G. Brace each gate, terminal, and corner post back to adjacent line post with horizontal center brace rail and diagonal truss rods.
   1. Gate leaves 8' or longer shall be braced in the center with a 1.66" O.D. vertical, and a 1.66" O.D. diagonal from the bottom at gate post to the upper intersection of the top rail and vertical brace. Install a second 1.66" O.D. diagonal from the intersection of the bottom rail and the vertical to the upper free corner. Weld all gate braces together and to the gate frame.

H. Stretch fabric between terminal posts or at intervals of 100' maximum, whichever is less.

I. Position bottom of fabric above finished grade as shown on the drawings.

J. Fasten fabric to top and bottom rail, line posts and braces with wire ties, maximum 18" on centers.

K. Attach fabric to terminal, corner, and gate posts with tension bars and tension bar clips.

L. Install swing gates with fabric to match fence.

M. Install gates in accordance with manufacturer's instructions, plumb, level, and secure for full opening without interference. Gates shall operate freely without binding or dragging and shall be easily operable by hand.

N. Adjust hardware for smooth operation and lubricate where necessary.

O. Confirm that latches and locks engage accurately and securely without forcing or binding. Provide padlocks and keys for each gate.

P. Remove temporary equipment and facilities when no longer required, and restore area to original or specified conditions upon removal.

3.5 PERMANENT TRAFFIC SIGNS

A. Signs shall be installed as shown on the plans. Exact sign locations shall be determined by the Architect/Engineer in the field.

B. Signs designated for relocation shall be removed and relocated in conformance with the requirements of NYSDOT Section 647.

C. Care shall be taken in removing sign panels to prevent damage. Any damage shall be repaired or replaced to the satisfaction of the Architect/Engineer at the Contractor’s expense

D. Existing signs shall be mounted on new posts. Mounting of signs shall be in conformance with NYSDOT Section 645-3.

END OF SECTION 320105

SECTION 321216 - ASPHALT CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 1.2 SUMMARY

A. Work of this Section includes, but is not limited to:
   1. Aggregates
   2. Hot Mix Asphalt Concrete
   3. Liquid Asphalts

B. Deliver all container materials in manufacturer's standard, unopened containers with labels legible and intact. Store and protect from damage, freezing, or sunlight and heat, if required of individual product.

C. Store all materials and other items where damage and/or contamination will not occur.

D. Related Sections:
   1. Division 31 Section “Earth Moving”

1.3 DEFINITIONS

A. Pavement Area: The full width of hard bituminous road, parking surfaces, and asphalt sidewalks as shown on the Drawings.

B. NYSDOT: New York State Department of Transportation

C. NYSS or NYSDOT Specification Section: Use latest edition of New York State Department of Transportation Standard Specifications.

1.4 QUALITY ASSURANCE

A. Provide at least one person who shall be present at all times during the execution of this portion of the work, and who shall be thoroughly qualified and experienced in the placing of the type of pavements specified and who shall direct all work performed under this section.

B. Comply with the referenced portions of NYSS.

C. All testing shall be performed by an approved testing laboratory. The Architect/Engineer may use the testing laboratory for inspection services.

D. Use only the materials and job-mix formula approved by the Architect/Engineer. Failure to consistently meet the approved job-mix formula shall be sufficient cause for the Architect/Engineer to prohibit the use of the asphalt supplier.

E. All finished paved surfaces shall be smooth, even, and free from surface defects and irregularities. Edges shall be straight, and shall meet existing pavements smoothly. Pavement shall present a smooth, continuous, and workmanlike appearance, free from patchwork, rough edges, spalling areas, potholes, depressions, bumps, and other defects. The finished installation shall meet with the complete approval of the Architect/Engineer and Owner with respect to appearance as well as structural integrity and other criteria.

F. Bituminous materials shall not be placed on any soft grade, when the grade is wet, when the temperature of the surface on which the mixture is to be placed is below 45oF (below 50oF for 1-inch compacted thickness or less), above 95oF, or when other weather conditions would prevent proper handling or finishing of asphalt mixtures unless otherwise ordered or approved by the Architect/Engineer.

1.5 SOURCE QUALITY CONTROL

A. The asphalt plant shall be approved by the Architect/Engineer.

B. All materials and the asphalt plant will be subject to inspections and tests by the Architect/Engineer and by the approved testing laboratory.

C. Submit sieve analysis of each subbase material from each granular material source.

D. Submit mill analysis of each grade of asphalt from each material source.

1.6 JOB-MIX FORMULA

A. No paving shall commence until a job-mix formula for each asphalt material to be placed has been submitted to and approved by the Architect/Engineer. The required job-mix formula shall be prepared by an approved testing laboratory and shall comply with the NYSS. Provide all testing as required to clearly show that materials meet specification requirements.

B. If a previously established job-mix formula is proposed, certified copies of the mix formula and all test reports made within the last six months by a recognized testing laboratory may be submitted. If the formula and test results comply with these specifications and sufficient evidence of compliance is submitted and is acceptable to the Architect/Engineer, a new job-mix formula will not be required. If insufficient data exists, the Architect/Engineer may request additional testing, or he may require a new job-mix formula.

1.7 SUBMITTALS

A. Proposed job-mix formula and certified materials tests as required under Part 1 – Job Formula shall be submitted.

B. Name, address and telephone number of the asphalt plant proposed for use and a certification that the proposed source conforms to the requirements of these specifications shall be submitted.

C. Evidence shall be submitted indicating that all materials meet the necessary requirements as specified herein.

D. Source quality control information as required in Part 1- Source Quality Control.

E. Certified test reports on tests required under Part 3 of this specification.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Hauling equipment shall conform to NYSS. The Contractor is advised that length of haul, manner of haul, temperature of asphalt, and similar criteria, have a direct bearing on the quality and acceptability of the finished pavements. These other criteria shall be properly controlled such that the job mix of asphalt, when placed, is identical to that specified, approved, and as it left the asphalt plant. Segregation of aggregates, whether occasioned by hauling operations, improper mixing at the asphalt plant, or for other reasons, will result in rejection of the pavement. Clusters and pockets of aggregate in the finished pavement surface, with voids surrounding the aggregates, are unacceptable and will be rejected.

B. All asphalt job mixes shall be delivered to the site and incorporated into the work within the mixing and placing temperature ranges as listed in the NYSS.

C. Subbase granular materials shall be hauled, placed, and graded in a manner to assure good drainage, to preclude the inclusion of foreign matter and to preserve the gradation.

D. Deliver all container materials in manufacturer's standard, unopened containers with labels legible and intact. Store and protect from damage, freezing, or sunlight and heat, if required of individual product.

E. Store all materials and other items where damage and/or contamination will not occur.

1.9 JOB CONDITIONS

A. Asphalt top course shall be placed only during the periods of May 1st up to and including the third Saturday of October when the temperature and conditions are as specified in Part 1- Quality Assurance. Deviations from this time schedule shall be only as approved by the Architect/Engineer.

B. Asphalt concrete pavement shall be installed upon previous courses, which are clean, dry, and free from standing water, and only when weather conditions are suitable.

C. Defective Pavement: Portions of the completed pavement which are defective in finish, compaction or elevation, or that do not comply in all respects with the requirements of the contract documents, shall be taken up, removed and replaced with suitable material, and properly installed in accordance with the contract documents.

D. Environmental Conditions:

1. Prime and Tack Coats: Minimum surface temperature of 60 deg F.
2. Asphalt Binder Course: Minimum surface temperature of 45 deg F and rising at time of placement.
3. Asphalt Top Course: As indicated in Part 1 – Job Conditions and Quality Assurance

E. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials, 50 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 STONE SUBBASE COURSE

A. The subbase course materials shall consist of granular materials as shown on the Contract Drawings and/or as specified in Division 31 Section "Earth Moving". Depth as shown on the Contract Drawings.

2.2 BITUMINOUS PAVEMENT

A. Bituminous pavement shall be constructed with approved materials as stipulated in NYSS, Section 400. Job-mix formulas shall be formulated and submitted by the Contractor within the general limits imposed by Table 401-1 from the NYSS Section 401.

B. A binder course shall be placed at a thickness as to produce a required completed thickness when well compacted with a ten (10) ton roller. The material shall be NYSDOT 19 mm Binder Course. Required completed thickness shall be as shown on the Contract Drawings.

C. A wearing course shall be constructed on top of the binder course and shall produce the required completed thickness when well compacted with a ten (10) ton roller. The material shall be NYSDOT 9.5 mm Top Course. Required completed thickness shall be as shown on the Contract Drawings.

D. Base course (where required) shall be placed at a thickness as to produce the required completed thickness when well compacted with a ten (10) ton roller. Base course shall be NYSDOT 37.5 mm Base Course. Required completed thickness shall be as shown on the Contract Drawings.

E. In milled areas, an Asphalt Truing and Leveling course shall be placed on top of the milled surface prior to overlay course. The material shall be NYSDOT Asphalt Truing and Leveling Course. Truing and Leveling Course will not be included in the measurement of completed asphalt thickness.

F. Asphalt tack coat shall conform to NYSS material designation table 702-8.

G. Bituminous sealer shall conform to NYSS material designation table 702-1.

H. Bituminous Joint and Crack Filler shall conform with requirements of NYSS material designation table 702-1.

2.3 MIXES

A. All bituminous concrete shall be mixed at the approved asphalt mixing plant in accordance with NYSS.

2.4 PAVEMENT STABILIZATION GEOTEXTILE FABRIC

A. The pavement stabilization geotextile materials shall be in accordance with Division 31 Section "Earth Moving".

2.5 PAVEMENT MARKING PAINT

A. Pavement markings paints shall conform to standards for reflectorized roadway striping. Epoxy reflectorized pavement striping is not required. Markings shall be yellow or white as indicated on the drawings.

B. Glass beads (if required) for use in reflectorized pavement marking paints shall conform to NYSDOT Specification 727-05.

C. Pavement striping for parking and lettering shall conform to roadway striping except that no glass beads are required. Marking colors for lettering and parking striping shall be as shown on plans.

PART 3 - EXECUTION

3.1 GENERAL

A. Prior to the work of this section, verify that all utility, piping and grading work is complete, tested and approved by the Architect/Engineer and to the point where pavement installation may be properly performed. Particular attention is given to items such as pipelines or conduits so as to avoid excavating pavements at a later date.

B. Joints, where required, due to the discontinuation of work, shall be well bonded and sealed in such a manner as to create an integral appearance. Joints in successive courses shall be offset a minimum of two (2) feet horizontally from the lower pavement course. Transverse and longitudinal joints shall be performed in accordance with NYSS Section 401. Care shall be taken by workmen at all times to avoid walking on freshly spread material.

C. Where, curbs, pavers, concrete sidewalk, manholes or other objects come in contact with the pavement, they shall receive a uniform coating of an asphalt tack coat. The asphalt coating shall be applied according to the manufacturer's recommendations but in no case shall it be applied above the elevation of the abutting asphalt materials.

D. All asphalt material shall be placed in a uniform layer by an approved bituminous paver. Hand placement may be permitted in small irregularly shaped areas, which are not accessible to a paver, only with prior Architect/Engineer approval.

E. Each days paving (base, binder or top) shall begin from a straight saw cut joint approved by the Architect/Engineer.

F. Joints at existing pavements shall be vertically sawcut. Apply tack coat on surfaces as shown on joint detail of Contract Drawings before beginning placement of new material. New material surfaces shall match existing surface.

G. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

H. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

I. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

J. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

K. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.2 SUBGRADE PREPARATION

A. Subgrade shall be prepared in accordance with Division 31 Section “Earth Moving”.

B. The Architect/Engineer may require a field demonstration of compaction equipment before approving subgrade. Rolling and compacting shall be done in the longitudinal direction of the traffic flow. If the moisture content of the soil is outside of the limits required to achieve the required compaction in accordance with Division 31 Section “Earth Moving”, the Architect/Engineer will require the addition of water or discing and re-grading so that the required degree of compaction shall be achieved. Obtain Architect/Engineer's approval of subgrade prior to placing subbase course or geotextile fabric (if fabric is required).

3.3 STABILIZATION FABRIC

A. Geotextile shall be installed in accordance with Division 31 Section “Earth Moving”.

3.4 SUBBASE COURSE INSTALLATION

A. Subbase course shall be prepared in accordance with Division 31 Section “Earth Moving”.

3.5 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).
   1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
   2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.6 BASE COURSE INSTALLATION

A. Asphalt concrete base course, as required by the Contract Documents, shall be placed to thickness and limits as shown on the Contract Drawings and only upon an Architect/Engineer approved subbase grade.

B. Compact the base course as specified in NYSS Section 401. In areas where rollers are inaccessible, compaction shall be effected with hand tampers or gas-fired compactors weighing not less than 25 pounds and having a bearing area not greater than 48 square inches.

C. Care shall be taken when rolling adjacent to a curb, sidewalk, light pole or other structure. Damage to any structure shall be repaired or replaced by the Contractor as ordered by the Architect/Engineer at no additional cost to the Owner.

D. The surface shall be tested with a 16-foot straight edge and all variations exceeding 1/4 inch in height or depth shall be eliminated.

3.7 BINDER COURSE INSTALLATION

A. Asphalt binder shall be placed to the thickness and limits as shown on the Contract Drawings and only upon an Architect/Engineer approved subbase grade (where no base course) or approved base course.

B. The roadway or sidewalk base surface to be covered shall be free from holes, depressions, bumps, waves, and corrugations. Any unsuitable surface areas or where directed by the Architect/Engineer shall be repaired by replacement of the unstable materials or by patching with a material to produce a tight surface having the correct grade. The roadway surface shall be cleaned by the use of mechanical sweepers, hand brooms, or other effective means until the surfaces are free of all material, which might interfere with the bond between the overlay material and the existing surfaces. All cleaning equipment shall be approved by the Architect/Engineer prior to use. Cleaning shall continue until adequate cleaning results as determined by the Architect/Engineer. Cleaning shall be done immediately prior to overlaying at no additional cost to the Owner.

C. Compact the binder course as specified in NYSS Section 401. In areas where rollers are inaccessible, compaction shall be effected with hand tampers or gas-fired compactors weighing not less than 25 pounds and having a bearing area not greater than 48 square inches.

D. Care shall be taken when rolling adjacent to a curb, sidewalk, light pole or other structure. Damage to any structure shall be repaired or replaced by the Contractor as ordered by the Architect/Engineer at no additional cost to the Owner.

E. The surface shall be tested with a 16-foot straight edge and all variations exceeding 1/4 inch in height or depth shall be eliminated.

3.8 TOP COURSE INSTALLATION

A. Asphalt top course shall be placed only during the periods indicated in Part 1 Job Conditions.

B. The roadway or sidewalk binder surface to be covered shall be free from holes, depressions, bumps, waves, and corrugations. Any unsuitable surface areas or where directed by the Architect/Engineer shall be repaired by replacement of the unstable materials or by patching with a material to produce a tight surface having the correct grade. The roadway surface shall be cleaned by the use of mechanical sweepers, hand brooms, or other effective means until the surfaces are free of all material, which might interfere with the bond between the overlay material and the existing surfaces. All cleaning equipment shall be approved by the Architect/Engineer prior to use. Cleaning shall continue until adequate cleaning results as determined by the Architect/Engineer. Cleaning shall be done immediately prior to overlaying at no additional cost to the Owner.

C. The Contractor shall coordinate the application of the upper courses for new and existing asphaltic pavements so that the finished surface of both top courses will be uniformly level. Any irregularities or depressions in the existing pavement shall be corrected by placing additional asphaltic concrete.

D. Roll the asphalt top course with a minimum ten ton roller, or as specified by the NYSS.

E. The finished pavement shall present a continuous and even appearance from edge of pavement to edge of pavement. The top course shall be blended in to meet existing pavements where applicable.

F. The surface shall be tested with a 16-foot straight edge and all variations exceeding 1/4 inch in height or depth shall be eliminated.

3.9 MANHOLE CASTINGS AND OTHER APPURTENANCES

A. Manhole frames and covers, valve boxes, cleanout covers, catch basin frames and grates and dry well frames and grates shall be set so that the finished asphalt top course is 1/4 inch above each. In no case shall these frames and covers, boxes or grates protrude above the finish pavement surface. Likewise these appurtenances shall not sit in depressions nor be paved over. Prior to completion of finished pavement, all castings and appurtenances shall be protected from damage by the Contractor.

3.10 PAVEMENT MARKINGS

A. A. The Contractor shall paint solid markings using two coats of paint in those areas indicated on the contract drawings and as, hereinafter, specified. Markings shall be painted immediately after all aspects of the paving operations have been completed and before dirt can accumulate on the pavement surface.

1. Protection: Install adequate barricades at points where trespassing can occur immediately after paving is completed so as to prevent vehicles or pedestrians from impeding the painting, operation.
2. Method: Carefully layout and define all painted markings on the surface of the pavement by means of chalk markings before painting, and accurately paint all markings within the limits and to the dimensions indicated on the contract drawings. All surfaces must be thoroughly cleaned before markings are painted. All markings shall be clear and distinct with sharply defined edges. Apply two coats of paint. At least 24 hours shall elapse between the painting of the first and second coats.
3. Removal of Equipment: Upon completion of the painting operation and once the paint has dried, remove all barricades and other debris, which has resulted from this operation.
4. Cleanup: Remove all spilled paint, tracking marks and unauthorized markings.

3.11 WEATHER AND SEASONAL LIMITATIONS

A. Contractor shall schedule paving operations such that all paving necessary to provide safe and adequate maintenance and protection of traffic or for the protection of previously laid course is completed within the weather and seasonal limitation described in previously.

B. Scheduling and sequencing of work to conform to seasonal limitations shall be reflected in the price bid.

C. If paving operations are not completed within the weather and seasonal limitations, all temporary materials and work needed (e.g. shimming of castings and protrusions, adequate drainage etc.) to provide acceptable ride-ability, and maintenance and protection of traffic shall be provided by the Contractor until paving operations can be completed at no additional cost to the Owner.

D. Base or binder course, placed by the Contractor, which will be permanently incorporated into the work and left open to traffic over the winter, shall be cleaned and tack coated in accordance with NYSS. Cleaning and tack coat shall be done immediately prior to overlaying at no additional cost to the Owner.

E. If the Contractor requests a waiver of the seasonal limitations and the Architect/Engineer determines it to be in the best interest of the Owner, the seasonal limitations may be waived for a limited period of time subject to temperature, time, weather and other conditions. Conditions of seasonal waiver shall include, but not be limited to, withholding of payment for work performed beyond the seasonal limitation date pending determination of the pavement condition and performance during the following spring; and, delaying start of one-year warranty period.

F. Contractor shall have no claim against the Owner for any costs attributable to disapproval of a waiver request. Architect/Engineer decision for approval or disapproval is final.

G. Any pavement damage which occurs as a result of Contractor either not protecting previously laid course or constructing any pavement course outside weather or seasonal limits whether a waiver

was granted or not, shall be repaired or replaced as determined by the Architect/Engineer at no additional cost to the Owner. All repairs or replacements shall be completed to the satisfaction of the Architect/Engineer and in accordance with these specifications.

3.12 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate subbase course to form new subgrade.

B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd. .
   1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
   2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

C. Patching: Partially fill excavated pavements with hot-mix asphalt binder mix and, while still hot, compact. Cover asphalt binder course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.13 WARRANTY

A. Settlement: Any settlement exceeding 1/8-inch in 10 feet horizontally or ¼-inch total depression, which occurs in any asphalt work within one year after final acceptance, shall be entirely removed and brought to proper grade and repaired, to the satisfaction of the Architect/Engineer.

B. If ponding or negative drainage patterns occur during within one year after final acceptance, the area shall be repaired to the satisfaction of the Architect/Engineer at no additional cost to the Owner.

END OF SECTION 321216

SECTION 321313 - CONCRETE PAVEMENT, SIDEWALKS AND CURBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Extent of concrete pavement work includes, but is not limited to furnishing and placing complete the following:
   1. 5-inch depth concrete sidewalk.
   2. 7-inch depth concrete ramps and aprons.
   3. Place premoulded bituminous joint filler to complete the concrete sidewalk and pavements.

B. Work for other cast-in-place slabs shall be completed in accordance with Division 03 Section “Cast in Place Concrete.

C. Related Sections:

   1. Division 03 Section "Cast-in-Place Concrete"
   2. Division 32 Section “Asphalt Concrete Paving”
   3. Division 31 Section “Earth Moving”

1.3 QUALITY ASSURANCE

A. Concrete shall be tested in accordance with Part 3 - Quality Control Testing During Construction, of this specification. Materials and Testing Laboratory services shall be paid by the Owner for testing concrete cylinders for compressive strength. All concrete not meeting the proper requirements shall be removed from the site by the Contractor. Additional testing as required in accordance with Part 3 shall be the responsibility of the Contractor.

B. All materials and work to prepare, form, place, finish, test, seal and cure the concrete sidewalk shall be completed in accordance with NYSDOT Specification Section 608 and as shown on the Contract Plans.

C. Installer Qualifications: An experienced installer who has completed pavement work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

D. ACI Publications: Comply with the following, unless more stringent provisions are indicated:
   1. ACI 301, “Specification for Structural Concrete”.
   2. ACI 117, “Specifications for Tolerances for Concrete Construction and Materials.”

1.4 SUBMITTALS

A. Submit proposed concrete mix design and laboratory test reports on mix design.

B. Submit manufacturer's catalog cuts, technical data, and recommendations on quantities, installation, and application for the following:

1. Formwork accessories.
2. Concrete admixtures.
3. Grout and patching materials.
4. Bonding agents.
5. Joint fillers and joint filler strips.
6. Curing and sealing compounds.

C. Submit concrete placement schedule prior to start of any concrete placement operations. Include location of all joints indicated on drawings, plus anticipated construction joints.

D. Steel Reinforcement Shop Drawings: Details of fabrication, bending, and placement, prepared according to ACI 315, “Details and Detailing of Concrete Reinforcement.” Include material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement and support of concrete reinforcement. Include special reinforcement required for openings through concrete structures.

1.5 DELIVERY, HANDLING, STORAGE

A. Deliver all container materials in manufacturer's standard, unopened containers with labels legible and intact. Store and protect from damage, freezing, or sunlight and heat, if required of individual product.

B. Store all aggregates and other items where damage and/or contamination will not occur.

C. Deliver, store and handle steel reinforcement to prevent bending and damage.

1.6 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for: other construction activities; access to Campus facilities; and, safety for workers, Campus employees and general public.

PART 2 - PRODUCTS

1.7 SUBBASE

A. The subbase course materials shall consist of granular materials as shown on the Contract Drawings and/or as specified in Division 31 Section “Earth Moving”. Depth as shown on the Contract Drawings.

1.8 CONCRETE FOR PAVEMENT, SIDEWALKS AND SIDEWALKS WITH INTEGRAL CURB

A. Readymix concrete conforming to ASTM C94 and this specification will be approved if obtained from an established contractor.

B. All concrete shall have minimum 28-day strength of 5,000 psi, conforming to ASTM C94.

Concrete shall have:

a. Water/Cement Ratio by wt. 0.48
b. Slump 3 ± 1 inches
c. Air Content 6.0 ± 1%

1. Normal Portland Cement: Standard brand ASTM C-150, Type I.
2. Sand: Shall be clean, sharp, natural sand, conforming to ASTM C-33-67. Material finer than #200 sieve shall not exceed 3 percent. Sand shall conform to NYSDOT Table 703-07 size designation.
3. Aggregate: Shall be clean, strong, crushed limestone or natural washed gravel conforming to NYSDOT #1 (Table 703-4) as follows:

Sieve Size Designation	Percent Passing By Weight
1 inch	100%
1/2 inch	90 - 100%
1/4	0 - 15%

4. Air-Entraining Admixture for Exposed Above Grade Concrete: Shall conform to ASTM C-260-69 "Specifications for Air-Entraining Admixtures for Concrete", "Class 1 Darex AEA," or approved equal.
5. High Range, Water-Reducing Admixture: ASTM C494, Type F
6. Water-Reducing and Retarding Admixture: ASTM C494, Type A
7. Water: Water for concrete shall comply with NYS Department of Health Standards for drinking water.
8. Fiber Reinforcement
    i. Synthetic Macro-Fiber: Synthetic macro-fibers engineered and designed for use in concrete, complying with ASTM C1116/C1116M, Type III, 1 to 2-1/4 inches long.
    ii. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
        1. Euclid Chemical Company (The); a subsidiary of RPM International, Inc.
        2. GCP Applied Technologies Inc
        3. Sika Corporation
    iii. Application rate shall be 3 lbs/CY in areas with pedestrian loading only or 5 lbs/CY in areas with vehicle or equipment loading.

C. Concrete Accessories:

1. Surface Sealant: Shall be a transparent, non-yellowing, waterborne, membrane-forming sealing compound meeting ASTM 1315, Type 1, Class A sealer for exterior use, such as Kure-N-Seal W by Sonneborn or other as approved by Architect/Engineer.
2. Expansion Joint Filler (horizontal and vertical): Use in conjunction with "Zip-strip" preformed recess strips. Filler shall be a non-impregnated cane fiber-preformed of thickness shown on Contract drawings (Closed cell, semi-rigid foam is an acceptable alternate).
3. Expansion Joint Sealer: Shall be a pour grade one-part, self-leveling polyurethane sealant,

such as Sonneborn Sonolastic SL1. Light gray in color. Use compatible primer where suggested by manufacturer.

4. Welded Wire Mesh (where shown on drawings): Shall be 6 inches x 6 inches, cold drawn 6-gauge wire conforming to ASTM A-185-69. Mesh shall be supplied in flat sheets. Provide 2 layers offset where indicated on the contract drawings.
5. Reinforcing Bars (where shown where shown on drawings): ANSI/ASTM A-615, Grade 60, deformed.
6. Supports: Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI recommendations, unless otherwise acceptable. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
7. Tie Wire: 16 gauge black steel.

1.9 CONCRETE FOR CONVENTIONALLY FORMED CONCRETE CURB (If Required)

A. Concrete - shall conform to the concrete as described for concrete pavement and sidewalks of this specification.

B. Curing Compounds - shall conform to NYSDOT (711-05) membrane curing compounds clear with fugitive dye, and shall be on the NYSDOT approved list latest edition.

C. Expansion Joints - At ends and at 20 foot maximum intervals, fill with cellular compression material 1/2 thick to within 1/4 inch of top of face. Cut to conform to cross-section of curb and place vertical. Material shall conform to ASTM D1751 per molded, bituminous impregnated material. When curb is cast adjacent to cement concrete pavement constructed with expansion joints, expansion joints in the curb shall be located at the expansion joints in the pavement.

1.10 CONCRETE FOR MACHINE FORMED CONCRETE CURB (If Required)

A. The material requirements, mix preparation and manufacturing of concrete shall comply with the requirements for Class J concrete Section 501 - Portland Cement as defined in the NYSDOT "Standard Specifications," as issued May 1, 2008 (and any subsequent revisions).

1.11 CONCRETE FORMS

A. Forms shall be steel or plywood with finished surface in contact with concrete. Forms shall be free of warps or kinks.

B. All forms shall be of suitable size and strength, braced and secured adequately to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. All forms shall extend for the full curb depth.

C. Use straight forms, free of distortion and defects. Use flexible spring steel forms or laminated boards to form radius bends as required.

D. Coat forms with a non-staining form release agent that will not discolor or deface surface of concrete and will not impair subsequent treatments of concrete surfaces.

1.12 CURING MATERIALS

A. Evaporation Retarder: Curing and Sealing Compound: Conform to NYSDOT Standard Specification 711-05.

1.13 CONTROL OF CONCRETE MIXING IN THE FIELD

A. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94. Furnish batch ticket information to concrete testing representative.

1. When air temperature is between 85 deg F (30 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 GENERAL - POURED IN PLACE CONCRETE

A. The contractor is responsible for the complete construction and/or installation of all concrete walks, curbs and other concrete work in accordance with the contract drawings and this specification.

B. Provide materials necessary to ensure adequate protection of concrete during inclement weather before beginning installation of concrete.

C. Before beginning concrete placement, inspect formwork, reinforcing steel, and items to be embedded, verifying that all such work has been completed.

D. If needed, provide runways for wheeled equipment to convey concrete. Do not support runways on reinforcing or wheel equipment directly over reinforcing.

E. Schedule continuous placement of concrete to prevent the formation of cold joints. Provide construction joints if concrete for a particular element or component cannot be placed in a continuous operation.

F. Deposit concrete as close as possible to its final location, to avoid segregation.

G. Concrete sidewalks shall be protected from damage, by temporary asphalt until such time as the final asphalt is placed.

3.2 PREPARATION

A. Subgrade: All large stone, organic material, soft clay, spongy material and other deleterious matter exposed during the course of preparing the subgrade shall be excavated and replaced with the specified base course material. The subgrade shall be properly shaped and uniformly compacted to conform with the accepted section, line and grade as indicated on the contract drawings.

B. Aggregate Subbase Course: The subbase course for concrete pavements shall consist of compacted aggregate placed on the prepared subgrade to the depths indicated on the contract drawings. Roll or tamp aggregate with an approved power roller or mechanical tamper until it is firmly compacted and meets compaction requirements listed in Division 31 Section "Earth Moving".

C. Remove loose material from compacted subbase prior to concrete placement.

3.3 FORM CONSTRUCTION

A. Forms shall be full depth, set accurately to line and grade, and be securely staked and held in position throughout placing and curing of concrete. Contractor shall obtain approval of forms for horizontal alignment from the Architect/Engineer prior to placing concrete.

B. Clean forms after each use and coat with form releasing agent as often as required to ensure separation from concrete without damage.

C. Allowable tolerances:
   i. Top of forms not more than 1/8” in 10’
   ii. Vertical face on longitudinal axis, not more that ¼” in 10’

3.4 REINFORCEMENT

A. Wire fabric for concrete reinforcement shall be embedded at mid-depth in the slab. Immediately prior to placing concrete, place all required reinforcing in the forms in accordance with the Contract Drawings. Place reinforcing mesh in such a manner that sheets of mesh overlap adjoining sheets by a minimum of 6 inches both longitudinally and transversely. Place mesh on brick chairs 2 inches above the surface of the subgrade. No reinforcing shall cross expansion joints. Any mesh bent, displaced or ruptured during handling shall be straightened or rewelded.

B. All outside edges of mesh (or reinforcing) shall not be more than 3 inches or less than 1-1/2 inches from the finished edges of the pavement.

3.5 FIBER REINFORCEMENT

A. Uniformly disperse in concrete mixture at manufacturer's recommended rate.

B. Install in accordance with manufacturer's requirements and recommendations.

3.6 CONCRETE PLACEMENT

A. Do not place concrete until subbase and forms have been checked for line and grade. Do not place concrete around manholes or other structures until they are at required finished elevation and alignment.

B. The subbase shall be wetted immediately prior to placing the concrete for the sidewalk and exterior slabs. Place concrete in the forms to the full depth as indicated on the Contract Drawings and thoroughly vibrate or tamp, ensuring that all honeycombing is eliminated and the surface of the concrete is true to line and grade. Do not use vibrators to move concrete laterally. Consolidate with care to prevent dislocation of reinforcing, dowels or joint devices.

C. Deposit and spread concrete in a continuous operation.

D. Place all concrete in forms within 45 minutes of mixing. Discard any concrete in which an initial set

has occurred prior to placing.

E. No retempering of concrete will be permitted and concrete shall not be dropped more than 3 feet.

3.7 JOINTS

A. When joining existing structures, sidewalks or other pavements place transverse joints to align with previously placed joints, unless otherwise directed.

B. Provide full depth premolded bituminous joint filler for expansion joints every 25 feet. Intervals in pavement surfaces shall not exceed 25 feet on center in any direction. Expansion joints shall go through curb as well and to the full depth of curb. In addition, place expansion joints wherever concrete pavement abuts curbs, catch basins, inlets, structures, existing walks, building walls, retaining walls, stairs, and, other fixed objects. Joint filler shall be held securely in place so that straight joints results. All expansion joints shall be keyed.

C. Extend joint fillers full width and depth of joint, not less than 1/2” or more than 1” below finished surface where joint sealer is indicated. If no joint sealer, place top of joint filler flush with finished concrete surface.

D. Protect top edge of joint filler during concrete placement with a metal cap or other temporary material. Remove protection after concrete has been placed on both sides of joint.

E. Allow concrete pavement to cure a minimum of 10 days prior to the time of installation of joint sealer. Install joint sealer after joint is thoroughly clean and one application of primer has been uniformly and continuously applied and thoroughly dried

F. Tooled control joints shall be placed every 5 feet. The jointer for tooled joints shall have a 3/4 inch to 1 inch deep bit, with 1/4 inch to 1/2-inch radius. Control Joints shall be performed as soon as possible after slab finishing without possibility of dislodging aggregate.

G. Joints shall be straight. Joints not straight will require removal of the concrete and replacement.

3.8 CONCRETE FINISHING FOR SIDEWALKS AND RAMPS

A. Strikeoff to required grade and within surface tolerances indicated. Verify conformance to surface tolerances. Correct deficiencies while concrete is still plastic.

B. Bull Floating: Immediately following screeding, bull float or darby before bleed water appears, to eliminate ridges, remove surface irregularities, fill in voids, and embed coarse aggregate. Recheck and correct surface tolerances. Refloat repaired areas to provide continuous smooth finish. Surface shall be smooth, even finish, free of any design swirls, float marks etc. Use hand methods only where mechanical floating is not possible.

C. Work edges of slabs and formed joints with a edging tool, and round to 1/2" radius, unless otherwise indicated. Eliminate tool marks on concrete surface.

D. Do not perform subsequent finishing until excess moisture or bleed water has disappeared and

concrete will support either foot pressure with less than ¼-inch indentation or weight of power floats without damaging flatness. Complete surface finish as follows:

1. For sidewalks and ramps provide a broom finish by drawing a stiff bristle broom across concrete surface, perpendicular to line of traffic. Provide uniform transverse corrugations approximately 1/16 inch deep, without tearing surface. Repeat operation if required to provide a line texture acceptable to the Architect/Engineer.
2. For ramps and flares only also provide a tooled grooved finish.
3. Finish in accordance with the pattern indicated on the contract drawings.

E. All pavement edges shall be tooled to round. Along each side of expansion joints, use Goldblatt Edger 2 inches wide, 3/8 inch radius, 1/2 inch lip, Catalogue No. 06260M7 or approved equal. For score joints, use Goldblatt bronze groover bit size 1/2 inch at top, 1 inch deep, 4-1/2 inches wide, Catalogue No. 0631M7 or approved equal.

F. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point-up any minor honeycombed areas. Rub all exposed surfaces of concrete. Remove and replace areas or sections with major defects, as directed by the Architect/Engineer.

G. All lines formed shall be true and straight. The walk surface shall have finish as noted above with exposed tooled edge and joint banding, flush with broomed finish, and free of all ridges.

H. Curb face shall be hand rubbed to remove all form markings.

3.9 CURING

A. Curing of the sidewalk and curb shall comply with the requirements of NYSDOT Section 502-3.10. Minimum curing periods for the various types of curing materials used shall comply with the requirements of Table 502-2 in NYSDOT Section 502 latest edition.

B. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

C. Apply curing compound to all exposed surfaces immediately after finishing operations are completed and surface water has evaporated. Provide curing covers over forms.

D. The manufacturer’s recommendation for application and use of the curing material shall be observed.

E. Protect all concrete work from traffic and the elements, for a minimum of three days. Do not open pavement to traffic until the Architect/Engineer so directs. Minimum curing periods for the various types of curing materials used shall comply with the requirements of Table 502-2 in NYSDOT Section 502 latest edition.

3.10 SURFACE SEALANT

A. Immediately upon completion of the concrete curing period apply two coats surface sealant, by means of an approved mechanical pressure spray distributor, capable of maintaining a pressure of 20

to 30 pounds per square inch, to pavement surfaces, which have been cleaned and thoroughly dried. Apply each coat of surface sealant, at the rate specified by the manufacturer, to all exposed surfaces of exterior concrete. Allow specified time to dry thoroughly between applications.

B. Exercise care in the use of surface sealant solution and avoid causing damage or harm to property and persons in the immediate vicinity of the spray operation.

3.11 SLAB SURFACE TOLERANCES:

1. Achieve flat, level planes except where grades are indicated. Slope uniformly to drains.
2. Floated finishes: Depressions between high spots shall not exceed 5/16 inch under a 10-foot straightedge.

3.12 WORKMANSHIP

A. All concrete work shall be first quality and in strict accordance with line and grade and the dimensions indicated on the contract drawings. The average thickness of concrete pavement shall not be deficient by more than 1/4 inch. Any concrete work not constructed or installed in accordance with the contract drawings will not be accepted and shall be removed and replaced at the contractor's expense.

B. Seasonal Limits: No concrete shall be poured on a frozen or thawing subgrade during inclement weather or when the temperature of the air is less than 38 degrees F.

C. Protect all concrete surfaces from traffic and the actions of the elements until surface sealant solutions completely dry. Provide barricades and/or fencing when required for a minimum period of 4 hours, or as directed by the Architect/Engineer.

D. All horizontal and vertical alignments shall be smooth. No abrupt changes in grade or horizontal alignment will be accepted.

3.13 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Bases and Foundations: Provide equipment bases and foundations as shown on Drawings. Set anchor bolts for equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

3.14 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect/Engineer. Remove and replace concrete that cannot be repaired and patched to Architect/Engineer’s approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than ½ inch (13 mm) in any dimension in solid concrete, but not less than 1 inch (25 mm) in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.

3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect/Engineer.

3.15 REMOVAL OF EXISTING CONCRETE

A. Saw cut surfaces or drill holes at regular intervals sufficient to establish a fracture plane for removal by power tools.

B. Salvage all existing reinforcing; do not cut away until specifically directed by the Architect/Engineer, or as shown on the Drawings.

C. New work bonded to existing work:

1. Clean and roughen existing surface by sandblasting, waterblasting, scabbler, or other approved method.
2. Embed dowels and reinforcing as detailed on the Drawings.
3. Coat surface with bonding agent applied in strict accordance with manufacturer's instructions.

D. Existing work cut away for new work.

1. Saw cutting and removal shall continue to within 1/4 inch of the finished surface. The final ¼-inch removal shall be completed by grinding to the final surface.
2. Provide bond breaker where new concrete work is adjacent to existing work but structurally separate.

3.16 COLD WEATHER CONCRETING

A. Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions or low temperatures, in compliance with requirements of ACI 306 and as specified.

B. Cold weather concreting (below 40º F) shall conform to ACI 306-72. Section 6.2 shall not apply.

C. When air temperature has fallen to or is expected fall below 40º F, provide adequate means to maintain temperature in area where concrete is being placed at 70º F for five days or 50º F. for seven days after placing. Sudden thermal shock due to rapid heating or cooling and rapid dry out due to overheating shall be avoided.

D. When air temperature has fallen to or is expected to fall below 40º F uniformly heat water and aggregates before mixing, as required, to obtain concrete mixture temperature of not less than 50º F or more than 80º F at time of placement. ACI 306-72, Chapter 2 shall apply only if approved by the Architect/Engineer.

E. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. Forms, reinforcing steel and adjacent concrete surfaces shall be entirely free of frost, snow and ice before placing.

3.17 HOT WEATHER CONCRETING

A. When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305-72 and as specified.

B. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90º F. Mixing water may be chilled or chopped ice may be used to control concrete temperature. Water added to mix shall be reduced by water content of ice.

C. Cover reinforcing steel with water soaked burlap if it becomes too hot. Steel temperature shall not exceed air temperature at time of embedment.

D. Wet forms thoroughly before placing concrete.

E. Do not use retarding admixtures without written approval of Architect/Engineer.

3.18 QUALITY CONTROL TESTING DURING CONSTRUCTION

A. Contractor shall provide free access to Work and cooperate with appointed testing firm.

B. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement. Tests will be performed according to ACI 301.

C. The following tests may be performed by the Owner:

1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with

ASTM C 94.

2. Slump: ASTM C 143; one test for each concrete load at point of discharge; and one test for each set of compressive strength test specimens.

3. Air Content: ASTM C 173; volumetric method for lightweight of normal weight concrete; ASTM C 231 pressure for normal weight concrete; one for each set of compressive strength test specimens.

4. Concrete Temperature: Test hourly when air temperature is 40º F (4º C) and below, and when 80º F (27º C) and above; and each time a set of compression test specimens are made.

5. Compression Test Specimen: ASTM C 31; One composite sample (minimum of 4 cylinders) for each day's pour of each concrete mix exceeding 5 cu. yd, but less than 25 cu. yd., plus one set of four standard cylinders for each additional 50 cu. yd. or fraction thereof. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required. One additional test cylinder will be taken during cold weather concreting, cured on job site under same conditions as concrete it represents.

6. Compressive Strength Tests: ASTM C 39; one set for each 25 cu. yds. or fraction thereof, of each concrete class placed in any one day; one specimen tested at seven days, two specimens tested at 28 days, one held for later testing as needed.

7. When frequency of testing will provide less than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.

8. When strength of field-cure cylinders is less than 85% of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.

9. Strength level of concrete will be considered satisfactory if averages of sets of two consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive by more than 500 psi.

10. Costs of any additional tests (including costs incurred by the Owner), as well as removal and reconstruction resulting from the failure to meet specified compression strength with the test cylinders, shall be borne by the Contractor. Costs for testing of concrete for replacement of defective concrete or non-conforming concrete (including costs incurred by the Owner and Architect/Engineer) shall be paid by the Contractor.

3.19 DEFECTIVE CONCRETE

A. Defective Concrete:

1. Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.

2. Concrete which shows excessive cracking or honeycombing so much that in the opinion of the Architect/Engineer the appearance or use of structure is adversely impacted.
3. Concrete not in conformance with compressive strength testing.

3.20 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet requirements in this Section.

B. Drill test cores where directed by Architect/Engineer when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

E. Backfill all concrete work immediately after removal of the forms. Fill material shall be an approved earth or the required aggregate material. Place and compact all backfill material in accordance with the standards as outlined in the Division 31 Section "Earth Moving" and to the line and grade indicated on the Contract Drawings.

END OF SECTION 321313

SECTION 321640 - GRANITE CURBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. A. Work of this section shall include, but is not limited to:
1. Storage of existing granite curb to be removed and turned over to the Owner.
2. Resetting of existing or stored granite curb.
3. Furnish and place new granite curb.

B. B. Related Sections:
1. Division 03 Section "Cast-in-Place Concrete"
2. Division 31 Section "Site Clearing"
3. Division 31 Section “Earth Moving”
4. Division 32 Section “Asphalt Concrete Paving”

1.3 QUALITY ASSURANCE

A. Granite stone curb shall be supplied from approved quarries. The stone shall be sound and durable, free from seams, which impair its structural integrity, and of smooth splitting and machine character. Natural color variations that are characteristic of the deposit will be permitted. Acceptance of any curb containing discoloration other than cleanable surface stains shall be subject to approval by the Architect/Engineer.

B. Curb will be inspected for compliance with material requirements upon arrival at the site, by the Architect/Engineer. Curb not in compliance with material requirements will be rejected.

C. Carefully remove existing curb to avoid damage and breakage.

D. Installer Qualifications: Engage an experienced installer who has completed granite curbing installations similar in materials, design and extent to that indicated on the Project and with a record of successful in-service performance.

1.4 DELIVERY, HANDLING, STORAGE

A. Store all curbing where damage will not occur and contamination will not result from improper storage. Location as approved by the Owner and Architect/Engineer.

B. All curbing shall be stored off the ground. Stone curb shall be handled so as not to scratch, chip or damage them.

C. When delivered, the curbing shall be placed neatly and orderly and in a location approved by the Owner and Architect/Engineer. An inventory listing of the curbing shall be submitted to the Architect/Engineer.

1.5 PROJECT CONDITIONS

A. Site Information: Perform site survey and layout for curbing. Verify that straight length, radius, and drop curbing sections may be installed in compliance with the Contract Drawings.

B. Weather Limitations: Protect mortar material against freezing when ambient air temperature is 40 degrees F and falling. Heat materials and provide temporary protection of completed joints.

C. Sequencing and Scheduling: Coordinate granite curbing work with location and alignment of roadways, parking areas, entrances, walks, traffic islands and drainage inlets.

PART 2 - PRODUCTS

2.1 GRANITE CURB

A. Granite curb shall be light gray, dimensions as shown on the Contract Drawings, have split faces and sawn top. Curb shall have a nominal depth of 16 inches, plus or minus 1 inch. Curb used in header sections shall have a depth of 12 inches. Drill holes will not be permitted in exposed curb surfaces.

B. Curb shall have a minimum length of 3 feet.

C. All granite curbing to be installed in radii of less than 100-foot shall be radius curb sections cut to conform to the required curvature indicated on the plans. The ends shall be cut on radial lines.

D. Top surfaces shall be finished to approximately true planes. No projection or depression shall be greater than 3/16 inch. Saw marks normal to the sawing process will be permitted if within the 3/16-inch tolerance.

E. Top front arris lines shall be straight and true with no variations greater than 1/8 inch measured from a 2-foot straightedge placed along the arris line. Arris lines at the joints shall not project beyond the plane of a split face and shall not fall under the plane of a split face more that 1/8 inch.

F. The front face of straight and radius curb is to be quarry split. Front exposed surfaces of straight curb shall have no projection greater than ¾ inch or depression greater than ½ inch measured from a vertical plane passing the arris line at the top of the split face for a distance of 8 inches down from the top. For radius units, the front exposed face shall have no projection greater than 1-1/4 inches. Front faces below 8 inches down from the top shall have no projections or depressions greater than 1 inch measured in the same manner.

G. Back surfaces shall have no projections or depressions, which exceed a batter of 1 inch in 4 inches for a distance of 3 inches down from the top.

H. Ends of curbs shall be approximately square with the plane of the exposed curb surfaces and shall be finished so that when curbs are set, no space greater than ½ inch or les than 1/8 inch shall show

in the joints for the full length of the exposed joint. Curb ends below the pavement surface shall it break over 6 inches from the joint plane.

2.2 CONCRETE FOR CURB SECTION

A. Concrete cradle and backing shall have a minimum 28-day strength of 3,000 psi, a minimum cement factor of 329 pounds per cubic yard of concrete, a maximum aggregate size of 1", slump range of 0 to 2 inches, and shall contain an air-entraining admixture equivalent to 3-5% plus or minus 1% by volume of total mix.
   1. Normal Portland Cement: Standard brand ASTM C-150, Type I.
   2. Sand: Shall be clean, sharp, natural sand, conforming to ASTM C-33-67. Material finer than #200 sieve shall not exceed 3%. Sand shall conform to NYS DOT Table 703-07 size designation.
   3. Aggregate: Shall be clean, strong, crushed limestone or natural washed gravel conforming to NYS DOT Size Designation #1 (Table 703-4) as follows:

Sieve Size	Percent Passing (%)
1 inch	100
1/2 inch	90-100
1/4 inch	00-15

   4. Air-Entraining Admixture for Exposed Above Grade Concrete: Shall conform to ASTM C-260-69 "Specifications for Air-Entraining Admixtures for Concrete", "Class 1 Darex AEA", or approved equal.
   5. Water: Water for concrete shall comply with NYS Department of Health Standards for drinking water.

B. Mortar: Cement mortar shall comply with the requirements of NYSDOT materials specification 705-20.

PART 3 - EXECUTION

3.1 INSTALLATION OF GRANITE CURB

A. Curb Trench: A trench of the widths and lengths necessary shall be prepared.

B. Curb Placement: All granite curb used adjacent to flexible type pavement shall be set on continuous concrete backing. Dry mix concrete shall be used for the portion of the backing below the bottom of the curb. All curb shall be set true to line and grade. The concrete foundation shall be allowed to cure for a minimum of two days prior to backfilling.

C. Driveway or Sidewalk Cuts: Curbs at driveways or sidewalks shall be sized and as configured as shown on the Contract Drawings and as directed by the Architect/Engineer. The typical transition curb for driveways and sidewalks shall be 3 feet and 6 feet in length respectively. When two driveway cuts are very close, consult the Architect/Engineer for direction on placement of the curb cuts. The finished header curb shall have a reveal as indicated on the Contract Drawings.

D. Curb Joints: Curb Sections shall be fitted together as closely as possible so that after setting a nominal 1/4- to 1/2-inch open joint will be formed. The joint shall be carefully filled with cement mortar for a minimum depth of 12 inches down from the top of the curb. The cement mortar shall be mixed and rodded in place as indicated in NYS DOT Section 705-20. The top and front face of the joint shall be neatly pointed and tooled flush with the curb surface. Excess mortar shall be immediately cleaned from curb.

E. Backfilling: Upon completion of the concrete curing time, the Contractor shall carefully backfill all curb trenches with the material indicated on the Contract Drawings. Care shall be exercised during the backfilling operations to ensure against dislodging, damaging, or disturbing the curb. The backfill material shall be thoroughly tamped before proceeding with any further work in the area adjacent to the curb.

F. Radius Curb and Sidewalk Ramps: When establishing curb radii elevations, care shall be taken so as to eliminate any low point and ponding of water that would occur within the area of the sidewalk ramp. Curb radii elevations may be adjusted as approved by the Architect/Engineer. It is important that all ponding of water within a sidewalk ramp area be eliminated and the intended use of the sidewalk ramp not be impeded or disrupted.

G. Fill all joints solid with cement mortar and remove excess mortar from exposed faces of curb.

3.2 WORKMANSHIP

A. The Contractor shall keep all curbs clean, in alignment, and protected from damage for the duration of the contract. Any curb, which is damaged at any time prior to final acceptance of the work, shall be removed and replaced in accordance with the Contract Drawings and this specification, at the Contractor's expense.

B. All horizontal and vertical alignments shall be smooth. No abrupt changes in grade or horizontal alignment will be accepted.

3.3 RESETTING EXISTING AND STORED CURB

A. Resetting existing curb and stored curb shall be done in the same manner as new curb. Care shall be used to avoid damage to existing and stored curb.

B. The Contractor shall utilize existing curb at location as shown on the Contract Drawings. The curb shall be trimmed or cut as necessary to fit the proper configuration. If directed by the Architect/Engineer, all joints and tops shall be redressed to obtain a smooth top surface and to obtain joints of the same class as specified for new curb.

C. In the event the existing curb is unusable or the quantity is insufficient, the Contractor shall notify the Architect/Engineer for direction. Under no circumstances shall the Contractor install new curb without prior approval from the Architect/Engineer.

3.4 SALVAGED GRANITE CURB

A. All solid, acceptable and resettable granite curbing as removed under normal excavation within the limits of the work to complete the work shall be cleaned, labeled, inventoried and delivered to the Owner.

B. Cleaning: All loose dirt and concrete shall be removed from salvaged curb.

C. Labeling: All salvaged curb shall be labeled on the top surface in yellow paint. Labeling shall indicate length of curb, thickness and radius size (if applicable), for example: 6 feet-15 foot radius-4 inches thick.

D. Inventoried: A complete listing of all salvaged curb delivered to the Owner shall be provided to the Architect/Engineer.

E. Delivery: All curb shall be delivered, handled, stacked and stored as described previously in this specification. On-site storage location will be field determined by the Owner.

F. Any curb broken during excavation or salvage operations, or found otherwise unacceptable for reuse by the Architect/Engineer, shall be properly disposed of off-site by the Contractor.

3.5 PROTECTION

A. Cleaning: Remove any visible stains and excess mortar from exposed surfaces, wash and scrub clean.

B. Protect installed curbing from chipping, staining, displacement or other damage during backfilling and paving operations. Protect curb from damage throughout construction duration.

END OF SECTION 321640

SECTION 329200 – TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Restoration and establishment of lawn areas: - This section describes the procedures for:
1. Establishment of turf and grasses
2. Restoration and establishment of lawn areas.
3. Screening, placing and spreading topsoil.
4. Importing, placing and spreading topsoil.
5. Sod and Seed bed preparation.
6. Seeding and sodding athletic fields and lawns
7. Maintenance: watering, fertilizing, mowing, core aerating and weed control.

B. Related Sections:
1. Division 31 Section “Earth Moving”

1.3 QUALITY ASSURANCE

A. Contractor shall retain for inspection the following items:
1. Receipts for all fertilizer, topsoil amendents and grass seed.
2. Seed and fertilizer in unopened bags, bearing the analysis of the contents, and in sufficient quantities to meet the requirements of the project.

B. All work in conjunction with topsoil placement, seeding and establishing lawns and landscaping shall be performed under the direction of individuals experienced in the establishment of lawns and landscape plantings.

C. Permanent seeding shall be placed only during the following periods as weather conditions permit:
1. Spring Seeding – Between April 1 (or thereafter when ground becomes workable) and June 1
2. Fall Seeding – Between August 15 and October 15

1.4 WARRANTY

A. Provide a uniform stand of grass by watering, mowing, and maintaining lawn areas until final acceptance. Reseed seeded areas, which fail to provide a uniform stand of grass, with specified materials until all affected areas are accepted by the Architect/Engineer.

B. The Contractor shall employ hay or straw bale checks in all swales, at intervals not exceeding 150 lineal feet. Stake bales into grade and clean out all sediment after each storm. Reseed area disturbed

by cleaning.

1.5 SUBMITTALS

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

B. Seed vendor's certified statement for each grass seed mixture is required, stating botanical and common name, percentages by weight, and percentages of purity of germination and weed seed; for each grass seed and seed species.

C. Product literature and certifications for amendment products including organic material, lime, and ammonium sulfate

D. Materials Test Reports: Submit topsoil borrow area test reports to the landscape architect a minimum 6 weeks prior to delivery to site.
   a. Provide location of topsoil borrow area.
   b. Provide name of independent soil testing laboratory.
   c. Provide date of sampling and testing.
   d. Provide confirmation of SPDES Permit for borrow pit.

1.6 DELIVERY, STORAGE AND HANDLING

A. Sod:
   1. Cut, deliver and install sod within a 24-hour period. Sod cutting and shipping shall be coordinated with the sod installers.
   2. Do not harvest or transport sod when moisture content may adversely affect sod survival.
   3. Protect sod from sun, wind and dehydration prior to installation.
   4. Do not tear, stretch or drop sod during handling and installation.
   5. Store sod materials at site in an orderly manner at location(s) acceptable to the Architect.

B. Seed:

   1. Packing and Shipping: Ship seed and associated materials with certificates of inspections required by governing authorities.
   2. Do not make substitutions. If specified seed material is not obtainable, submit to the Architect proof of non-availability and a proposal for use of equivalent material with similar performance criteria as the originally specified seed material.
   3. Store all seed in the site in a cool, dry place in a manner to prevent wetting and deterioration, as approved by the Architect. Replace any seed damaged during storage as directed by the Architect.
   4. Deliver seed in supplier’s unopened packages bearing labels showing the supplier’s ame and seed analysis by weight.

C. Fertilizer:
   1. Deliver fertilizer in the manufacturer’s standard sized bags showing the weight, analysis and manufacturer’s name. Store all fertilizer under a waterproof cover in a dry place as approved by the Architect.

1.7 JOB CONDITIONS

A. Contractor shall coordinate scheduling of topsoil placement, preparation of topsoil for permanent seeding, and seeding to meet the seasonal time frames.

B. Topsoil placed outside the seasonal times frames shall be temporary seeded by the Contractor, cost to be included in the price bid.

C. The Contractor is responsible to provide mechanically screened topsoil; complete fine grading; maintain topsoil and finish grade; complete preparation of topsoil; complete seeding and necessary reseeding; restore areas if eroded, settled, or otherwise disturbed after fine grading; and, provide additional topsoil and seed and restore finish grade where washout or damage occurs before grass is established.

D. The Contractor is responsible for all erosion control measures. Contractor shall provide straw bales or stoned check dams in ditches or problem swales at intervals required to adequately slow water velocity and impede soil loss.

E. Contractor shall provide mulch for temporary or winter seed and for permanent seed.

F. Lawn Topsoil Limits: All ground area within the indicated contract limit lines, or any additional area which has been disturbed in any way by the construction operations, shall be topsoiled and fine graded by the Contractor for permanent lawn seeding, unless otherwise indicated on the drawings to be covered with trees, shrubs, structure(s), walks, roads, or other surfaced areas

1.7 SEQUENCE AND SCHEDULING

A. Schedule: Prior to construction, provide a schedule which addresses the following lawn thresholds involving erosion control stabilization and competitive use of playfields:

1. Seeding and Sodding Installation: The Contractor may invoice for 50% of the approved schedule of value breakdown at the time of acceptable installation.

   a. Unless otherwise directed in writing by the Architect, seed and sod lawns from April 1 to May 15 and from August 15 to October 1. Seeding and sodding between May 16 and August 14 is not acceptable unless adequate water supply is available and applied to the turfgrass as required herein and approved by the Architect.

   b. Proceed with and complete seeding and sodding as rapidly as portions of the site become available, working within the seasonal limitations for each kind of landscape work required.

2. Substantial Completion: The Contractor may invoice for 25% of the approved schedule of value breakdown at the time of substantial completion as described in Part 3, “Standards for Substantial Completion of Lawns” of this specification section. At this time, the Architect may issue the Notice of Termination to satisfy the NYS DEC stabilization requirements. The date of substantial completion is anticipated approximately 60 days after the lawn installation presuming all Contractor maintenance operations have been vigorously performed.

3. Final Acceptance: The Contractor may invoice for the final 25% of the approved schedule of value breakdown at the time of final acceptance as described in Part 3, “Standards for Final Acceptance of Lawns” of this specification section. The date of the final acceptance is anticipated approximately 30 days after substantial completion presuming all Contractors maintenance operations have been vigorously performed.

4. Owner Maintenance: After final acceptance of the lawns, the Owner will maintain for 1 to 3 growing seasons to reach competitive maturity and beyond per ASTM F2060.

PART 2 - PRODUCTS

2.1 FERTILIZER

A. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
   1. Composition: 10 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight

B. Cyanamide compounds and hydrated lime are not permitted in fertilizer mixtures.

C. Fertilizer is not required for temporary seed.

2.2 SEED – EROSION CONTROL AND LAWN MIX

A. Grade A quality, fresh and recleaned and proven to produce satisfactory growth in the locality of the project.

B. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances in unopened original packages composed of the varieties and mixed in the proportions by weight as shown on the plans, and tested as to minimum percentages of purity and germination. Any substitutions must be submitted to the designers for approval. The seed shall be certified (Blue Tag) seed for genetic purity.

C. Seed Standards:
   1. All seed shall be furnished in bags or containers clearly labeled to show the name and address of the supplier, the seed name, lot number, net weight, the percent of weed seed content and the guaranteed percentage of purity and germination. Seed and seed labels shall conform to all current state and federal regulations and will be subject to the testing provisions of the Association of Official Seed Analysis.

D. All seed mixes shall be free from such noxious weeds as Canadian Thistle, Coarse Fescue, European Bindweed, Johnson Grass and leafy Spurge. The landscape contractor shall furnish to the Architect/Engineer a signed statement certifying that the seed furnished is from a lot that has been tested by a recognized laboratory. Seed which has become wet, moldy or in any other way damaged in transit or storage, will not be accepted.

E. Seed Mix: Fresh, clean and from current season’s crop, delivered in original packages, unopened, and bearing guaranteed analysis. Seed shall meet New York State standards of germination and

purity.

1. Composed of the following varieties, mixed to the specified proportions by weight, and tested to minimum percentages of purity and germination. Shall be free of: Poa Annua, bent grass, and noxious weed seed such as Canadian Thistle, Coarse Fescue, European Bindweed, Johnson Grass and leafy Spurge. The landscape contractor shall furnish to the Architect/Engineer a signed statement certifying that the seed furnished is from a lot that has been tested by a recognized laboratory. Seed which has become wet, moldy or in any other way damaged in transit or storage, will not be accepted.

2. Permanent Seed Species: Blend - Mix Type 'A' Rate: 5 to 6 pounds per 1,000 SF Provide state-certified (Blue Tag) seed of grass species and percentages as follows: (Acceptable for all lawn applications)

LAWN MIX Common Names	Percent by Weight	Percent Purity	Percent Germination
Adelphi Kentucky Bluegrass	30%	90%	87%
Baron Kentucky Bluegrass	30%	90%	87%
Pennlawn Fescue	30%	90%	82%
Pleasure Perennial Ryegrass	10%	90%	90%

F. Temporary Seed Species for Erosion Control:
1. If spring, summer or early fall, seed with perennial ryegrass at 1 lb per 1,000 SF.
2. If late fall or early winter, seed with Certified “Aroostook” winter rye (cereal rye) at 2.5 lbs. per 1,000 SF.

2.4 WATER

A. Free of substance harmful to plant growth. Hoses, pumps, sprinklers or other methods of transportation furnished by Contractor.

2.5 TOPSOIL (See Division 31 Section “Earth Moving”)

2.6 SEEDING ACCESSORIES

A. Lime: Natural dolomitic limestone containing at least 85% of total carbonates, and 30% magnesium carbonates; ground so that at least 90% passes a ten mesh sieve, and at least 50% passes a 100 mesh sieve.

1. Shall be applied at a rate sufficient to adjust pH to between 6.0 and 7.0 as determined by the pH testing laboratory. (Laboratory costs paid by the Contractor.) Rate of lime application not to exceed 50 pounds per 1000 sf.

2. In addition, lime shall meet the following requirements:
   a. Calcic or dolomitic ground limestone.
   b. Shall contain not less than 85% of total carbonates.
   c. Magnesium oxide - 10% minimum content for dolomitic and high magnesium

limes.

d. Sieve Analysis - at least 50% will pass through a No. 100 mesh sieve and 90% will pass through a No. 20 mesh sieve.
e. Coarser material may be used providing the rates of application are increased as approved by the Architect/Engineer or Landscape Architect.

B. Weed Killer

1. If necessary in the opinion of the Architect/Engineer or Landscape Architect, an application of broadleaf weed killer may be required prior to final acceptance. Provide one application of a pesticide for weed, insect, or disease infestations if required by Architect/Engineer. Pesticides shall be chosen from the Cornell Pest Management Guidelines for Commercial Turfgrass. Pesticides shall be applied by a N.Y.S. licensed commercial applicator per the label instructions. Pesticides shall be applied at least 48-hours before watering or anticipated rainfall.

C. Ammonium Sulfate: Lilly Miller, 21-0-0 Ammonium Sulfate for use on lawns, containing 21% Nitrogen, and 24% elemental sulfer or approved equal.

D. Compost for mixing with topsoil to modify organic content shall be 'We Care' compost as manufactured by We Care Organics, Inc. or approved equal.

E. Lawn fertilizer shall be complete fertilizer of which at least 50% of the nitrogen is derived from a urea-form source. Fertilizer shall be delivered in original, unopened packages bearing the following certified analysis:

10% Nitrogen
10% Phosphorous
10% Potash

F. Lawn mulch shall be stalks of approved crops such as wheat, oats, and rye: free from noxious weeds for seed.

-or-

Hydro-Mulch shall be Conwed Hydromulch Fiber of Conwed Hydromulch 2000 Fiber (with tack) or the Landscape Architect's approved equal.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that all underground and above ground work has been completed to the point where topsoiling, fertilizing, seeding and mulching operations may properly commence without unnecessary disturbances at a later date.

3.2 SPREADING TOPSOIL

A. In areas to be seeded, provide topsoil to a minimum compacted thickness of 4-inches. In the event that insufficient topsoil is not available from stripping the area to be excavated, the Contractor shall import enough additional topsoil to make up the deficit at no additional cost to the Owner.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4-inches to facilitate bonding of the topsoil to the subgrade. Use discs, spike-toothed harrows or other approved means. Clean surface of subgrade of all stones larger than ½-inch in any dimension and all sticks, roots, rubbish, and other extraneous matter and legally dispose of them offsite.

1. Apply slow release fertilizer directly to subgrade before loosening at a rate equal to 1.0 pound of actual nitrogen per 1,000 square feet (430 pounds of fertilizer per acre).
2. Thoroughly blend planting soil mix off-site before spreading, or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.
3. Spread planting soil mix, evenly on the approved prepared subgrade, to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement.

C. Unchanged Subgrades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.
    a. Apply slow release fertilizer directly to surface soil before loosening at a rate equal to 1.0 pound of actual nitrogen per 1,000 square feet (430 pounds of fertilizer per acre).
3. Remove stones larger than 1/2 inch in any dimension and sticks, roots, trash, and other extraneous matter.
4. Legally dispose of waste material, including grass, vegetation, and turf, offsite.

D. Carry out spreading so that turfing operations can proceed with a minimum of soil preparation or tilling. Do not spread topsoil when the ground is frozen, excessively wet or otherwise in a condition detrimental to the work in conformance with all legal requirements and in a manner acceptable to the Architect/Engineer.

E. Finished Grades: Shall be understood to be final spot grades and contours indicated on the contract drawings. Where final spot grades or new contours are not indicated, finished grades shall be uniformly level or sloping between points for which elevations are given or contours are shown or shall be graded to the elevations which previously existed. However, final surface grades shall afford positive drainage of all areas at all times.

F. Tops and Bottoms of All Slopes: Round tops and bottoms of slopes and drainage swales. Adjust and warp slopes, at intersections of cuts and fills, to flow into each other or into the existing natural ground surface without noticeable break. Cuts and fills shall have a maximum slope of 3-foot horizontally to 1-foot vertically, unless otherwise shown on the contract drawings.

G. Fine Grading Lawn Areas: Bring the grade of areas to receive lawns to a uniform, level slope, as determined by the use of surveying instruments, by discing, harrowing and other methods approved by the Architect/Engineer. Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture.

When establishing finish grades, remove and dispose of all clods, hard lumps, stones and rocks, roots, litter and other foreign matter not passing through the teeth of a hand iron rake. Tractor drawn

raking equipment that compacts lawn areas will not be allowed. Dispose of all such materials off-site.

H. Remove all topsoil spilled on highways, shoulders, sidewalks, driveways and other surfaces for which topsoil is not specified or required.

I. Settlement: Maintain ground surfaces to the finish grades shown on the contract drawings, and deposit whatever additional topsoil that may be required to correct any settlement or erosion that occurs prior to the date of issuance of the Certificate of Final Acceptance. The surface upon which additional topsoil is to be deposited shall be raked or otherwise satisfactorily prepared to ensure a proper bond. Fill hollows that develop from settling, to the finished elevations, with approved topsoil. Finished lawn areas shall be left sufficiently high to meet all paved areas and catch basins after settlement.

3.3 PREPARATION OF TOPSOIL

A. If the following conditions exist at the time of sowing seed, placing fertilizer and lime, this paragraph may be omitted:
   1. Topsoil has been spread and raked clean within the past 10 days and is shaped to the required grade.4-inches is loose, friable, reasonably free from large clods, rocks, large roots, or other undesirable matter and shaped to the required grade.

B. If any of the above conditions do not exist, then prepare the topsoil in accordance with the following paragraphs.

C. Repair all eroded and damaged surfaces, cut or otherwise remove all weeds and grass and scarify or otherwise loosen topsoil to a depth of not less than 3 inches.

D. Break up large, stiff clods, and hard lumps, and rake off all stones and rocks larger than 1-inch in size, roots, litter, foreign matter, poisonous materials, and other materials, which may be detrimental to the work. Dispose of all such materials off-site in conformance with all legal requirements and in a manner acceptable to the Architect/Engineer.

E. Liming (used when required to adjust pH of topsoil):
   1. Apply separately at a rate sufficient to bring the pH of the topsoil between 6.0 and 7.0 as determined by the pH-testing lab, prior to fertilizing, seeding and sodding. Lime may be applied dry by spreader or as an aqueous solution by spraying. Rate of lime application not to exceed 50 lbs per 1000 sf.
   2. After application, work lime into the top 3-inches of topsoil and redress surface to a smooth finish.

3.4 SEEDING LAWNS AREAS

A. Loosen grade of lawn areas to a minimum depth of four inches to facilitate bonding of the topsoil to the subgrade. Use discs, spike-toothed harrows, chisel plows, or other approved means. Remove stones measuring over 1 1/2 inches in any dimension. Remove sticks, roots, rubbish, and other extraneous matter and legally dispose of them offsite. Limit preparation to areas which will be planted promptly after preparation.

1. Preparation of Unchanged grades: Where lawns are to be planted in areas that have not been altered or disturbed by excavating, grading, or stripping operations, prepare soil for lawn planting as follows: till to a depth of six inches, apply soil amendments and initial fertilizers as specified, remove high areas and fill in depressions, and till soil to a homogeneous mixture of fine texture (free of lumps, clods, stones, roots, and other extraneous matter).

2. Clean all areas to be seeded of all debris, branches, stumps, brush, logs, metal, sticks, stones, etc., larger than two inches (2") in diameter.

3. Topsoil modification: The contractor shall engage an independant testing laboratory to test at least 3 topsoil samples from the existing, stockpiled topsoil and from areas to be reconditioned and obtain recommendations for treatment of the topsoil as may be required to meet the following conditions:

    a. Organic content shall be no less than 6% nor more than 12% by weight.
    b. Should the pH be below 6.0, provide lime the recommended rate such that the pH is raised to a minimum of 6.0.
    c. Should the test results indicate a pH level above 7.5, provide Ammonium Sulfate in quatities, as recommended by the testing laboratory, to lower the pH to a maximum of 7.5.
    d. In all modification of topsoil, amendments will be thoroughly mechanically mixed with existing stockpiles of topsoil

4. After all areas have been stripped and cleaned of debris, surfaces shall be loosened or scarified to a four inch (4") minimum depth to achieve a loose friable soil. Any irregularities which form low areas that will hold water will be eliminated. Fine grade lawn areas to smooth, even surface with loose, uniformly fine texture. Roll, rake, and drag lawn areas to remove ridges and fill depressions as required to meet finish grades. Limit fine grading to areas which can be planted immediately after grading.

5. If seeding by mechanical method, fertilize to achieve uniform distribution of fertilizer at a rate as specified above. Work into topsoil.

6. Rake immediately before seeding or sodding to achieve a uniform, smooth, friable surface. Remove all stones and debris two inches (2") or greater in diameter.SEEDING: The contractor may place seed by either mechanical or hydroseeding means.

7. Mechanical Seeding Application: Seed in two directions with approved mechanical spreader to achieve the required application rate. Lightly rake in seed and roll with 200 pound roller.

    a. Mulch all seeded areas immediately after seeding. Uniformly spread mulch at a rate of two tons per acre.
    b. Place straw mulch on seeded areas within 24 hours after seeding.
    c. Place straw mulch uniformly, in a continuous blanket, at the rate of 2-1/2 tons per acre or two 50-pound bales per 1,000 square feet of area. A mechanical blower may be used for straw mulch application, when acceptable to the Architect/Engineer.
    d. Anchor straw mulch with liquid tackifier, applied uniformly at a rate of 60 gallons

per acre.

e. Protect all paving, buildings, plantings and all nonseeded areas from liquid tackifier over-spray.

f. Provide stoned check dams in ditches or problem swales at intervals required to adequately slow water velocity and impede soil loss.

8. Hydroseeding Application: Seed, fertilizer, hydromulch fiber, and water shall be placed in the hydro-seeding mixture tank. Rates of application are as follows:

Hydromulch	1,200 pounds per acre
Water	500 gallons per acre minimum
Inoculant	4x manufacturer's rate (if necessary)

1. A non-harmful color additive which colors the hydroseed mixture green shall be added to the mixture to allow visual metering of its application. The hydroseed mixture shall be sprayed upgrade and uniformly on the surface of the soil to form an absorbent cover, allowing percolation of water to the underlying soil.3. The Contractor is responsible for keeping topsoil, seed, fertilizer, soil amendments, and mulches off structures, pavements, and any other site amenities; and will clean up unwanted deposits at his expense.

3.5 SOD INSTALLATION

A. Care shall be taken to eliminate depressions or air pockets by rolling or tamping base before installation. The soil shall be moistened prior to laying the sod.

B. The sod shall be laid smoothly, edge to edge, and where continuous or solid sodding is called for on the plans sod shall be laid with the longest dimension parallel to the contours. Vertical joints between sods shall be staggered. Immediately after laying, sod shall be pressed firmly into contact with the sod bed by light rolling, or by other approved methods so as to eliminate all air pockets, provide true and even surfaces, insure knitting and protect all exposed sod edges, but without displacement of the sod or deformation of the sod surface. Sod shall be laid with all joints compressed and at no time will shrinkage leave greater than 1/8” gap.

C. Sod may be placed from April 15th to November 1st as long as the ground is not frozen.

D. Sod shall be harvested, delivered and transplanted within a period of twenty four (24) hours.

E. Sod shall be watered immediately during and after installation to prevent drying. It shall then be thoroughly irrigated to a depth sufficient that the underside of the new sod pad, and soil immediately below the pad, is thoroughly wet.

F. Any sod on slopes 4 to 1 or greater will be securely fastened to the base by wooden pegs or an acceptable substitute.

G. 24 hours after installation, the sod shall be hand rolled by approved methods.

H. Repair joint separations. Dead or washed out sod will be replaced with sod similar to the original installation. The turf bed will also be repaired as is necessary before replacement sod is laid.

3.6 MAINTENANCE FOR PERMANENT LAWN AREAS

A. Maintenance by Contractor begins as soon as lawns are sodded or seeded. Protect lawns from drought, washout and wind erosion. In general, maintain new installed lawn areas, including watering, fertilizing, core aerating, spot weeding, overseeding, mowing applications of herbacides, fungicides, insecticides, and re-sodding until a full, uniform, healthy, vigorous stand of grass free of weed, undesirable grass species, disease, and insects is achieved and accepted by the Architect. Specifically:

1. Watering Seeded Lawns:
    a. First Week: In the absence of adequate rainfall, watering shall be performed daily or as often as necessary during the first week to maintain moist soil to promptly germinate the lawn seed, preventing it from drying out, and keeping it in a healthy, growing condition until final acceptance. Lawn areas shall receive a minimum of (1") of water per week, by natural rainfall, irrigation or a combination of both. Water daily until 2nd mowing (just enough water to keep the top1/2" of soil moist, 1 time daily).
2. Watering Sodded Lawns:
    a. First Week: Soil on sod pads shall be kept moist. In the absence of adequate rainfall, watering shall be performed daily or as often as necessary during the first week and in insufficient quantities to maintain moist soil to a depth of at least (4") inches.
3. Second and Subsequent Weeks: Contractor shall provide water to the lawns as required to maintain adequate moisture, in the upper four (4") inches of soil, necessary for the promotion of deep root growth until final acceptance. After 2nd mowing, water two (2) times weekly until thoroughly established.
4. Protect: Protect lawn areas against trespass, vandalism and routine pedestrian traffic and Owner maintenance traffic by temporary fencing or other means.
5. Repair: Repair, rework, resod, and overseed (as originally specified for that area) areas that have washed out, eroded, do not germinate and are vandalized or otherwise damaged. Overseeding rates are to be adjusted to 6lbs. of seed per 1,000 s.f.
6. Mow: Initial mowing shall begin when the blade height reaches 2" and the soil will bear the weight of the lawn mower. Use mowers with low impact tires. For the first 3 mowings cut the grass blades to 1.5 inches. After that mow the grass when it reaches a height of 3.5" to a height of about 2.5". Never remove more than 1/3 of the grass blade at any one mowing. A minimum of eight (8) to ten (10) mowings are required (approximately once per week after the initial germination period to final acceptance). Notify the Architect of dates in wiring as mowing is performed. Excess clippings shall be carefully raked so as not to remove healthy grasses, and removed.
7. Core aerating on Lawn Type 3 and 4 Only: Between mowings five (5) and six (6), core aerate lawns about three (3") inches on center minimum three (3") inches deep to ensure aggressive root growth. This will required multiple passes at different directions to achieve 16 to 20 holes ¾" to 1" diameter per square foot. Sweep scattered plugs off

paved areas onto adjacent lawn areas. Pulverize plugs during subsequent mowing operations. Provide additional core aerating as directed by the Architect to expedite the lawn maturation process. Moisten field by thoroughly watering the topsoil profile, several days in advance of coring to facilitate proper penetration of the topsoil.

8. Fertilizer: Immediately after core aerating, apply subsequent fertilizer at the rate of 1.5-2 lbs./1,000 sf. Provide additional fertilizer after the 10th mowing as directed by the Architect to expedite the lawn maturation process.

9. Weed Control: When infestation of weeds or crabgrass develops, treat infestation by hand weeding or herbicides control appropriate to the area. Furnish and install weed chemical control as recommended by manufacturer. Herbicides controls must be acceptable to the Owner. Obtain and pay for permits. Use as directed by the manufacturer and applicable laws, codes, ordinances and regulatory requirements. Under NO circumstances is it acceptable to seed or overseed over Nutsedge, Crabgrass or other grassy/broadleaf weeds.

B. Maintenance by the Contractor continues through the certificate of substantial completion final acceptance by the Architect as described below. Maintenance by Owner begins after final acceptance of the lawn.

B. Contractor shall roll, regrade and re-topsoil washed out, eroded, settled or damaged areas as required.

C. Maintain seeded areas for a period of at least **60** days after completion and final acceptance of seeding operations.

D. Maintain seeded areas, including watering, spot weeding, mowing, applications of herbicides, fungicides, insecticides and reseeding until a full, uniform stand of grass free of weeds, undesirable grass species, disease and insects is achieved and accepted by the Architect/Engineer.

E. Water daily to maintain adequate surface soil moisture for proper seed germination. Continue watering as necessary to establish a full uniform stand of grass and until final acceptance.

F. Repair, rework, and reseed all areas where seed fails to germinate or where seeded areas have been damaged by wash out, erosion, people, vehicular traffic, or other causes.

G. Mow lawn areas as soon as lawn top growth exceeds a 3-inches in height. Cut back to 2-1/2-inches in height. Repeat mowing as required to maintain specified height of 2-1/2-inches inches until accepted by the Owner's Designated Representative.

H. Apply fertilizer to lawns (only) approximately 30 days after seeding, at a rate equal to 0.3 pounds of actual nitrogen per 1,000 square feet (140 pounds/acre). Apply with mechanical rotary or drop type distributor. Thoroughly water into soil.

I. Maintain seeded banks, ditches, medians and fields. Regrade and reseed washed out or eroded areas as required, until a suitable cover is established.

3.7 MAINTENANCE FOR TEMPORARY LAWN AREAS

A. Contractor shall roll, regrade, re-topsoil and reseed, washed out, eroded, settled or damaged areas as required.

B. Contractor shall establish and maintain temporary lawn by seeding, watering, reseeding, and other operations.

C. Mowing of temporary seeded areas for erosion control is not required.

3.8 SUBSTANTIAL COMPLETION

A. Review to determine substantial completion of lawns will be made by the Architect, upon request. Provide notification at least five (5) working days before requested review date.

B. Lawn areas will be substantially complete provided requirements, including maintenance, have been complied with. A healthy, vigorous, uniform, partially mature stand of lawn is established free of weeds, undesirable grass species, disease, and insects. With proper watering and maintenance as indicated herein, this should culminate after an approximate 60-72 day period for initial germination with average temperatures above 40°F. Grass roots shall have matured to a minimum of 1 1/2" depth as determined by the Architect when core samples are taken.

C. Lawn areas shall not have more than 10% dead/bare spots.

D. Contractor shall provide a written cop of all maintenance activities performed up to this date.

E. The Architect will prepare a written punch list of items which need correction prior to final acceptance.

3.9 FINAL ACCEPTANCE

A. Review to determine final acceptance of lawns will be made by Architect, upon request. Provide notification at least five (5) working days before requested review date.

B. Lawn areas will be acceptable provided requirements, including maintenance, have been complied with. A healthy, vigorous, uniform, full stand of lawn is established free of weeds, undesirable grass species, disease, and insects. Grass roots shall have matured to a minimum of 2" depth as determined by the Architect when core samples are taken.

C. Any lawn which contains disease, more than 1% dead/bare spots, or any dead/bare area greater than one (1) square foot shall be rejected and the unacceptable area(s) repaired as originally specified at no additional cost to the Owner.

D. In the vent the Contractor fails to complete the punch list items within a 30 day period with average temperatures of 40°F after the time of Substantial Completion, the Contractor shall be liable to the Owner for any additional costs including those charged by the Architect.

E. Contractor shall provide a written cop of all maintenance activities performed during the contract up to final acceptance of lawns.

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END OF SECTION 329200

SECTION 330513 - PRECAST MANHOLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Furnishing and installing complete, all storm and sanitary precast manholes with frames, grates, covers, steps, inverts, and testing at the locations shown on the plans or as directed by the Architect/Engineer.

B. Adjustment of existing manholes and frames and covers/grates to grade with brick or rings.

C. Shallow manholes shall be used wherever depth of manhole is less than minimum for a precast base.

D. Related Sections:
   1. Division 31 Section **"Earth Moving"**
   2. Division 32 Section **"Turf and Grasses"**
   3. Division 33 Section **"Storm Utility Drainage Piping"**

1.3 QUALITY ASSURANCE

A. All precast concrete sections and structures, and all castings shall each be the product of a single manufacturer who can furnish evidence of satisfactory experience in the product of high quality products of the type indicated and specified.

B. All structures and castings shall be of good quality and free from defects which would make it unfit for the use intended.

1.4 SUBMITTALS

A. Submit manufacturer's data shop drawings for precast base, riser, and precast tops, steps, frames and cover, grates, coatings, pipe connectors, etc.

B. Submit manufacturer's certification of compliance for precast concrete sections and castings.

1.5 PRODUCT HANDLING

A. All material shall be delivered to the job site intact and in good condition.

B. Carefully handle precast sections and all castings when loading and unloading to avoid damage.

C. In the event of damage, either in delivery or installation, the damaged section shall be immediately removed from the project site and replaced at no additional cost to the Owner.

PART 2 – MATERIALS

2.1 PRECAST CIRCULAR MANHOLE SECTIONS

A. Precast grade rings, riser bases, and risers shall be circular in cross section and precast tops shall be flat slab. Eccentric cone type tops may be used where the inside height dimension from the bench wall to the bottom of the eccentric section exceeds eight (8) feet. The flat slab shall be reinforced to withstand AASHTO H2O-44 concentrated wheel loading and 30 percent impact loading. An opening matching the casting frame inside base diameter shall be centrally located in the flat roof slab.

B. All precast sections shall conform to ASTM C-478 construction and minimum dimension criteria. Riser sections shall be of maximum practicable length to attain the specified grade elevation with the minimum number of joints and the shortest possible chimney.

C. All concrete shall be made with Type II Portland Cement.

D. Precast reinforced bases shall be integrally cast with wall riser conforming to ASTM C-478 with a minimum 3500 psi concrete.

E. Openings in precast riser sections to receive pipes shall be accurately cast, both vertically and circumferentially. Where openings are incorrectly cast, the riser section shall be removed from the project site and replaced with a satisfactory base. Costs for replacements, whether attributed to improper manufacturing, field changes, or for any other reason shall be borne by the Contractor.

F. Provide adequate lifting anchors on each precast section. Lifting holes shall not be allowed.

G. Precast sections for sanitary and storm manholes shall be manufacturer coated as follows: two coats (12 mils minimum per coat) of Sikaguard 62 by Sika or Duralkote 240 by Euclid Chemical Company or approved equal for interior coating of base to top of highest pipe, two coats (12 mils minimum per coat) of Conseal CS-55 or approved equal on other interior and all exterior surfaces. All coating shall be completed in accordance with the paint manufacturer's instructions.

2.2 PRECAST MANHOLE JOINTS

A. Joints shall be formed with male and female ends so that when assembled, a continuous and uniform manhole without appreciable irregularities in interior wall surfaces will be completed.

B. O-ring seals shall conform to ASTM C-443.

C. Permissible variations are as follows:
   1. Internal dimensions – not more than 1 percent
   2. Wall thickness – not more that 5 percent or $\pm$ 3/16 inch, whichever is greater
   3. Length of two opposite sides – not more than 5/8 inch

4. Length of section – not more than 1/2 inch in any one section

D. Seal all manhole section joints with flexible joint sealant, which shall be "Kent Seal No. 2" by Hamilton-Kent, Butyl-Tite by Blue Ridge Rubber Company or approved equal.

2.3 MANHOLE STEPS

A. Manhole steps where required shall be installed by the precast manhole manufacturer and integrally cast into the precast riser sections.

B. Manhole steps shall be designed for a concentrated live load of 300 pounds. The steps shall be manufactured of a material, which is resistant to highly corrosive conditions.

C. Steps in riser and conical sections shall be aligned in each section so as to form a continuous ladder with runs equally spaced vertically in the assembled manhole at a maximum distance of 12 inches apart. The lowest rung shall be within 18 inches of solid footing (e.g., structure bench) upon which the person descending the rungs would normally step. The uppermost rung shall be set within 18 inches of the rim of the structure frame to act as a handhold. If this rung must be set in the brick chimney, it shall set so as to extend 3 inches from the face of the brick to facilitate easy passage. Make every effort to locate rungs on a wall with no pipe penetrations.

D. Steps shall be embedded in the wall sections a minimum of 3 inches and project a minimum clear distance of 4 inches from the points of embedment.

E. The minimum centerline width of rungs shall be 13 inches.

F. The steps shall be constructed of a minimum 1/2 inch grade 60 steel reinforcement imbedded in copolymer polypropylene plastic.

G. Steps shall be as manufactured by M.A. Industries Inc. PS2-PF or approved equal.

2.4 BRICK

A. Brick shall be first quality sound, hard-burned, common brick conforming to ASTM Standard C-32, Grade SS. Brick shall be culled of all irregulars and unsound or damaged brick before laying.

2.5 MORTAR

A. Mortar shall consist of one part Portland Cement to two parts sharp, clean masonry sand to which hydrated lime may be added in the proportion of 10 pounds for each bag of cement. Mortar materials shall conform to the following:

Portland Cement	ASTM C-150 Type I or II
Sand Aggregate	ASTM C-144
Hydrated Lime	ASTM C-207

2.6 HYDRAULIC CEMENT

"Sikaplug" by Sika Chemical Corp., "Waterplug" by Standard Dry Wall Products, Inc., or approved equal.

2.7 MANHOLE COVERS, GRATES, AND FRAMES

A. All manhole frames, grates, and covers shall be iron castings conforming to ASTM A48, Class 30. They shall be true to pattern in form and dimensions, without unfilleted angles or corners; and shall be free from pouring faults, sponginess, cracks, blowholes, shrinkage, distortion and other defects. After casting and prior to shipping, smooth and clean all surfaces by sand blasting. Castings shall be factory coated with coal tar pitch varnish. Castings shall be thoroughly shop coated with one coat of Conseal CS-55 or coal tar enamel or asphalt base bituminous material with a minimum dry thickness of 12 mils.

B. Frames and covers shall be accurately made and covers shall fit in any position without rocking. Horizontal and vertical fitting surfaces shall be milled to true and even surface to ensure uniform bearing.

C. All frames, grates, and covers must conform to these specifications as to quality, strength, thickness of metal and finish. Covers shall be furnished with lettering on face where required and as shown on the contract drawings. All castings shall be designed to sustain AASHTO H20-44 wheel loading. The minimum thickness of metal at any point shall be 3/4 inch.

D. Fabricate all frames, grates, and covers so that covers and grates fit in any position without rocking. Mill horizontal fitting surfaces to a true and even surface to ensure uniform bearing. Units and portions of units shall be interchangeable.

E. SANITARY COVER: All sanitary manhole covers shall be solid and provide a non-penetrating pick hole for lifting. The covers shall have a non-skid surface and shall have raised lettering of two inches or more in size (cast into the cover). On the covers, the following shall be clearly printed: "SANITARY SEWER". The minimum clear opening of the frame shall be 24 inches. Acceptable frame and cover shall be Neenah R-2557A, or approved equal.

F. SOLID STORM COVERS: All solid storm manhole covers shall have a non-skid surface and shall have raised lettering of two inches or more in size (cast into the cover). On the covers the following shall be clearly printed: "STORM SEWER". The minimum clear opening of the frame shall be 24 inches. Acceptable frame and cover shall be Neenah R-2557A, or approved equal. Where indicated on the Contract Drawings the minimum clear opening of the frame shall be 30 inches. Acceptable frame and cover for 30-inch clear openings shall be Neenah R-2557A, or approved equal.

G. STORM ROUND INLET COVER: All storm inlet manholes where shown on the contract drawings shall be provided with inlet covers with openings for entrance of surface water. The inlet covers shall be of the flat grate type, bicycle proof with a 24-inch minimum clear opening of the frame. Acceptable frame and cover shall be Neenah R-2556-A or approved equal.

H. WATERTIGHT SANITARY FRAME AND COVER: All watertight sanitary manhole covers shall be solid and bolted with four (4) ½" 13 SS bolts and a removable hinge with captive. The cover shall have a non-skid surface and shall have raised lettering of two inches or more in size

(cast into the cover). On the cover, the following shall be clearly printed: "SANITARY SEWER". The minimum clear opening of the frame shall be 24 inches. A composite cover shall be provided for access. Acceptable frame and cover shall be Syracuse Casting 1032ZPT or approved equal.

2.8 SANITARY PIPE CONNECTIONS TO NEW MANHOLES

A. A gasket shall be cast into the manhole wall for sanitary manholes to assure a watertight connection with the attached pipe. The gasket shall meet the requirements of ASTM C-923.

B. Gasket shall be "A-Lok" by A-Lok, Inc., of Trenton, New Jersey, Star Seal by Hail Mary Rubber Company, or approved equal.

2.9 SANITARY PIPE CONNECTIONS TO EXISTING MANHOLES

A. An approved flexible and watertight connection at the wall shall be provided. Acceptable product shall be Model S Link-Seal of the appropriate size for the pipe material or approved equal. For sanitary use the seal component shall be EPDM rubber with stainless steel bolts and nuts.

2.10 CONCRETE BENCH WALLS

Concrete for bench walls and inverts shall be:

1. Normal Weight Concrete – Type A
   a. Minimum compressive strength f'c: 3,000 psi @ 28 days.
   b. Maximum water-cement ratio by weight: 0.50.
   c. Minimum cement content: 475 lbs. per cubic yard.
   d. Coarse aggregate size: 1 inch.
   e. Maximum slump: 3-1/2 inches $\pm$ 1 inch.
   f. Air Content: 6 percent $\pm$ 1 percent by volume of total mix.

2.11 PRECAST DOGHOUSE MANHOLE (if required)

A. Provide cast-in-place slab to accommodate the actual manhole base provided and a minimum of 12-inch of clear for an extended foot.

B. Provide continuous waterstop between riser and interior concrete fill.

C. Provide minimum manhole base diameter as shown on the Plans. Provide minimum riser section of 4 feet in diameter. Refer to Plans for additional details.

2.12 ADJUSTMENT OF RIM

H. Precast grade rings shall conform to ASTM C-478 construction and minimum dimension criteria. All concrete shall be made with Type II Portland Cement.

I. Brick shall be first quality sound, hard-burned, common brick conforming to ASTM Standard C-32, Grade SS. Brick shall be culled of all irregulars and unsound or damaged brick before laying.

J. Mortar shall consist of one part Portland Cement to two parts sharp, clean masonry sand to which

hydrated lime may be added in the proportion of 10 pounds for each bag of cement. Mortar materials shall conform to the following:

Portland Cement	ASTM C-150 Type I or II
Sand Aggregate	ASTM C-144
Hydrated Lime	ASTM C-207

K. Hydraulic Cement shall be "Sikaplug" by Sika Chemical Corp., "Waterplug" by Standard Dry Wall Products, Inc., or approved equal.

PART 3 – EXECUTION

3.1 GENERAL

A. It is the intent of this specification to secure soundly constructed, watertight manholes constructed in accordance with the Contact Drawings.

B. Verify that excavation is in the proper location, that pipes have been installed at the correct elevations and that the subgrade has been properly prepared. Foundations shall not be placed upon frozen or muddy subgrade.

3.2 ORIENTATION OF COVERS, GRATES, AND RUNGS

A. General – The intent of this paragraph is to provide guidance in the selection of the location of the frame and cover. The location should provide for convenient ingress and egress, and minimizes adverse visual impacts. Unless otherwise specified, shown on the Drawings, or directed by the Architect/Engineer, orient the location of covers and steps by using the following criteria, with precedence given in the order presented.

C. Safety – Give primary concern to safety considerations for providing convenient access to structure interiors.

D. Covers and Pavements – To avoid future problems with snow removal or street cleaning, orient covers to lie completely outside of paved surfaces, including walks and roadways. If this cannot be accomplished, locate covers completely in pavement. Covers partially in pavement are not permitted without the prior approval of the Architect/Engineer. When covers occur in paved areas, locate entirely within a single traffic lane and as near to the edge of pavement as is possible, but no closer than 8 inches from the edge of pavement.

E. Ingress/Egress – Coupled with the above, convenient and safe access to within the structure must be evaluated. Coordinate cover location with pipe openings, structure benches and inverts, safety landings and the like. Make every effort to locate steps on a wall with no pipe penetrations and, where steps are not specified to be provided, consideration shall be given to the safest means of seating the feet of ladders which will be used for access to structure interiors.

F. Non-compliance – Non-compliance with the requirements of this paragraph may result in Architect's/Engineer's disapproval of the entire structure. When requested, Architect/Engineer

will assist in determining the optimum location of covers, grates, and rungs.

3.3 INSTALLATION OF PRECAST MANHOLES AND STRUCTURES

A. Precast Bases: Place stone bedding, level, and tamp firmly in place. When absolutely necessary, pea stone may be used for minor grade adjustments in the stone bedding, but the depth shall not exceed 3/4 inch. Carefully lower precast base in place, taking extra care not to shift the stone bedding, and align all openings with the pipes to be connected. Leveling of the base by tamping or pounding on the top of the precast product is prohibited. If base is not level, lift it out; readjust stone bedding, and reset base. Continue this procedure until base is level.

B. Precast Risers and Top Sections: Thoroughly clean all joints of precast sections and install jointing material. Carefully set precast sections in place, making sure that rubber gasket jointing material is not displaced and that a good seal is attained.

C. Filling Precast Section Joints: Fill interior and exterior joints with flexible joint sealer. Cover inside and outside of joint with two coats of Conseal CS-55 coal tar, or approved equal.

D. Inverts:

1. Inverts shall be constructed in all manholes.

2. Pipe entering or leaving the manhole shall be placed in openings with flexible connections (neoprene boot) provided in precast shell at the proper invert elevation.

3. For bases with preformed openings pipes entering or leaving the manhole shall be placed in preformed openings provided in the precast wall at the proper invert elevation and grouted into place with non-shrink grout. (For PVC pipes use 100 percent epoxy non-shrink grout).

4. Inverts built upon precast base shall be constructed of concrete brick, half sections of sewer pipe or be cast in place. Care shall be exercised in forming inverts to give proper slope and shape to each channel. Inverts shall be the depth of the pipe.

5. When PVC material is used, all brick, concrete, or other masonry material that interfaces with the PVC, shall adhere to the PVC with 100 percent epoxy non-shrink grout.

6. Bench walls shall be constructed of sewer brick (Grade SS) and bench filled with concrete. Bench walls shall be carried a minimum of one brick course above top of highest pipe entering the manhole. Slope the top surface of the benching towards the channel at a pitch of approximately ½-inch/foot.

7. After initial setting bare concrete or grout shall be waterproofed with coal tar coating.

E. Roof Slabs

1. Slab shall be formed to fit into ends of vertical pipe and shall have full bearing for its entire circumference. The slab shall be set in a bed of cement mortar.

2. Opening diameter shall match manhole casting inside base diameter.

3. The location of center of opening for frame and cover shall be 1 foot 6 inches from inside of manhole wall unless otherwise noted.

F. Frames:

1. All manhole frames shall be set firmly in a bed of mortar not less than ½-inch thick. Concrete fill shall be placed around the outside as shown on the details and kept 2 inches below the top of the frame.

2. Precast grade rings set in mortar shall be used to bring manhole frames to grade, maximum 8 inches height for grade ring.

3. The frame and cover shall be depressed below edge of pavement elevation as indicated on the contract drawings.

G. The Contractor shall be responsible for maintaining and keeping all manholes clean and free of debris until completion of the Contract.

3.4 DROP MANHOLES

A. Wherever the invert of the entering sewer is more than 2 feet above the invert of the outlet sewer, it shall be connected with a vertical outside drop with a clean-out pipe half bricked up. When drops are placed, the entire excavation around the drop pipe shall be filled with 3,000 psi concrete extending not less than 2 feet along the main sewer.

B. The clean-out opening in the barrel of the manhole shall be cut in after the manhole wall pipe is in place. The joint between the clean-out pipe and the manhole wall shall be thoroughly sealed with cement mortar on the inside and bituminous joint material on the outside.

3.5 CONNECTION TO EXISTING MANHOLE(S) OR STRUCTURE(S)

A. Where noted on the Drawings or as directed by the Architect/Engineer, the Contractor shall make connection to existing manholes or structures. The use of excessive force or blunt instruments is prohibited in installing the pipe into the existing wall.

If a stub exists and matches the size of the new sewer, the Contractor shall connect to the stub. The stub to manhole connection should be checked and repaired if damaged or in poor shape. If stub does not match the size of the new sewer, the stub shall be removed and the new sewer shall be inserted into the manhole.

If no stub exists, neatly core drill a hole through the existing wall, taking care to achieve the minimum diameter hole required to install the pipe true to line and grade, as shown on the contract drawings or as directed by the Architect/Engineer, and in a manner which will not effect the structural integrity of the existing concrete. The structure shall be maintained in good repair.

For sanitary manholes or structures only, provide an approved flexible and watertight connection at the wall. For other structures, after inserting the connecting pipe, fill the annular space with non-shrink grout.

B. In making the connection to existing manhole(s), it shall be the Contractor's responsibility to

dewater the structure in order to make the connection.

C. The manhole shall be visually inspected by the Architect/Engineer for tightness of fit at all new joints.

3.6 MANHOLE CONNECTION TO EXISTING SEWERS (DOGHOUSE) (if required)

A. Where noted on the contract drawings or as directed by the Architect/Engineer, the Contractor shall provide a new connection to the existing sewer system by constructing a new manhole over the existing main. The Contractor shall be responsible for locating the existing service. Any damage to the existing sewer as a result of this work shall be repaired by the Contractor immediately and at no additional cost to the Owner.

B. Details of this connection shall be as shown on the contract drawings. Temporary support for the existing sewer shall be provided until the bench is poured. A watertight seal around the barrel openings of the existing main shall be provided.

C. Provide necessary adapters and specials required to make the connections.

D. Do work at such times and in such a manner as to cause a minimum of interruption to existing services.

E. The existing sewer shall remain in service as work progresses.

3.7 RAISE EXISTING MANHOLE TO FINISHED GRADE

A. The existing manhole structure shall be excavated to the minimum depth necessary, a vertical riser installed and the top cone or flat roof section or frame and cover raised to finished grade.

B. The vertical riser or riser ring section shall be coated with two coats of Conseal CS-55 Coal Tar and the joints sealed tightly with joint sealer all around and two coats of Conseal CS-55 inside and outside.

C. The manhole shall be visually inspected by the Architect/Engineer for tightness of fit at all joints.

3.8 LOWER EXISTING MANHOLE TO FINISHED GRADE

A. The Contractor shall submit for approval the method by which the manhole frame and cover will be lowered.

B. The existing manhole structure shall be excavated to the minimum depth necessary.

C. If sufficient adjusting rings exist to meet the proposed lower grade, the Contractor shall appropriately adjust these rings and reset grade rings and frame and cover in mortar. The adjustment rings shall be coated with two coats of Koppers Super Service Black Coal Tar and the joints sealed tightly with joint sealer all around and two coats of Koppers Super Service black inside and outside.

D. If grade rings do not exist or the removal/adjustment of grade rings is insufficient to meet the

lower proposed grade, the Contractor shall remove a vertical riser section and replace with a new vertical riser of appropriate size to meet the necessary grade with adjustment rings and frame and cover completed.

E. The vertical riser section shall be coated with two coats of Conseal CS-55 Coal Tar and the joints sealed tightly with joint sealer all around and two coats of Conseal CS-55 inside and outside.

F. The manhole shall be visually inspected by the Architect/Engineer for tightness of fit at all joints.

3.9 TESTING

A. Completed sanitary manholes only shall be subject to vacuum tests. When the sanitary sewer is tested and approved by the Architect/Engineer, the manholes shall be tested. The inlet and outlet pipe for the manholes shall be plugged with a plug that allows no leakage.

B. The test head shall be placed inside the 24-inch opening and the seal inflated in accordance with the manufacturer's recommendations.

C. A vacuum of 10 inches of mercury shall be drawn and the vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum to drop to 9 inches. The manhole shall pass the test if the time is greater than the following:

Diameter of Manhole	Time (seconds)
48 inches	60
60 inches	75
72 inches	90

D. If the manhole fails the initial test, necessary repairs shall be made. Retesting shall proceed until satisfactory results are obtained.

E. Equipment: NPC manhole vacuum tester, as manufactured by NPC Systems, Inc. of Worcester, MA, or approved equal.

F. All structures, manholes, and drop inlets shall be visually inspected for tight joints and neat

3.10 REJECTION AND REPAIR

A. Manhole sections shall be subject to rejection on account of failure to conform to any of the specification requirements. In addition, individual sections of manhole sections may be rejected because of any of the following:

1. Fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.

2. Defects that indicate imperfect proportioning, mixing, and molding.

3. Surface defects indicating honeycombed or open texture.

4. Damaged or cracked ends, where such damage would prevent making a satisfactory joint.

5. Any continuous crack having a surface width of 0.01 inch (0.25 mm) or more and extending for a length of 12 inches (305 mm) or more, regardless of position in the section wall.

6. Improper waterproofing materials or mil thickness.

B. Manhole sections may be repaired with prior approval of the Architect/Engineer, if necessary, because of occasional imperfections in manufacture or accidental injury during handling and will be acceptable if, in the opinion of the Architect/Engineer, the repairs are sound and properly finished and cured, and the repaired manhole sections conform to the requirements of this specification.

3.11 MARKING AND PAINTING

A. Name and trademark of the manufacturer, as well as manhole number, shall be clearly marked on each manhole section.

B. Marking shall be indented into the manhole bases, risers, and top sections or shall be painted thereon with waterproof paint.

C. The precast manufacturer shall apply bitumastic coal tar to all precast sections as described in Part 2- Precast Circular Manhole Sections.

D. Immediately after installation is completed, the Contractor shall touch up all marks, scars, and imperfections found and paint all interior surfaces not factory coated with two coats of coal tar, Conseal CS-55 or approved equal. Work shall be done in accordance with the paint manufacturer's recommendation.

E. Cover inside and outside of joints all around with flexible joint sealer and two coats, Conseal CS-55 or approved equal. Coating shall be required for sanitary and storm manholes.

END OF SECTION 330513

SECTION 334100 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Extent of storm sewer system work includes, but is not limited to the following:
   1. Furnish and install new concrete catch basins and PVC drain basins
   2. Furnish and install storm sewer drainage and underdrain piping, fittings, and accessories
   3. Flushing existing and new storm pipes, capturing and removing debris

B. Contractor shall be responsible to maintain flow through existing storm sewer systems by whatever means necessary, including pumping, temporary piping etc. Contractor shall coordinate with the Architect/Engineer for approval of proposed methods.

C. Related Sections:
   1. Division 31 Section “Earth Moving”
   2. Division 31 Section “Erosion and Sediment Control”
   3. Division 32 Section “Turf and Grasses”

1.3 QUALITY ASSURANCE

A. All precast concrete sections and structures, and all castings shall each be the product of a single manufacturer who can furnish evidence of satisfactory experience in the product of high quality products of the type indicated and specified.

B. Pipe and pipe fittings shall be produced in a plant of recognized reputation that is regularly engaged in the production of pipe conforming to the specified standards. Pipe and pipe fittings of the same type shall be the product of a single manufacturer.

C. All pipe and pipe fittings, structures, and castings shall be of good quality and free from defects which would make it unfit for the use intended.

D. Contractor shall be responsible for furnishing all labor, materials, surveying instruments and tools necessary to establish and maintain all lines and grades.

1.4 SUBMITTALS

A. Submit manufacturer’s data and shop drawings for precast structures, frames and covers, coatings, pipe connectors, etc.

B. Manufacturer’s certifications of compliance for precast concrete sections and castings shall be

submitted.

C. Manufacturer's literature and catalog cuts including technical, material specifications, dimensions, tolerances, and installation information for all underdrain products, pipe and pipe fittings, and geotextile fabrics.

D. Shop drawings, catalog cuts, and manufacturer's literature for all pipe and pipe fittings, to include coatings and linings, material specifications, dimensions, tolerances, and all related data shall be submitted.

E. Manufacturer's certification that pipe supplied meets the required specifications shall be submitted.

F. Pipe manufacturers shall furnish Certificates of Compliance on pipe, with each load of pipe supplied. Immediately turn certificates over the Architect/Engineer. Materials delivered to the site without accompanying certificates will be subject to rejection.

G. Submit record drawings indicating actual location of pipe runs, connections, wyes, stubs, structures and associated invert elevations. Record actual vertical separations at all exposed utility crossings. Record invert elevations at all utility crossings.

H. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Each length of pipe delivered to the site shall be clearly marked at the factory with the name of the manufacturer, class of pipe, pipe diameter and all else as required by the codes, standards, and specifications referred to under this section. Omission of this information will be cause for rejection of pipe.

B. Store all materials in accordance with manufacturer's approved instructions. Store all materials so they can be easily inspected and so they will not be damaged prior to installation.

C. Carefully handle all pipes and fittings when loading and unloading to avoid damage to pipe, coatings, or linings. Pipe or fittings with damaged coatings or linings shall be repaired or replaced by the Contractor at his expense and to the satisfaction of the Architect/Engineer. Lift pipes and fittings by hoists or lower on skid in a manner to avoid shock. Lower pipe into trench with derricks, rope, or suitable equipment for the safety and protection of workmen, materials, equipment, property, and the work.

D. Do not dump or drop pipe and fittings. Those that are dumped or dropped are subject to rejection by Architect/Engineer.

1.6 ABBREVIATIONS

CIP	Cast Iron Pipe
CMP	Corrugated Metal Pipe
DIP	Ductile Iron Pipe

PVC	Polyvinyl Chloride Pipe
PCPP	Perforated Corrugated Polyethylene Drain Pipe
SICPP	Smooth Interior Corrugated Polyethylene Pipe

1.7 MATERIAL TESTS

A. Various tests and checks shall be performed, as specified herein, to determine compliance with the specifications and drawings. The Contractor is advised that failure of a test is suitable grounds for the Architect/Engineer to order that portion of the work removed and reconstructed, if necessary, to meet the requirements of the Contract Documents.

1.8 JOB CONDITIONS

A. The drawings indicate the required structure and pipe sizes, and locations of all structures, piping and appurtenances. Verify all locations and immediately notify Architect/Engineer of any discrepancies or conflicts.

B. Contractor shall verify that survey benchmark and intended elevations for the work are as indicated. Contractor shall verify existing site conditions.

C. Utilities shown on the Contract Drawings are for the convenience of the Contractor, exact locations are not guaranteed. The Contractor shall verify existing utilities with the proper authorities.

D. The Contractor shall take precautions to protect from harm the work of other contractors on site, existing facilities, as well as adjacent property. The Contractor shall be responsible for all damage or injury done to pipes, structures, utilities, pavement, buildings, property or person as a result of work to complete this contract. The Contractor at his own expense shall repair or replace such property or item to the satisfaction of the property owner, utility owner, public agency having jurisdiction, Architect/Engineer and Owner's Designated Representative.

1.9 PROTECTION OF WATER AND GAS LINES FROM STORM SEWER

A. Parallel Water (or Gas) and Sewer Lines – Potable water (or gas) lines and pipelines carrying sewage, (including vaults, manholes or structures) shall not be installed any closer than 10 feet horizontally from one another. The distance shall be measured outside edge to outside edge of pipe or structure.

B. Water (or Gas) and Sewer Line Crossings – Whenever water (or gas) and sewer lines must cross, the sewer must be situated below the water (or gas) line with at least an 18-inch clear, vertical separation between top of sewer line and bottom of water line. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water (or gas) line joints (at least one full laying length of water (or gas) pipe shall be centered over the sewer). In no case shall a water (or gas) line pass under a sewer unless specifically approved by the Architect/Engineer. Where a water (or gas) line is approved to cross under a sewer, adequate structural support (compacted select fill) shall be provided for the sewer to prevent excessive deflection of joints and settling of the sewer on the water (or gas) line.

C. Special Conditions – When it is not practical to maintain a 10-foot horizontal separation between sewer and water (or gas) lines, immediately notify the Architect/Engineer. If the Architect/Engineer concurs, the utilities shall be installed as follows:

1. For water (or gas) lines that pass over sewers: the water (or gas) line shall be installed as far away from the sewer as possible with a minimum horizontal separation of 3 feet and a minimum of 6-inches above the sewer, as measured from the invert of the water (or gas) line to the crown of the sewer.

2. For water (or gas) lines installed below sewers: the water (or gas) line shall be installed 18-inches below the invert of the sewer or by one of the following as approved by the Architect/Engineer with a variance obtained from the Monroe County Department of Health office:

   a. Construct the sewer using water main standard pipe and testing said pipe at 150 psi, or
   b. Encase, sleeve, or otherwise envelope the water main or sewer to maximize protection of the water main.

D. Special Conditions – Crossing Lines – When it is impossible to obtain proper vertical separation, immediately notify the Architect/Engineer. If the Architect/Engineer concurs, the utilities shall be installed as follows:

1. For water (or gas) lines that pass over sewers: If 18-inches of vertical separation is not feasible and the vertical separation is between 6- and 18-inches, all water (or gas) line joints within 20 feet of the sewer shall be encased in control density fill.

2. For water (or gas) line that pass below sewers: If 18-inches of vertical separation is not feasible one of the following shall be completed as approved by the Architect/Engineer with a variance obtained from the Monroe County Department of Health office:

   a. Construct the sewer using water main standard pipe and testing said pipe at 150 psi, or
   b. Encase, sleeve, or otherwise envelope the water main or sewer for a distance equal to two full lengths of water pipe to maximize separation between the crossing and unprotected joint.

PART 2 – PRODUCTS AND MATERIAL

2.1 GENERAL

A. Caps and Plugs – Water tight, of similar manufacturer and producing the same joint conditions as the pipe on which the cap or plug is placed.

A. Foundation Materials:
1. Gravel or crushed stone bedding shall be as detailed on the Contract Drawings and as specified in Division 31 Section “Earth Moving”.
2. Select earth backfill shall be as detailed on the Contract Drawings and as specified in Division 31 Section “Earth Moving”.

B. Pipe Adapters – Join pipes of different materials with adapters specifically manufactured for that purpose and as approved by the Architect/Engineer. Where dissimilar materials join, such that galvanic action may produce corrosion, provide dielectric couplings to preclude damage to the materials.

C. Concrete for Pipe Encasements and Cradles – Class A concrete per NYSDOT Standard Specification Section 501.

D. Flowable concrete fill for sewer abandonment shall be Controlled Low Strength Material (CSLM) as specified in Division 31 Section "Earth Moving".

2.2 POLYVINYL CHLORIDE (PVC) PIPE – SDR-21

A. Pipe and Pipe Fittings
   1. Materials shall conform to Division 33 Section "Site Waste Utility Sewerage Piping"

2.3 SMOOTH INTERIOR CORRUGATED POLYETHYLENE PIPE (SICPP)

A. Corrugated polyethylene pipe storm sewers shall be high-density corrugated polyethylene smooth interior pipe. Four-inch to 10-inch diameter pipe shall conform to AASHTO M252 with the addition of smooth interior and 12-inch to 36-inch diameter pipe shall conform to AASHTO M294, Type S. Material compounds shall conform to ASTM D3350. Pipe shall be Hi-Q as manufactured by Hancor, N-12 as manufactured by Advance Drainage Systems, Inc., or approved equal.

B. Pipe joints and fittings shall be of the same material as the pipe.

2.4 PERFORATED CORRUGATED POLYETHYLENE UNDERDRAIN PIPE (PCPP)

A. Perforated corrugated polyethylene drain pipe 4 inches through 10 inches in diameter shall be flexible high density corrugated polyethylene, corrugated on the inside and outside conforming to AASHTO M252 except that tubing manufactured from material meeting ASTM D1248, Class B shall also be acceptable. Pipe shall be heavy-duty AASHTO pipe as manufactured by Hancor, or approved equal.

B. Perforated corrugated polyethylene tubing and fittings 12 inches and 15 inches diameter shall meet the requirements of AASHTO M292 Type CP.

C. Pipe joints and fittings shall be of the same material as the pipe.

D. The geotextile fabric around the under drain shall be Mirafi 140N as manufactured by Mirafi, or approved equal.

E. The underdrain filter stone shall be as specified in Division 31 Section "Earth Moving".

2.5 CATCH BASINS (HEAVY DUTY)

A. Provide precast or cast-in-place concrete structures as shown on the Contract Drawings. Precast concrete strength shall meet 4,000 psi at 28 days. Structures shall be designed for AASHTO H-20 loading with 30 percent impact.

B. Frame and grate shall be as indicated on the contract drawings, or an approved equivalent.

C. The interior and exterior of the catch basin shall be coated with two coats of Conseal CS-55, or approved equal.

D. Where shown on the Contract Drawings, provide catch basin with cast iron catch basin trap Model R-3704 as manufactured by Neenah Foundry Company, or approved equal.

2.6 DRAIN BASIN

A. Shall be manufactured from PVC pipe stock, utilizing a thermo-molding process to reform the pipe stock to the specified configuration.

B. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. This joint tightness shall conform to ASTM D3212 for joints for drain and sewer plastic pipe using flexible elastomeric seal. The flexible elastomeric seals shall conform to ASTM F477.

C. The pipe bell spigot shall be joined to the main body of the drain basin or catch basin.

D. The raw material used to manufacture the pipe stock that is used to manufacture the main body and pipe stubs of the surface drainage inlets shall conform to ASTM D1 784 cell class 12454.

E. The grates and frames furnished for all surface drainage inlets shall be ductile iron for sizes 8”, 10”, 12”, 15”, 18”, 24” and 30” and shall be made specifically for each basin so as to provide a round bottom flange that closely matches the diameter of the surface drainage inlet. Grates for drain basins shall be capable of supporting H-20 wheel loading. 12” and 15” square grates will be hinged to the frame using pins. Metal used in the manufacture of the castings shall conform to ASTM A536 grade 70-50-05 for ductile iron. Grates shall be provided painted black.

2.7 CONNECTIONS TO EXISTING PIPE LINES

A. Provide connections where shown on the Contract Drawings. Where no details of the connections are shown, submit a proposal for approval, showing fittings, adapters, and procedures used.

2.8 DETECTABLE UNDERGROUND MARKING TAPE

A. For all PVC, SICPP, or DIP sewer pipe or laterals, provide detectable warning tape. Refer to

Division 31 Section "Earth Moving".

2.9 TRENCH DRAIN

A. Trench drain shall be provided from a plant of recognized reputation that is regularly engaged in the production of modular trench drain systems, precast from corrosion resistant materials for on-site assembly and installation.

B. Submit catalog cuts and layout drawings indicating part numbers and slopes for trench drains. Submit manufacturer's certification that trench drain meets specified loading requirements.

C. Carefully handle precast sections, modular trench drain and all castings when loading and unloading to avoid damage. In the event of damage, either in delivery or installation, the damaged section shall be immediately removed from the project site and replaced at no additional cost to the Owner.

D. Frame and grate shall be as indicated on the contract drawings, or an approved equivalent.

PART 3 – EXECUTION

3.1 PREPARATION

A. Thoroughly clean interiors of pipes, fittings, and appurtenances, joint surfaces, and gaskets prior to installation. Maintain pipes and fittings clean.

B. Verify that excavation is in the proper location, that pipes and structures have been installed at the correct elevations, and that the subgrade has been properly prepared.

3.2 PIPE AND STRUCTURE INSTALLATION - GENERAL

A. Trenching and related excavation work shall be completed in accordance with Division 31 Section "Earth Moving" and in a manner as approved by the Architect/Engineer. Remove all boulders, organic or spongy material, and other deleterious matter. Verify that trench excavation is ready to receive work and that excavations, dimensions, and elevations are as indicated on drawings.

Remove large stones or other hard matter, which could damage piping or impede consistent backfilling or compaction.

B. Pipe Foundation: All pipes, fittings, or specials to be installed shall be properly bedded in uniformly supported on pipe foundations of the type specified in Division 31 Section "Earth Moving" and indicated on the Contract Drawings.

C. Firmly bed pipe in the required depth of aggregate in such a manner that the pipe barrel is uniformly supported and cradled throughout its length. Provide suitable depressions where required in the foundation material to permit adequate bedding of the bells or other projections.

The total depth of bedding shall be constant across the trench width.

D. Install storm structures and pipelines to the required lines and grades indicated on the drawings, or as directed by the Architect Engineer using an approved method of control.

E. Carefully lower pipes, fittings, and structures into the trench. Apply joint lubricant (if required) in accordance with the approved manufacturer's recommendations. Join pipe sections and fittings. Join pipe and structures.

F. Select pipe and fittings so that there will be as small a deviation as possible at the joints and so that inverts present a smooth surface. Pipe and fittings, which do not fit together to form a tight fitting joint, are not permitted.

G. Use only mechanical cutters for cutting pipe.

H. Cut ends of pipe which terminate at catch basins, manholes, or other structures cleanly and trim to a neat, sheared edge, flush with the inside wall of the structure.

I. Maintain cleanliness of installed pipe, fittings, and structure interiors throughout the work. Plug ends when installation is not in progress so that dirt, foreign matter, water, animals, and people do not enter the work. Drainage of construction excavations through installed pipes shall not be permitted.

J. Maintain the excavation free of water during the progress of the work. No pipes or structures shall be laid in water nor shall there be any joints made up in water. No separate allowance for pumping or otherwise removing water will be made. All slides or cave-ins of the trenches or cuts shall be remedied at the expense of the Contractor, and to the satisfaction of the Architect/Engineer.

3.3 ADJUSTMENT OF CATCH BASINS TO FINISHED GRADE

A. Adjustment of catch basins shall be completed as specified in Division 33 Section "Precast Manholes" and as shown on the drawings.

3.4 DRAIN BASINS

A. The specified PVC surface drainage inlet shall be installed using conventional flexible pipe backfill materials and procedures. The backfill material shall be crushed stone or other granular material meeting the requirements of class 2 material as defined in ASTM D2321. Bedding and backfill for surface drainage inlets shall be placed and compacted uniformly in accordance with ASTM D2321. The drain basin body will be cut at the time of the final grade. No brick, stone or concrete block will be required to set the grate to the final grade height.

3.5 TESTING

A. Deflection testing on all 12-inch and under storm piping shall be completed. Tests shall be same as for sanitary sewer Division 22 Section "Facility Sanitary Sewer".

B. Deflection testing of underdrain piping and storm piping is not required.

3.6 FIELD QUALITY CONTROL

A. In the presence of the Owner's Designated Representative, inspect each length of pipe and each structure delivered to the job for flaws, cracks, dimensional tolerance and compliance with the applicable specifications. Only pipes, fittings, and structures accepted by the Owner's Designated Representative and so marked shall be installed in the work.

B. The Contractor shall inspect pipe joints and verify that they have been properly installed and made up, and free from sags, high spots, and excessive deflections.

C. The Owner's Designated Representative shall inspect each stretch of completed pipeline and structure prior to backfilling, to ensure compliance with the Contract Documents. The Contractor shall not continue with backfilling operations prior to inspection by the Owner's Designated Representative, utility representatives or prior to recording as built information.

D. Afford Architect/Engineer access to the work so that he may spot check the installations or check each length of pipe immediately after it has been installed or check it at any time after installation.

E. Contractor shall request Owner's Designated Representative inspection prior to and immediately after placing aggregate cover over pipe.

F. Upon completion of construction of the storm sewer, including trench backfill, the Contractor shall clean and flush all pipes. The system shall be left free of all stones, sand, silt, or mortar projects. The benches and inverts of manholes and bottoms of inlets shall have all mortar dropping chipped away to leave a smooth, clean surface.

G. All materials flushed from the storm sewer shall be intercepted and removed to prevent the materials from entering the existing storm sewer system.

3.7 DAMAGED FACILITIES

A. Any section of piping that is found defective in material, alignment, grade, joint, or otherwise, shall be corrected at no additional cost to the Owner.

B. In the event that dirt, debris, or any other foreign material has entered any portion of the piping or structures, flush the piping or structure with clean water. Continue the flushing process until the piping or structure is clean, as determined by Architect/Engineer.

C. Any damage done to existing utility mains or their appurtenances as a result of work under this Contract shall be repaired or replaced by the Contractor to the satisfaction of the Architect/Engineer at no additional cost to the Owner.

END OF SECTION 334100