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FRANCIS WALSH INTERMEDIATE
SCHOOL & BOARD OF EDUCATION
CENTRAL OFFICES

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CONSTRUCTION DOCUMENTS

**Volume 3: Mechanical – Plumbing – Fire
Protection – Security - Civil**

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PART 1 GENERAL

1.1 SUMMARY

- A. Section includes pipe, fittings, valves, backflow preventers and connections for sprinkler and standpipe systems.
- B. Related Sections:
 - 1. Section 03 10 00 - Concrete Forming and Accessories: Execution requirements for inserts and sleeves specified by this section.
 - 2. Section 09 90 00 - Painting and Coating: Execution requirements for piping painting specified by this section.
 - 3. Section 21 05 16 – Expansion Fittings and Loops for Fire-Suppression Piping.
 - 4. Section 21 05 48 – Vibration and Seismic Controls for Fire-Suppression Piping and Equipment.
 - 5. Section 21 12 00 – Fire Suppression Standpipes.
 - 6. Section 21 13 13 – Wet-Pipe Sprinkler System.
 - 7. Section 21 30 00 – Fire Pumps

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 PHASE 2 SUPPORT REQUIREMENTS

- A. All mechanical systems including equipment, ductwork, piping and accessories being hung from above shall not be supported from the existing “space truss” roof structure unless noted otherwise. Systems shall be supported from new framing only. Refer to structural drawings for locations of new framing. Provide supplemental framing as required.

1.5 REFERENCES

- A. American Society of Mechanical Engineers:
1. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.
 2. ASME B16.3 – Malleable Iron Threaded Fittings, Class 150 and 300.
 3. ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.
 4. ASME B16.5 - Pipe Flanges and Flanged Fittings
 5. ASME B16.9 – Factory-made Wrought Steel Butt Welding Fittings.
 6. ASME B16.11 - Forged Steel Fittings - Socket-Welding and Threaded.
 7. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
 8. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 9. ASME B16.25 – Butt Welding Ends.
 10. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.
 11. ASME Sec 9 - Welding and Brazing Qualifications.
- B. American Society of Sanitary Engineers:
1. ASSE 1015 – Standard for Double Check Backflow Preventer Assembly
 2. ASSE 1048 – Standard for Double Check Detector Assembly Backflow Preventer.
- C. ASTM International:
1. ASTM A47 – Malleable Iron Castings.
 2. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 3. ASTM A135 - Standard Specification for Electric-Resistance-Welded Steel Pipe.
 4. ASTM A126 – Standard for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 5. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 6. ASTM A536 – Standard for Ductile Iron Casting.
 7. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
 8. ASTM B32 - Standard Specification for Solder Metal.
 9. ASTM B75 - Standard Specification for Seamless Copper Tube.
 10. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
 11. ASTM B251 - Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.

- D. American Welding Society:
 - 1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
 - 2. AWS D1.1 - Structural Welding Code - Steel.
 - 3. AWS D10.9 - Specifications for Qualification of Welding Procedures and Welders for Piping and Tubing.

- E. American Water Works Association:
 - 1. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
 - 2. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - 3. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
 - 4. AWWA C510 – Standard for Double Check Valve Backflow Prevention Assembly.
 - 5. AWWA C606 – Standard for Grooved and Shouldered Joints.

- F. National Fire Protection Association:
 - 1. NFPA 13 - Installation of Sprinkler Systems 2010 Edition.
 - 2. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems 2010 Edition.
 - 3. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances 2010 Edition.

- G. Underwriter Laboratories, Inc.:
 - 1. UL 1887 - Fire Tests of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics.
 - 2. UL - Fire Resistance Directory.

- H. Factory Mutual:
 - 1. FM - Factory Mutual Approval Guide.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

- B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

- C. Product Data: Submit manufacturer's catalogue information. Provide data on valves, and fittings, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

- D. Grooved joint couplings and fittings shall be shown on shop drawings and product submittals and shall be specifically identified with the applicable Victaulic style or series designation.

- E. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and all code requirements.
- F. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.7 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of components and tag numbering.
- C. Operation and Maintenance Data: Submit spare parts lists.

1.8 QUALITY ASSURANCE

- A. Workmanship and Qualifications: All materials and equipment shall be installed in accordance with NFPA and all applicable local codes and ordinances. The Sprinkler Contractor shall be state licensed to install sprinkler systems. The Sprinkler Contractor shall make sure that all work and materials conform to the requirements set forth by this Specification. Fire protection equipment shall be installed to conform to NFPA as applicable, and devices used shall be listed and approved by Underwriters laboratories (UL) and/or Factory Mutual (FM).
- B. Codes and Standards: All work shall be equal or superior to that required by codes, regulations, ordinances, and laws imposed by the jurisdictional authorities, including those of the State of Connecticut, State Fire Marshall, local ordinances and OSHA.

Nothing in the Specifications permit violations of such directives, and where conflict occurs, the directive shall govern, except where superior work is specified or indicated.

- C. In addition to complying with the above codes and regulations, comply with the requirements of the following:
 - 1. NFPA Standard 13 2010.
 - 2. NFPA Standard 14 2010.
 - 3. NFPA Standard 20 2010.
 - 4. NFPA Standard 24 2010.
 - 5. 2016 Connecticut State Building and Connecticut State Fire Codes.
 - 6. Local Jurisdictional Authorities.
- D. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
- E. Valves: Bear UL and/or FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.
- F. All items of similar class shall be the products of the same manufacturer. All valves, accessory items, etc., shall be from the same source.
- G. Provide fire sprinkler piping located in plenums with peak optical density not greater than 0.5, average optical density not greater than 0.15, and flame spread not greater than 5 feet (1.5 m) when tested in accordance with UL 1887.
- H. Maintain one copy of each document on site.
- I. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.9 QUALIFICATIONS

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

1.10 PRE-INSTALLATION MEETINGS

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

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Deliver and store valves in shipping containers, with labeling in place.
- C. Furnish cast iron and steel valves with temporary protective coating.
- D. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. All equipment, valves, gages and etc., shall be covered and protected during the execution of the work. All equipment and piping shall be protected from freezing. Labeling to remain in place.
- F. All unloading, hauling, and handling of materials shall be the responsibility of the Sprinkler Contractor.
- G. The Sprinkler Contractor can obtain information on available storage space on site from the Owner when making examination of the site.

1.12 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for basic fire suppression materials and methods.

1.13 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two sets of valve stem packing for each size and type of valve installed.

PART 2 PRODUCTS

2.1 VALVES

- A. Manufacturers:
 - 1. Kennedy Valve Mfg. Co.
 - 2. Victaulic.

3. Stockham.
4. Nibco.
5. Watts.
6. Hammond.
7. Milwaukee.
8. Substitutions: Section 01 60 00 - Product Requirements.

B. Gate Valves:

1. Up to and including 2 inches: Bronze body and trim, 175 lb, cold water non-shock working pressure, rising stem, hand wheel, solid wedge or disc, threaded ends.
2. Over 2 inches: Iron body, bronze trim, 175 lb, cold water non-shock working pressure, rising stem pre-grooved for mounting tamper switch, hand wheel, outside screw and yoke, solid taper bronze or cast iron wedge, grooved or flanged ends.
3. Over 4 inches: Iron body, bronze trim, 175 pound cold water, non-shock working pressure. Valve shall have solid taper wedge; outside screw and yoke, rising stem; flanged bonnet with body and bonnet conforming to ASTM A126 Class B; replaceable bronze wedge facing rings; grooved or flanged ends; and a packing assembly consisting of a cast iron gland flange, brass gland, packing, bonnet and bronze bonnet bushing. Valve shall be capable of being repacked under pressure, with valve wide open.

C. Globe Valves:

1. Up to and including 2 inches: Class 125, Bronze body, bronze trim, rising stem and hand wheel, inside screw, renewable rubber disc, threaded ends, with back seating capacity, packable under pressure.
2. Over 2 inches: Iron body, bronze trim, rising stem, hand wheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

D. Ball Valves:

1. Up to and including 2 inches: Bronze two piece body, standard port, chrome plated brass ball, 316 stainless steel stem, teflon seats brass stem nut, die-cast brass gear box with supervisory switches, threaded or grooved ends.
2. Over 2 inches: Manufacturers: Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle.

E. Butterfly Valves:

1. Ductile iron body, ductile iron disc with EPDM disc coating and integrally cast stem, grooved ends.
2. Cast bronze body, ductile iron disc with EPDM disc coating and integrally cast stem, copper-tubing dimensioned grooved ends.
3. Cast iron with resilient replaceable EPDM seat, wafer or lug ends, extended neck with 316 stainless steel stem, MSS-SP-67, 200 psi.
4. Disc: EPDM coated ductile iron or Aluminum bronze.
5. Operator: Notched plate lever handle. handwheel and weatherproof actuator with supervisory switches.

F. Check Valves:

1. Up to and including 2 inches: Class 125, Bronze swing disc, screwed ends.
2. Horizontal Swing Over 2 inches:
 - a. 300 psi CWP, ductile iron body and coupled cap conforming to ASTM A536, Grade 65-45-12; horizontal swing, with stainless steel disc, elastomer seat, and grooved ends.
 - b. Class 175, cast iron body and bolted cap conforming to ASTM A126, Class B; horizontal swing, with a bronze disc or cast iron disc with bronze disc ring, and flanged ends.
 - c. Valve shall be capable of being refitted while the valve remains in line.
3. Spring Actuated Over 2 inches:
 - a. 300 psi CWP, ductile iron body conforming to ASTM A536, Grade 65-45-12; vertical or horizontal check; with stainless steel spring and shaft.
 - 1) 2-1/2 (65 mm) and 3 inches (75 mm): Aluminum bronze disc with disc mounted elastomer seal and PPS (Polyphenylene Sulfide) coated seat.
 - 2) 4 inches (100 mm) and Larger: Elastomer coated ductile iron disc with welded-in nickel seat.

G. Drain Valves:

1. Compression Stop: Bronze with hose thread nipple and cap.
2. Ball Valve: Brass with cap and chain, 3/4 inch hose thread.

H. All valves shall be either UL listed or FM approved for use on fire protection systems.

2.2 BACKFLOW PREVENTERS

- A. Double Check Detector Check Valve Assemblies: ANSI/ASSE 1048, AWWA C510; bronze body; two independently operating, spring loaded check valves; metered bypass; assembled with two gate valves, strainer, test cocks. Watts 709RPDA or approved equal.

2.3 BURIED PIPING

- A. Ductile Iron Pipe: ANSI/AWWA C151, cement lined.
1. Fittings: ANSI/AWWA C110, standard thickness.
 2. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings.
 3. Joints: ANSI/AWWA C111, rubber gasket.

2.4 ABOVE GROUND PIPING

- A. Steel Pipe: ASTM A53; Schedule 40 seamless carbon steel. Schedule 10 pipe shall be allowed for pipe sizes larger than 2" diameter when roll grooved mechanical couplings are used. Plain end joint connections shall not be used.
1. Cast Iron Fittings: ANSI/ASME B16.1, flanges and flanged fittings; ANSI/ASME B16.4, screwed fittings.
 2. Malleable Iron Fittings: ANSI/ASME B16.3, screwed Class 300 type. Threads shall conform to ANSI/ASTM A47.

3. Grooved Mechanical Fittings: ANSI A21.10/AWWA C-110 ductile iron; ASTM A536 Grade 65-45-12 ductile iron; ASTM A234 Grade WPB; or factory fabricated from carbon steel pipe conforming to ASTM A53; with grooves or shoulders designed to accept grooved end couplings. Fittings shall be of the same manufacturer as the adjoining couplings. Grooved Mechanical Couplings: ASTM A536 Grade 65-45-12, ductile iron housing, elastomer gasket with nuts and bolts to secure roll grooved pipe and fittings.

Fire Protection Service	Temperature Range	Gasket Recommendation
Dry Systems	Ambient	FlushSeal®, or EZ Style 009 design Grade EPDM, Type A
Freezer Applications	-40°F to 0°F	FlushSeal®, Grade L, Silicone
Water/Wet Systems	Ambient	C-Shape or EZ Style 009

- a. Rigid Type Couplings: Housings cast with offsetting, angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with NFPA-13.
- 1) 1-1/4" through 4": Factory assembled for direct stab installation without field disassembly. Victaulic Style 009 EZ.
 - 2) 5" through 8": Victaulic FireLock™ Style 005.
 - 3) 10" and larger: Victaulic Zero-Flex® Style 07.
- b. Flexible Type Couplings: Use in locations where vibration attenuation and stress relief are required, and for seismic considerations in accordance with the manufacturer's instructions. Victaulic Style 75.

- B. Cast Iron Pipe: AWWA C151.
1. Fittings: AWWA C110, standard thickness.
 2. Joints: AWWA C111, rubber gasket.
 3. Mechanical Grooved Couplings: Ductile iron housing clamps to engage and lock, "C" shaped composition sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.

2.5 UNIONS AND DIELECTRIC CONNECTIONS

- A. Unions for Pipe 2 Inches (50 mm) and Under:
1. Ferrous Piping: 150 psig (1034 kPa) malleable iron, threaded.
 2. Copper Pipe: Bronze, soldered joints.
- B. Dielectric Connections: Union, waterway fitting, or flange with water impervious isolation barrier; Victaulic Style 47 or Watts 3000 Series or approved equal.

2.6 PIPE HANGERS AND SUPPORTS

- A. Conform to NFPA 13, NFPA 14.
- B. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, Carbon steel, adjustable swivel, split ring.

- C. Hangers for Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
- D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- E. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.
- F. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.
- G. Vertical Support: Steel riser clamp
- H. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- I. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

PART 3 EXECUTION

3.1 PREPARATION

- A. Coordinate work of this Section with other affected work.
- B. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- C. Remove scale and foreign material, from inside and outside, before assembly.
- D. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION – GENERAL

- A. Install in accordance with manufacturer's instructions.
- B. The Contractor shall provide a complete and fully code compliant fire suppression system throughout the entire building.
- C. The Contractor shall maintain a clean and orderly site during the installation of the sprinkler system. Materials shall not be stored in the halls or other public areas.
- D. Cutting, welding and other hot work shall not be permitted without permission from the building owner. Contractor shall provide a fire watch for one hour after all welding.
- E. The required tests shall be witnessed by the Fire Marshall, authority having jurisdiction, Owner's insurance underwriter and Architect/Engineer.
- F. Pipe Hangers and Supports:
 - 1. Install in accordance with NFPA 13 and NFPA 14.
 - 2. Install hangers to with minimum 1/2 inch space between finished covering and adjacent work.
 - 3. Place hangers within 12 inches of each horizontal elbow.

4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
6. Where installing several pipes in parallel and at same elevation, provide multiple or trapeze hangers.
7. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.3 INSTALLATION – PIPE AND FITTINGS

- A. Pipe/insulation: All wet sprinkler piping must be plumbed on the heated side of the building insulation to prevent freezing. The fire protection contractor must install the wet sprinkler piping such that space is provided around all wet piping for insulation to be installed. The space required for insulation is dictated by the insulation R-value for the specific area as specified by the Architect.
- B. Install piping in accordance with NFPA 13 for sprinkler systems, NFPA 14 for standpipe and hose systems, and NFPA 24 for service mains.
- C. Place piping in concealed spaces above finished ceilings unless noted otherwise.
- D. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- E. Install piping to conserve building space, to not interfere with use of space and other work.
- F. Group piping whenever practical at common elevations.
- G. Install pipe sleeve at piping penetrations through footings partitions, walls, and floors. Seal pipe and sleeve penetrations to maintain fire resistance equivalent to fire separation.
- H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Use Victaulic Style 77 or 75 couplings in accordance with Victaulic instructions for expansion and contraction of pipe.
- I. Grooved joint couplings and fittings shall be installed in accordance with the manufacturer's written installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be verified as suitable for the intended service prior to installation. Gaskets shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer's representative shall periodically visit the jobsite and review installation. Contractor shall remove and replace any joints deemed improperly installed.

- J. Pitch piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- K. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding. Refer to Section 09 90 00.
- L. Do not penetrate building structural members unless indicated.
- M. Provide sleeves when penetrating footings, floors and walls. Seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- N. Where more than one piping system material is specified, install compatible system components and joints. Install flanges, union, and couplings at locations requiring servicing.
- O. Die cut threaded joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.
- P. Provide dielectric fittings whenever joining two dissimilar metals.
- Q. Provide surge restrainers on all end of branches and arm overs in excess of 12-inches.

3.4 INSTALLATION – VALVES

- A. Install drain valves at main shut-off valves, low points of piping and apparatus.
- B. All valves shall be accessible for operation and servicing. Provide access panels where required.
- C. Install valves with stems upright or horizontal, not inverted. Remove protective coatings prior to after installation.
- D. Install gate or butterfly valves for shut-off or isolating service.
- E. Install buried shut-off valves in valve box.
- F. Provide Double check valve assembly with detector check assembly at sprinkler system water source connection. Install a drain line from the air gap fitting and terminate at the nearest floor drain. The backflow preventer shall be installed at a minimum height to allow installation of the air gap fitting, but shall not be installed at more than 5'0" above finished floor for maintenance.

3.5 SERVICE CONNECTION

- A. Provide new fire service complete with reduced pressure double detector check valve assembly and isolation valves with tamper switches.
 - 1. Provide sleeve in wall for service main and support at wall with reinforced concrete bridge. Caulk enlarged sleeve and make watertight with pliable material. Anchor service main inside to concrete wall.
 - 2. Provide 18 gage (1.20 mm) galvanized sheet metal sleeve around service main to 6 inch (150 mm) above floor and 6 feet (1800 mm) minimum below grade. Size for minimum of 2 inches (50 mm) of loose batt insulation stuffing. Provide Link Seal Modular Seal assembly Model C for temperature rating of -40°F to 250°F. Install per manufacturers written instructions.

3.6 TESTING

- A. Piping: The complete system shall be subject to a pressure test, and to such other tests as the authorities having jurisdiction may require. The pressure test shall be a hydrostatic pressure of 200 pounds per square inch for a period of two hours. The above ground piping and attached appurtenances shall show no pressure loss or leaks, refer to NFPA Standard 13 Hydrostatic tests. For buried piping refer to NFPA Standard 24 Testing Underground Systems. Before applying specified test pressure, all air must be expelled from the system. All defects of whatever type shall be repaired or replaced to the satisfaction of the Owner and authorities having jurisdiction and at no additional cost to the Owner. Packing rings, special joint bolts, gaskets, and other material required for the proper installation of the pipe and fittings shall be provided. Testing shall be completed prior to permanent sealing of walls and partitions.
- B. Leaks in mechanical joints shall be repaired by dismantling the joint, reassembling it, and tightening the bolts in the correct order. Leaks in screw or grooved joint shall be repaired by dismantling the joint and reassembling it. Attempting to repair leaks in joints by over tightening the bolts or fittings shall not be permitted.
- C. Upon satisfactory completion of all tests, the Contractor shall submit three copies of the Standard Contractors Material and Test Certificate to the Owner.

3.7 INTERFACE WITH OTHER PRODUCTS

- A. Inserts:
 - 1. Install inserts for placement in concrete forms.
 - 2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Install hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

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BRANFORD, CONNECTICUT
State Project No.s: 014-0034 EA / 014-0035 BE-EA

3.8 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Clean entire system after other construction is complete.

END OF SECTION

SECTION 210516 - EXPANSION FITTINGS AND LOOPS FOR FIRE-SUPPRESSION PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Each Contractor, Subcontractor and/or supplier providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 SUMMARY

- A. Section Includes:
 - 1. Flexible pipe connectors.
 - 2. Expansion joints.
 - 3. Expansion compensators.
 - 4. Pipe alignment guides.
 - 5. Swivel joints.
 - 6. Pipe anchors.

- B. Related Sections:
 - 1. 21 05 00 - Common Work Results for Fire Suppression: Product and installation requirements for piping used in fire protection systems.
 - 2. Section 21 05 48 - Vibration and Seismic Controls for Fire-Suppression Piping and Equipment: Product and installation requirements for vibration isolators used in piping systems.
 - 3. Section 21 12 00 - Fire-Suppression Standpipes.
 - 4. Section 21 13 13 – Wet-Pipe Sprinkler System.

1.5 REFERENCES

- A. American Society of Mechanical Engineers:
 - 1. ASME B31.9 - Building Services Piping.
 - 2. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.
- B. American Welding Society:
 - 1. AWS D1.1 - Structural Welding Code - Steel.

1.6 DESIGN REQUIREMENTS

- A. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.
- B. Expansion Compensation Design Criteria:
 - 1. Installation Temperature: 50 degrees F.
 - 2. Fire Protection System Temperature: 50 degrees F.
 - 3. Safety Factor: 30 percent.

1.7 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawings: Indicate layout of piping systems, including flexible connectors, expansion joints, expansion compensators, loops, offsets and swing joints. Submit shop drawings sealed by a registered professional engineer.
- C. Product Data:
 - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
 - 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
- D. Design Data: Indicate criteria and show calculations. Submit sizing methods and calculations sealed by a registered professional engineer.

- E. Manufacturer's Installation Instructions: Submit special procedures.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- G. Welders' Certificate: Include welders' certification of compliance with ASME Section IX. AWS D1.1.
- H. Manufacturer's Field Reports: Indicate results of inspection by manufacturer's representative.
- I. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.8 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.
- C. Operation and Maintenance Data: Submit adjustment instructions.

1.9 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

- B. Perform Work in accordance with the Connecticut State Building Code and Connecticut State Fire Safety Code.
- C. Maintain one copy of each document on site.
- D. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.10 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.
- C. Design expansion compensating system under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Connecticut

1.11 PRE-INSTALLATION MEETINGS

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

1.12 DELIVERY, STORAGE, AND HANDLING

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

1.13 WARRANTY

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

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

1.14 EXTRA MATERIALS

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

PART 2 PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS

- A. Manufacturers:
 - 1. Mason.
 - 2. Metraflex.
 - 3. Vibration Eliminator.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Steel Piping:
 - 1. Inner Hose: Stainless Steel.
 - 2. Exterior Sleeve: Double braided stainless steel
 - 3. Pressure Rating: 200 psig WOG and 250 degrees F.
 - 4. Joint: Flanged or Threaded with Union
 - 5. Size: Use pipe-sized units.
 - 6. Maximum offset: 1 inch on each side of installed center line.

2.2 EXPANSION JOINTS

- A. Manufacturers:
 - 1. Metraflex.
 - 2. Mason.
 - 3. Vibration Elimination.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Stainless Steel Bellows Type:
 - 1. Pressure Rating: 200 psig WOG and 250 degrees F.
 - 2. Maximum Compression: 1-3/4 inch 3 inch.
 - 3. Maximum Extension: 1/4 inch.
 - 4. Joint: Flanged Threaded
 - 5. Size: Use pipe sized units
 - 6. Application: Steel piping 3 inch and smaller.
- C. External Ring Controlled Stainless Steel Bellows Type:
 - 1. Pressure Rating: 200 psig WOG and 250 degrees F

2. Maximum Compression: 15/16 inch 1-1/4 inch.
 3. Maximum Extension: 5/16 inch 3/8 inch.
 4. Maximum Offset: 1/8 inch 5/16 inch.
 5. Joint: Flanged
 6. Size: Use pipe sized units
 7. Accessories: Internal flow liner.
 8. Application: Steel piping 3 inch and larger.
- D. Single Double Sphere, Elbow Flexible Compensators:
1. Body: Teflon Neoprene and nylon
 2. Working Pressure: 120 psi
 3. Maximum Temperature: 140 degrees F.
 4. Maximum Compression: 1 inch.
 5. Maximum Elongation: 7/8 inch.
 6. Maximum Offset: 3/4 inch 7/8 inch.
 7. Maximum Angular Movement: 30 degrees.
 8. Joint: Tapped steel flanges, Galvanized flanges, Galvanized unions.
 9. Size: Use pipe sized units
 10. Accessories: Control cables.
 11. Application: Steel piping 2 inch and larger.
- E. Two-ply Bronze Bellows Type:
1. Construction: Bronze with anti-torque device, limit stops, internal guides.
 2. Pressure Rating: 200 psi WOG and 250 degrees F.
 3. Maximum Compression: 1-3/4 inch.
 4. Maximum Extension: 1/4 inch.
 5. Joint: Soldered
 6. Size: Use pipe sized units
 7. Application: Copper piping.
- F. Low Pressure Compensators with two-ply Bronze Bellows:
1. Working Pressure: 80 psig.
 2. Maximum Temperatures: 250 degrees F.
 3. Maximum Compression: 1/2 inch.
 4. Maximum Extension: 5/32 inch.
 5. Joint: Soldered.
 6. Size: Use pipe sized units
 7. Application: Copper or steel piping 2 inch and smaller.

2.3 ACCESSORIES

- A. Manufacturers:
1. Metraflex.
 2. Mason.
 3. Vibration Elimination.
 4. Substitutions: Section 01 60 00 - Product Requirements.

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

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install Work in accordance with ASME B31.9
- B. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Refer to Section 21 05 48. Provide line size flexible connectors.
- C. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
- D. Rigidly anchor pipe to building structure. Provide pipe guides to direct movement only along axis of pipe. Erect piping so strain and weight is not on cast connections or apparatus.
- E. Provide support and anchors for controlling expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required. Refer to Section 21 05 00 for pipe hanger installation requirements. Refer to architectural and structural drawings for location of expansion joints.
- F. Provide grooved piping systems with minimum one joint per inch pipe diameter instead of flexible connector supported by vibration isolation. Grooved piping systems need not be anchored.
- G. Provide expansion loops as required indicated on Drawings.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Section 01 40 00 - Quality Requirements: Manufacturers' field services.
- B. Furnish inspection services by flexible pipe manufacturer's representative for final installation and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION

SECTION 210548 - VIBRATION AND SEISMIC CONTROLS FOR
FIRE PROTECTION PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 INTENT

- A. All fire protection equipment and piping as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
- B. All isolators and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.
- C. It is the intent of the seismic portion of this specification to keep all mechanical and electrical building system components in place during a seismic event.
- D. All such systems must be installed in strict accordance with seismic codes, component manufacturer's recommendations and building construction standards. Whenever a conflict occurs between the manufacturer's recommendations or construction standards, the most stringent shall apply.
- E. This specification is considered to be minimum requirements for seismic consideration and is not intended as a substitute for legislated, more stringent, national, state or local construction requirements.
- F. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 SUMMARY

- A. Section Includes:
 - 1. Certification of seismic restraint designs and installation supervision.
 - 2. Certification of seismic attachment of housekeeping pads.
 - 3. NOTE: For all mechanical and electrical systems. Equipment buried underground is excluded but entry of services through the foundation wall is included.
 - 4. Seismic restraint products
 - a. Vibration isolation elements.
 - b. Equipment isolation bases.
 - c. Piping flexible connections.
 - d. Seismic restraints for isolated and non-isolated mechanical and electrical items.
 - 5. Inertia bases.
- B. Related Sections:
 - 1. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for placement of isolators in floating floor slabs specified by this section and product requirements for concrete for placement by this section.
 - 2. Section 07 90 00 - Joint Protection: Product requirements for joint sealers specified for placement by this section.
 - 3. Section 21 04 00 – General Conditions for Fire protection Trades
 - 4. Section 21 05 16 - Expansion Fittings and Loops for Fire protection Piping: Product requirements for anchors and piping expansion compensation.
 - 5. Section 21 05 29 - Hangers and Supports for Fire protection Piping and Equipment: Product requirements for pipe hangers and supports.

1.5 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI S1.4 - Sound Level Meters.
 - 2. ANSI S1.8 - Reference Quantities for Acoustical Levels.
 - 3. ANSI S12.36 - Survey Methods for the Determination of Sound Power Levels of Noise Sources.

- B. Air-Conditioning and Refrigeration Institute:
 - 1. ARI 575 - Method of Measuring Machinery Sound within Equipment Space.
- C. American Society of Heating, Refrigerating and:
 - 1. ASHRAE Handbook - HVAC Applications.
- D. International Building Code, 2012, Section 16.

1.6 RELATED WORK

- A. Housekeeping Pads
 - 1. Housekeeping pad reinforcement and monolithic pad attachment to the structure details and design shall be prepared by the restraint vendor if not already indicated on the drawings.
 - 2. Housekeeping pads shall be coordinated with restraint vendor and sized to provide a minimum edge distance of ten (10) bolt diameters all around the outermost anchor bolt to allow development of full drill-in wedge anchor ratings. If cast-in anchors are to be used, the housekeeping pads shall be sized to accommodate the ACI requirements for bolt coverage and embedment.
- B. Supplementary Support Steel
 - 1. Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc. including roof mounted equipment, as required or specified.
- C. Attachments
 - 1. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the vibration vendor's calculations.

1.7 SEISMIC FORCE LEVELS

- A. Installations shall be designed to safely accept external forces determined in accordance with the International Building Code –2012, Section 16 in any direction for all rigidly supported equipment without failure and permanent displacement of the equipment. Seismic restraints shall not short circuit vibration isolation systems or transmit objectionable vibration or noise.

1.8 DEFINITIONS

- A. Life Safety Systems:
 - 1. All systems involved with and/or connected to emergency power supply including all generators, transfer switches, transformers and all flow paths to fire protection and/or emergency lighting systems.
- B. Positive Attachment:
 - 1. A positive attachment is defined as a cast-in anchor, a drill-in wedge anchor, a double sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure. Single sided "C" type beam clamps for support rods of

overhead piping, fire protection, electrical conduit, or any other equipment are not acceptable on this project as seismic anchor points.

- C. Transverse Bracing:
 - 1. Restraint(s) applied to limit motion perpendicular to the centerline of the pipe or conduit.
- D. Longitudinal Bracing:
 - 1. Restraint(s) applied to limit motion parallel to the centerline of the pipe or conduit.
- E. Failure
 - 1. For the purposes of this project, failure is defined as the discontinuance of any attachment point between equipment or structure, vertical permanent deformation greater than 1/8" (3mm) and/or horizontal permanent deformation greater than 1/4" (6mm).

1.9 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings:
 - 1. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
 - 2. Provide Drawings showing methods of suspension and support guides for conduit, piping and ceiling hung equipment.
 - 3. Record actual locations and installation of vibration isolators and seismic restraints including attachment points.
 - 4. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
 - 5. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
 - 6. Drawings showing methods for isolation of conduits and pipes penetrating walls and floor slabs.
 - 7. Specific details of restraints including anchor bolts for mounting and maximum loading at each location, for each piece of equipment and/or pipe locations.
- C. Product Data: Submit schedule of vibration isolator type with location and load on each. Submit catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.
- D. Seismic Certification and Analysis:
 - 1. Seismic restraint calculations must be provided for all connections of equipment to the structure. Calculations must be stamped by a registered professional engineer with at least five years of seismic design experience, licensed in the state of the job location.

2. All restraining devices shall have a preapproval number from California OSHPD or some other recognized government agency showing maximum restraint ratings. Preapprovals based on independent testing are preferred to preapprovals based on calculations. Where preapproved devices are not available, submittals based on independent testing are preferred. Calculations (including the combining of tensile and shear loadings) to support seismic restraint designs must be stamped by a registered professional engineer with at least five years of seismic design experience and licensed in the state of the job location. Testing and calculations must include both shear and tensile loads as well as one test or analysis at 45 degrees to the weakest mode.
 3. Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, the forces detailed in section 1.06 acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.
- E. Design Data: Submit calculations indicating maximum room sound levels are not exceeded. Use sound power levels of actual equipment to be installed on project. Analysis shall include breakout noise calculations. In the absence of specified background sound level criteria, the guidelines as express in Table 34 of Chapter 47, "Sound and Vibration Control" of the 2015 ASHRAE Handbook – HVAC Applications, shall be used.
- F. Test Reports: Indicate dynamic insertion loss and noise generation values of silencers. acoustic housings meet or exceed specified sound transmission loss values.
- G. Manufacturer's Installation Instructions: Submit special procedures and setting dimensions. Indicate installation requirements maintaining integrity of sound isolation.
- H. Manufacturer's Certificate: Certify isolators meet or exceed specified requirements.
- I. Manufacturer's Field Reports: Indicate sound isolation installation is complete and in accordance with instructions.
- J. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.

3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.10 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of hangers including attachment points.

1.11 QUALITY ASSURANCE

- A. Perform Work in accordance with ARI 575 ANSI S12.36.
- B. Maintain one copy of each document on site.
- C. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.12 QUALIFICATIONS

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

1.13 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

- B. Convene minimum one week prior to commencing work of this section.

1.14 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.15 CONTRACTOR'S RESPONSIBILITIES

- A. Contractor shall have the following responsibilities:
 1. Determine vibration isolation and seismic restraint sizes and locations per specifications.
 2. Provide and install isolation systems and seismic restraints as scheduled or specified.
 3. Guarantee specified isolation system deflection.
 4. Provide installation instructions, drawings and field supervision to assure proper installation and performance.
 5. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.
 6. Substitution of "Internally Isolated" mechanical equipment in lieu of the specified isolation of this section is acceptable

1.16 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for inertia bases.

PART 2 PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Manufacturers:
 1. Mason
 2. Vibration Eliminator
 3. Amber Booth
 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Open Spring Isolators:
 1. Spring Isolators:
 - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 3. Spring Mounts: Furnish with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.

4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
- C. Restrained Spring Isolators:
1. Spring Isolators:
 - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 3. Spring Mounts: Furnish with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
 4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
 5. Restraint: Furnish mounting frame and limit stops.
- D. Closed Spring Isolators:
1. Spring Isolators:
 - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
 3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance.
- E. Restrained Closed Spring Isolators:
1. Spring Isolators:
 - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
 3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance and limit stops.
- F. Spring Hanger:
1. Spring Isolators:
 - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.

3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators rubber hanger with threaded insert.
 4. Misalignment: Capable of 20 degree hanger rod misalignment.
- G. Neoprene Pad Isolators:
1. Rubber or neoprene-waffle pads.
 - a. 30 durometer.
 - b. Minimum 1/2 inch thick.
 - c. Maximum loading 40 psi.
 - d. Height of ribs: not to exceed 0.7 times width.
 2. Configuration: Single layer.
- H. Rubber Mount or Hanger: Molded rubber designed for 0.5 inches deflection with threaded insert.
- I. Glass Fiber Pads: Neoprene jacketed pre-compressed molded glass fiber.
- J. Seismic Snubbers:
1. Type: Non-directional and double acting unit consisting of interlocking steel members restrained by neoprene elements.
 2. Neoprene Elements: Replaceable, minimum of 0.75 inch thick.
 3. Capacity: 4 times load assigned to mount groupings at 0.4 inch deflection.
 4. Attachment Points and Fasteners: Capable of withstanding 3 times rated load capacity of seismic snubber.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify equipment and piping is installed before work in this section is started.

3.2 INSTALLATION

- A. Bases:
 1. Set steel bases for 1 inch clearance between housekeeping pad and base.
 2. Set concrete inertia bases for 2 inch clearance between housekeeping pad and base.
- B. Adjust equipment level.
- C. Install spring hangers without binding.
- D. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

- E. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
- F. Provide resiliently mounted equipment and piping with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.05 inch maximum clearance. Provide other snubbers with clearance between 0.15 inch and 0.25 inch.
- G. Support piping connections to isolated equipment resiliently to nearest flexible pipe connector. as follows:
 - 1. Up to 4 inch Diameter: First three points of support.
 - 2. 5 to 8 inch Diameter: First four points of support.
 - 3. 10 inch Diameter and Over: First six points of support.
 - 4. Select three hangers closest to vibration source for minimum 1.0 inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch static deflection or 1/2 static deflection of isolated equipment.

3.3 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect isolated equipment after installation and submit report. Include static deflections.
- C. After start-up, final corrections and balancing of systems take octave band sound measurements over full audio frequency range in areas adjacent to plumbing equipment rooms, and pipe shafts, and other critical locations. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements. Submit complete report of test results including sound curves.
- D. Furnish services of testing agency to take noise measurement. Use meters meeting requirements of ANSI S1.4.

3.4 SCHEDULES

- A. Pipe Isolation Schedule:

Pipe Size Inch	Isolated Distance from Equipment
1	120 diameters
2	90 diameters
3	80 diameters
4	75 diameters
6	60 diameters
8	60 diameters

10	54 diameters
12	50 diameters

3.5 VIBRATION ISOLATION AND SEISMIC RESTRAINT INSTALLATION

- A. Horizontal pipe isolation: The first three pipe hangers in the main lines near the mechanical equipment shall be as described in specification 11. Specification 11 hangers must also be used in all transverse braced isolated locations. Brace hanger rods with SRC clamps specification 14. Horizontal runs in all other locations throughout the building shall be isolated by hangers as described in specification 10. Floor supported piping shall rest on isolators as described in specification 6. Heat exchanger's and expansion tanks are considered part of the piping run. The first three isolators from the isolated equipment will have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment located in basements and hangs from ceilings under occupied spaces the first three hangers shall have 0.75" (19mm) deflection for pipe sizes up to and including 3" (75mm), 1 1/2" (38mm) deflection for pipe sizes up to and including 6" (150mm), and 2 1/2" (64mm) deflection thereafter. Hangers shall be located as close to the overhead structure as practical. Where piping connects to mechanical equipment install specification 23 expansion joints or specification 24 stainless hoses if 23 is not suitable for the service.
- B. Riser isolation: Risers shall be suspended from specification 10 hangers or supported by specification 5 mountings, anchored with specification 25 anchors, and guided with specification 26 sliding guides. Steel springs shall be a minimum of 0.75" (19mm) except in those expansion locations where additional deflection is required to limit load changes to $\pm 25\%$ of the initial load. Submittals must include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and seismic loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.
- C. Seismic Restraint of Piping
1. Seismically restrain all piping listed as a, b or c below. Use specification 12 cables if isolated. Specification 12 or 13 restraints may be used on unisolated piping.
 - a. Piping located in boiler rooms, mechanical equipment rooms, and refrigeration equipment rooms that is 1 1/4" (32mm) I.D. and larger.
 - b. All other piping 2 1/2" (64mm) diameter and larger.
 2. Transverse piping restraints shall be at 40' (12m) maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
 3. Longitudinal restraints shall be at 80' (24m) maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
 4. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.
 5. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is

installed within 24" (600mm) of the elbow or TEE or combined stresses are within allowable limits at longer distances.

6. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
7. Branch lines may not be used to restrain main lines.
8. Cast iron pipe of all types, glass pipe and any other pipes joined with a four band shield and clamp assembly in Zones 2B, 3 and 4 shall be braced as in sections 3.2.D.2 and 3. For Zones 0, 1 and 2A, 2 band clamps may be used with reduced spacings of 1/2 of those listed in sections 3.2.D.2 and 3.

D. Vibration Isolation and Seismic Restraint of Fire Suppression Equipment

1. All equipment shall be vibration isolated and seismically restrained as per the schedules in part 3.5 of this specification.
2. Equipment mounted on housekeeping pads: Pads shall be properly doweled or expansion shielded to deck to meet acceleration criteria.
3. Requirements for installation on concrete inertia bases shall be as follows:
 - a. Minimum operating clearance between concrete inertia and base and housekeeping pad or floor shall be 2".
 - b. The equipment structural steel or concrete inertia base shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the machine or isolators.
 - c. The isolators shall be installed without raising the machine and frame assembly.
 - d. After the entire installation is complete and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. When all isolators are properly adjusted, the blocks or shims shall be barely free and shall be removed.
 - e. Install equipment with flexibility in wiring connection.
 - f. Verify that all installed isolator and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to flexibly limit start-up equipment lateral motion to 1/4".
 - g. Prior to start-up, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base, isolators, or seismic restraints.

3.6 SEISMIC RESTRAINT EXCLUSIONS

- A. General: All fire suppression, mechanical and electrical components and systems that are considered exempt from the requirement for seismic restraint, in accordance with The International Building Code – 2012, Section.16 and all related State of Connecticut Supplements, shall not require seismic restraint.
- B. Piping
 1. Piping in boiler and mechanical rooms less than 1 1/4" (32mm) inside diameter.
 2. All other piping less than 2 1/2" (64mm) inside diameter.
 3. All piping suspended by individual hangers 12" (300mm) or less as measured from the top of the pipe to the bottom of the support where the hanger is attached. However, if the 12" (300mm) limit is exceeded by any hanger in the run, seismic bracing is required for the run.

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4. The 12" (300mm) exemption applies for trapeze supported systems if the top of each item supported by the trapeze qualifies.

3.7 INSPECTION

- A. Examine systems under provisions of Division 1.
- B. On completion of installation of all vibration isolation devices herein specified, the local representative shall inspect the completed system and report in writing any installation error, improperly elected isolation devices, or other faults in the system that could affect the performance of the system. Contractor shall submit a report to the Owner, including the manufacturers representatives' final report, indicating all isolation reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.

END OF SECTION

SECTION 210800 - COMMISSIONING OF FIRE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. OPR and BoD documentation are included by reference for information only.

1.2 SUMMARY

- A. This Section includes general requirements that apply to implementation of the commissioning process to the fire suppression systems, assemblies, and components.
- B. Related Sections include the following:
 - 1. Division 01 Section 019113 "General Commissioning Requirements" for general commissioning process activities.
 - 2. Division 01 Section 013300 "Submittal Procedures" for submitting procedures
 - 3. Division 01 Section 017823 "Operation and Maintenance Data" for the operation and maintenance data
 - 4. Division 01 Section 017900 "Demonstration and Training" for training and demonstration requirements
 - 5. Division 21 Fire Suppression
 - 6. Division 28 Electronic Safety and Security for fire alarm interaction and requirements

1.3 DEFINITIONS

- A. Commissioning Plan: A document, prepared by CxA, that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. Quality Assurance: A program for the systematic monitoring and evaluation of the various aspects of a system, assembly, or component to ensure that standards of quality are being met. This is the responsibility of the CxA.
- D. Quality Control: A system for ensuring the maintenance of proper standards in systems, assemblies, and components. This is the responsibility of the Contractor.
- E. Official: State or Local official having jurisdiction over the conveying systems

- F. Systems, Assemblies, Equipment, and Components: Where these terms are used together or separately, they shall mean “as-built” systems, assemblies, equipment, and components.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION CHECKLISTS

- A. The CxA shall provide Construction Checklists to the Contractors for execution that will indicate expected Quality Control features required for a highest-quality installation. The contractor shall complete the checklists as construction progresses and return them to the CxA as indicated in Section 01 9113 General Commissioning Requirements.
- B. Checklists for this section will include:
1. Wet-pipe sprinkler system and equipment
 2. Fire-suppression standpipes and accessories
- C. A sample installation checklist is included to show the typical scope and rigor of the process.

3.2 PREREQUISITES TO TESTING

- A. Prior to the testing of these systems or assemblies, the Contractor shall certify that:
1. The system or assembly is completely installed, functional, and documented.
 2. Work performed by other trades, but essential for this system or assembly’s operation, is complete (e.g., electrical components are wired and power is provided).
 3. All contractor-performed start-up procedures and Pre-Functional Tests are complete and documented.
 4. The system or assembly is ready for the Owner to take beneficial use.

3.3 SYSTEM OR ASSEMBLY TEST REQUIREMENTS

- A. The CxA will provide Functional Performance Test procedures to the Contractor for execution for the following specific systems, assemblies, and components:
1. Wet-pipe sprinkler systems
 2. Fire-suppression standpipes
 3. Fire alarm system interactions
- B. Acceptance criteria and test details will be in accordance with the related sections including the following:

1. Division 01 Section 019113 “General Commissioning Requirements” for general commissioning process activities.
2. Division 21 Fire Suppression
3. Division 28 Electronic Safety and Security
4. Division 01 Section 017823 “Operation and Maintenance Data” for the operation and maintenance data
5. Division 01 Section 017900 “Demonstration and Training” for training and demonstration requirements

C. A sample functional performance test is included to show the typical scope and rigor of the process.

3.4 TEST REPORTS

A. Provide copies of all reports required in the listed reference sections (see Section 1.2 SUMMARY above for the sections) for review.

3.5 SAMPLE FORMS

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**SAMPLE
Installation Checklist
Sprinkler Piping- Second Floor**

Schedule ID# from drawings: Fire Protection
Reference Specification: 15300
Reference Drawing: F-101
Location: Second Floor

Model Verification

	Specified	Submitted	Installed
Manufacturer			
Model Number			
Pumps: QTY/HP			
Capacity			
Voltage/Ph			

Installation Checks

ID	Description	Pass/Fail	Comments
1	Verify sprinkler piping is run level.	<input type="checkbox"/> <input type="checkbox"/>	
2	Verify sprinkler piping is schedule 40 black steel piping and has been provided with the appropriate fittings: a) Piping 1" to 2" Threaded Fittings b) Piping 2-1/2" and greater- Victaulic Fittings	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	
3	Verify piping has been properly supported.	<input type="checkbox"/> <input type="checkbox"/>	
4	Verify that the "Wet" system piping is not run in MDF Room 225 and PC Lab 223.	<input type="checkbox"/> <input type="checkbox"/>	
5	Verify that standpipe and hose valve cabinets are installed at each stair landing at 48" A.F.F.	<input type="checkbox"/> <input type="checkbox"/>	
6	Verify that floor zone control valve assembly and drain piping have been installed in Stair #2.	<input type="checkbox"/> <input type="checkbox"/>	
7	Verify piping has been provided with seismic bracing where required.	<input type="checkbox"/> <input type="checkbox"/>	
8	Verify that auxiliary drains have been provided for all trapped piping.	<input type="checkbox"/> <input type="checkbox"/>	
9	Verify piping has been clearly identified with the proper color coding.	<input type="checkbox"/> <input type="checkbox"/>	

Approvals (only one required)

	Name (printed neatly)	Signature	Date
Contractor/Manuf. Rep.			
Engineer			
Construction Administrator			
Commissioning Agent			

**Sample Functional Performance Test
Fire Pump**

1. Participants

Name/Representing	Participation (Testing, Witness, etc)
/	
/	
/	

Party filling out this form _____

Date of test _____

2. Prerequisite Checklist

(Y/N) An as-built version of the controls submittal has been provided.

(Y/N) A start up service report has been provided by a factory-authorized service representative.

(Y/N) The controls contractor has certified that their internal commissioning is complete and the project is ready for third-party verification. CC initials: _____. Date:_____.

(Y/N) The general contractor has certified that the construction is substantially complete and ready for third-party verification. GC initials: _____. Date:_____.

(Y/N) Record all values for setpoints, control parameters, limits, delays, lockouts, schedules, etc. that were changed to accommodate testing:

Parameter	Pre-Test Values	Returned to Pre-Test Values <input type="checkbox"/>
Fire Pump Status		<input type="checkbox"/>
Fire Pump Inlet Valve Status		<input type="checkbox"/>
Fire Pump Discharge Valve #1 Status		<input type="checkbox"/>
Fire Pump Discharge Valve #2 Status		<input type="checkbox"/>
Fire Pump Bypass Line Valve #1 Status		<input type="checkbox"/>
Fire Pump Bypass Line Valve #2 Status		<input type="checkbox"/>

Parameter	Pre-Test Values	Returned to Pre-Test Values <input type="checkbox"/>
Jockey Pump Status		<input type="checkbox"/>
Jockey Pump Inlet Side Valve Status		<input type="checkbox"/>
Wet Alarm Check Valve Status		<input type="checkbox"/>
Fire Pump Test Header Valve Status		<input type="checkbox"/>
Fire Dept Connection Valve Status		<input type="checkbox"/>
Low Pressure Alarm		<input type="checkbox"/>

3. Sensor Calibration Checks. The sensors listed below are to be checked for calibration and adequate location.

Sensor	Location OK ¹	BAS Value	Measured Value	Pass Y/N
	Y / N			Y / N
	Y / N			Y / N
	Y / N			Y / N
	Y / N			Y / N

Sensor	Location OK ¹	BAS Value	Measured Value	Pass Y/N
	Y / N			Y / N
	Y / N			Y / N
	Y / N			Y / N
	Y / N			Y / N

¹ Sensor location is appropriate and away from causes of erratic operation.

Comments:

4. Device Calibration Checks. The actuators or devices listed below are to be checked for proper operation and/or calibration.

Device or Actuator	Procedure / State	BAS Value	Site Observation	Pass Y/N
Fire Pump Inlet Valve Status	1. On			Y / N
	2. Off			Y / N
Fire Pump Discharge Valve #1 Tamper Switch Status	1. Alarm			Y / N
	2. Normal			Y / N
Fire Pump Discharge Valve #2 Tamper Switch Status	1. Open			Y / N
	2. Closed			Y / N
Fire Pump Bypass Line Valve #1 Tamper Switch Status	1. Open			Y / N
	2. Closed			Y / N
Fire Pump Bypass Line Valve #2 Tamper Switch Status	1. Open			Y / N
	2. Closed			Y / N
Jockey Pump Inlet Side Valve Tamper Switch Status	1. Open			Y / N
	2. Closed			Y / N
Fire Pump Test Header Valve Tamper Switch Status	1. Open			Y / N
	2. Closed			Y / N
Fire Dept Connection Valve Tamper Switch Status	1. Open			Y / N
	2. Closed			Y / N

5. Notes

6. Functional Testing Record

Seq. ID	Mode ID	Test Procedure (including special conditions)	Expected Response	Pass Y/N	Notes
1	JOCKEY PUMP AUTOMATIC START	<ol style="list-style-type: none"> 1. With jockey pump in "AUTO" position lower sprinkler pressure by opening system drain valve. 2. Close system drain valve. 	<ol style="list-style-type: none"> 1. The jockey pump will start when the system pressure reaches the pre-set turn on setting. 2. The pump runs until the system pressure reaches the shut off setting at which time the jockey pump will stop. 	Y / N	
2	FIRE PUMP AUTOMATIC START	<ol style="list-style-type: none"> 1. With the jockey pump in the "ON" position, open the "Alarm Test Module" valve to reduce system pressure. 2. Close the "Alarm Test Module" valve. 	<ol style="list-style-type: none"> 1. The Fire Pump will start when the system pressure reaches the pre-set fire pump "start" setting. 2. The system returns to the proper pressure. The fire pump runs for a predetermined time and shuts off at the end of that time period. 	Y / N	
3	FIRE PUMP RUNNING ON EMERGENCY GENERATOR	<ol style="list-style-type: none"> 1. If equipped, activate the Emergency Generator "RUN" switch. 2. With the emergency generator running and the jockey pump switch in the "OFF" position reduce the pressure in the sprinkler system by opening the Alarm Test Module valve. 3. Close test valve. 4. Return generator switch to "Normal" position. 	<ol style="list-style-type: none"> 1. Emergency generator starts. Fire pump is now fed from generator. 2. Fire pump runs. 3. Fire pump turns off after a predetermined time period. 4. Fire pump power is fed from normal power and Emer. Generator shuts off. 	Y / N	

-- END OF TEST --

END OF SECTION 210800

SECTION 211200 - FIRE-SUPPRESSION STANDPIPES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes entire standpipe system from fire department connection to fire hose connection.
- B. Related Sections:
 - 1. Section 21 05 00 - Common Work Results for Fire Suppression: Product and execution requirements for pipe, fittings, valves, hangers, supports, identification and painting for placement by this section.
 - 2. Section 21 05 16 – Expansion Fittings and Loops for Fire-Suppression Equipment.
 - 3. Section 21 05 48 - Vibration and Seismic Controls for Fire-Suppression Piping and Equipment: Product and installation requirements for vibration isolators used in piping systems.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. FM Global:
 - 1. FM - Approval Guide, Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.
- B. National Fire Protection Association:
 - 1. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Where the terms “authorities having jurisdiction” is used, within this Specification, it is intended to include the Insurance Underwriter and all regulatory agencies having vested interest in this project.
- C. Shop Drawings:
 - 1. Provide fire protections shop drawings drawn to a minimum scale of 1/4"=1'-0". Indicate pipe materials used, joining methods, supports, floor and wall penetration seals. Indicate installation, detailed pipe layout, weights, mounting and support details, components, accessories, sizes and piping connections.
 - 2. Provide hydraulic calculations in accordance with the requirements of NFPA 13.
 - 3. All standpipe drawings and calculations shall bear the seal of a Professional Engineer licensed in the State of Connecticut. Seal and signature shall not be copied and shall be provided as an original drawing and each calculation.
- D. Product Data: Provide data on valves and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- E. Manufacturer's Installation Instructions: Submit with product data.
- F. After successful review by the Engineer, submit standpipe layout shop drawings, product data, hydraulic calculations to authority having jurisdiction, Fire Marshall, and Owner's insurance underwriter for approval. Submit proof of approval to Architect/Engineer
- G. Grooved joint couplings and fittings shall be shown on shop drawings and product submittals and shall be specifically identified with the applicable Victaulic style or series designation.
- H. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and all code requirements
- I. Field Test Reports: Indicate compliance with specified performance.
- J. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:

1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of components and tag numbering.
- C. Operation and Maintenance Data: Submit servicing requirements and test schedule.

1.7 QUALITY ASSURANCE

- A. Workmanship and Qualifications: All materials and equipment shall be installed in accordance with NFPA and all applicable local codes and ordinances. The Sprinkler Contractor shall be state licensed to install standpipe systems. The Sprinkler Contractor shall make sure that all work and materials conform to the requirements set forth by this Specification. Fire protection equipment shall be installed to conform to NFPA as applicable, and devices used shall be listed and approved by Underwriters laboratories (UL) and/or Factory Mutual (FM).
- B. Codes and Standards: All work shall be equal or superior to that required by codes, regulations, ordinances, and laws imposed by the jurisdictional authorities, including those of the State of Connecticut, State Fire Marshall, local ordinances and OSHA. Nothing in the Specifications permit violations of such directives, and where conflict occurs, the directive shall govern, except where superior work is specified or indicated.
- C. In addition to complying with the above codes and regulations, comply with the requirements of the following:
 1. NFPA Standard 14.

2. State Building and Fire Codes.
 3. Local Jurisdictional Authorities.
- D. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
- E. Valves: Bear UL and/or FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.
- F. All items of similar class shall be the products of the same manufacturer. All valves, accessory items, etc., shall be from the same source.
- G. Maintain one copy of each document on site.
- H. High Performance Building Requirements:
1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

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

1.9 PRE-INSTALLATION MEETINGS

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

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Deliver and store products in shipping packaging until installation.
- C. Furnish cast iron and steel valves with temporary protective coating.

- D. All equipment, valves, gages and etc., shall be covered and protected during the execution of the work. All equipment and piping shall be protected from freezing. Labeling to remain in place.
- E. All unloading, hauling, and handling of materials shall be the responsibility of the Sprinkler Contractor.
- F. The Sprinkler Contractor can obtain information on available storage space on site from the Owner when making examination of the site

1.11 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for standpipes and hoses.

1.12 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two hose nozzles hoses.

PART 2 PRODUCTS

2.1 FIRE HOSE CABINETS

- A. Manufacturers:
 - 1. Crocker.
 - 2. Potter Roemer.
 - 3. Allenco.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Hose Cabinets:
 - 1. Style: Recessed mounted. Fire rated when installed in fire rated assemblies.
 - 2. Tub: 18 gage thick steel, prepared for pipe and accessory rough in.
 - 3. Door: 20 gage thick steel, with double strength glass full panel, with solid door panel, with 1/4 inch thick wired glass full panel, hinged, positive latch device.
 - 4. Finish: Enameled, color as selected.
- C. Hose Rack: Steel with polished chrome finish; swivel stationary type with pins and water stop.

2.2 VALVES

- A. Manufacturers:
 - 1. Kennedy.
 - 2. Fairbanks.
 - 3. Stockham.
 - 4. Victaulic.
 - 5. Nibco.
 - 6.
 - 7. Substitutions: Section 01 60 00 - Product Requirements.
- B. Hose Station Valve: Angle type, brass with chrome plated finish, 2-1/2 inch nominal size with automatic ball drip.
- C. Hose Connection Valve: Angle type; brass with chrome plated finish; 2-1/2 inch size, thread to match fire department hardware, 300 psi working pressure, with threaded cap and chain of chrome plated finish.
- D. Hose Connection Valve Cabinets:
 - 1. Style: Recessed mounted. Fire rated when installed in fire rated assemblies.
 - 2. Tub: 1 gage thick steel, prepared for pipe and accessory rough in.
 - 3. Door: 12 gage thick steel, flush, glazed, with 1/4 inch thick wired glass full panel, hinged, positive latch device.
 - 4. Finish: Enameled, color as selected.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify blocking in place for cabinet installation.

3.2 INSTALLATION

- A. Install in accordance with NFPA 14, IBC.
- B. Install cabinets plumb and level. Secure to adjacent surfaces. Establish top of cabinet (inside horizontal) surface 60 inches above finished floor.
- C. Install hose station valve in cabinet at 60 inches above floor. Install hose-connection valve under hose station valve and not closer than 4 inches from side or bottom of cabinet.
- D. Hose cabinets installed within rated walls, partitions, or assemblies shall include the same level or rating.

3.3 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Hydrostatically test entire system in accordance with NFPA 14.
- C. Require test be witnessed by Fire Marshall. Authority having jurisdiction. Owner's insurance underwriter. Architect/Engineer.

3.4 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Flush entire system of foreign matter.

END OF SECTION

SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes wet-pipe sprinkler system, system design, installation, and certification.
- B. Related Sections:
 - 1. Section 21 05 00 - Common Work Results for Fire Suppression: Product and execution requirements for pipe, fittings, valves, hangers, supports, identification and painting for placement by this section.
 - 2. Section 21 05 16 – Expansion Fittings and Loops for Fire-Suppression Equipment.
 - 3. Section 21 05 48 - Vibration and Seismic Controls for Fire-Suppression Piping and Equipment: Product and installation requirements for vibration isolators used in piping systems.
 - 4. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. National Fire Protection Association:
 - 1. NFPA 13 - Installation of Sprinkler Systems 2010 Edition.
 - 2. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances 2010 Edition..
- B. Factory Mutual:
 - 1. FM - Factory Mutual Approval Guide.
- C. Underwriters Laboratory:
 - 1. UL - Fire Resistance Directory.

1.5 SYSTEM DESCRIPTION

- A. Provide a wet pipe system hydraulically designed in accordance with NFPA 13 and all requirements of the local Authority Having Jurisdiction.
- B. System to provide coverage for entire building.
- C. Provide system to NFPA Standard occupancy requirements as noted on the drawings.
- D. Hydraulic data and water supply information shall be as noted on the drawings.
- E. Interface system with building fire alarm system.
- F. The sprinkler locations and piping arrangements indicated on the contract documents are diagrammatic. It is the responsibility of the contractor to fully coordinate sprinkler and piping locations with all other trades.
- G. Sprinkler locations indicated on the Contract Documents indicate sprinkler coverage utilizing standard coverage sprinklers maximum 225 square feet per sprinkler for light hazard and 130 square feet per sprinkler for ordinary hazard. Extended coverage sprinklers shall not be installed in any locations unless specifically indicated on the Contract Document drawings.
- H. All sprinklers installed in a light hazard classification occupancy shall be a listed quick response type.
- I. Provide fire department connections as indicated on Drawings.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Where the terms “authorities having jurisdiction” is used, within this Specification, it is intended to include the Insurance Underwriter and all regulatory agencies having vested interest in this project.

- C. Shop Drawings:
1. Provide fire protections shop drawings drawn to a minimum scale of $\frac{1}{4}''=1'-0''$. Indicate pipe materials used, joining methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
 2. Provide hydraulic calculations, detailed pipe layout, hangers and supports, components and accessories. Indicate system controls.
 3. All sprinkler drawings and calculations shall bear the seal of a Professional Engineer licensed in the State of Connecticut. Seal and signature shall not be copied and shall be provided as an original drawing and each calculation.
 4. Sprinklers shall be as shown on drawings and submittals and shall be specifically identified with the applicable style or series designation as published in the appropriate agency listing or approval. Trade names or other abbreviated designations are not permitted.
- D. Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- E. After successful review by the Engineer, submit sprinkler layout shop drawings, product data, and hydraulic calculations to authority having jurisdiction, Fire Marshall, and Owner's insurance underwriter for approval. Submit proof of approval to Architect/Engineer.
- F. Grooved joint couplings and fittings shall be shown on shop drawings and product submittals and shall be specifically identified with the applicable Victaulic style or series designation.
- G. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and all code requirements.
- H. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.

- I. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.7 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.
- C. Operation and Maintenance Data: Submit components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

1.8 QUALITY ASSURANCE

- A. Workmanship and Qualifications: All materials and equipment shall be installed in accordance with NFPA and all applicable local codes and ordinances. The Sprinkler Contractor shall be state licensed to install sprinkler systems. The Sprinkler Contractor shall make sure that all work and materials conform to the requirements set forth by this Specification. Fire protection equipment shall be installed to conform to NFPA as applicable, and devices used shall be listed and approved by Underwriters laboratories (UL) and/or Factory Mutual (FM).
- B. Codes and Standards: All work shall be equal or superior to that required by codes, regulations, ordinances, and laws imposed by the jurisdictional authorities, including those of the State of Connecticut, State Fire Marshall, local ordinances and OSHA. Nothing in the Specifications permit violations of such directives, and where conflict occurs, the directive shall govern, except where superior work is specified or indicated.
- C. In addition to complying with the above codes and regulations, comply with the requirements of the following:
 - 1. NFPA Standard 13 2010 Edition.
 - 2. NFPA Standard 24 2010 Edition.
 - 3. 2016 Connecticut State Building and Connecticut State Fire Codes.
 - 4. Local Jurisdictional Authorities.
- D. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
- E. Valves: Bear UL and/or FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.

- F. All items of similar class shall be the products of the same manufacturer. All valves, accessory items, etc., shall be from the same source.
- G. Maintain one copy of each applicable NFPA standard on site.
- H. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- I. Installer: Company specializing in performing work of this Section with minimum five years experience.
- J. Design sprinkler system under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State where the project is located.
- K. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.9 QUALIFICATIONS

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

1.10 PRE-INSTALLATION MEETINGS

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

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Deliver and store products in shipping containers, with labeling in place.
- C. All equipment, valves, gages and etc., shall be covered and protected during the execution of the work. All equipment and piping shall be protected from freezing. Labeling to remain in place.

- D. All unloading, hauling, and handling of materials shall be the responsibility of the Sprinkler Contractor.
- E. The Sprinkler Contractor can obtain information on available storage space on site from the Owner when making examination of the site.

1.12 WARRANTY

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

1.13 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish extra sprinklers under provisions of NFPA 13.
- C. Furnish suitable wrenches for each sprinkler type.
- D. Provide metal storage cabinet adjacent to the sprinkler riser.

PART 2 PRODUCTS

2.1 SPRINKLERS

- A. Manufacturers:
 - 1. Viking.
 - 2. Tyco.
 - 3. Victaulic.
 - 4. Substitutions: Section 01 60 00 - Product Requirements
- B. All sprinklers shall be adjustable, glass bulb, automatic sprinklers with ½ inch orifice and 5.6 K-factor unless noted otherwise. Type of sprinkler head shall be as indicated on the plans and in accordance with the following.
- C. Sprinkler bodies shall be die-cast brass, with hex shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation.
- D. Unless noted otherwise, ordinary temperature rated sprinkler heads shall be used throughout the building.
- E. Where sprinklers will be installed in close proximity to heat sources and special locations, as identified in NFPA 13, temperature ratings shall be in accordance with the requirements of NFPA 13

- F. Where plans call for extended coverage sprinkler heads coordinate coverage requirements with required pressure and K-factor.
- G. Spare Sprinklers: The Sprinkler Contractor shall furnish spare automatic sprinklers in accordance with the requirements of NFPA for stock of extra sprinklers. The sprinklers shall be packed in a suitable container and shall be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed. The Sprinkler Contractor shall furnish no less than two special sprinkler wrenches, or at least one wrench for each container or sprinkler box, whichever is greater.
- H. In areas where sprinkler heads are subject to physical damage, provide sprinkler guard assembly over head, finish to match sprinkler finish. This shall include but not limited to the following locations.
1. Heads in elevator shafts.
 2. Heads under lower rakes of stairways.
 3. Heads in electrical rooms, boiler rooms and other mechanical rooms.
 4. Heads installed 7'-0" or less above finished floors.
 5. Heads in gymnasium/fitness center areas.
- I. Sprinklers shall be in accordance with the following table:

Sprinkler Type	Sprinkler Finish	Manufacturer/Model Number
Quick-response Pendant and Upright Type Sprinklers	Chrome plated finish with chrome plated, adjustable, semi-recessed escutcheon.	Victaulic Model V2708 and V2704.
Quick-response Sidewall Type Sprinklers	Chrome plated finish with chrome plated, adjustable, semi-recessed escutcheon.	Victaulic Model V2710.
Quick-response Concealed Type Sprinklers	Brass finish with factory painted white cover plate.	Victaulic Model V3802.
Window type sprinklers (water curtain)	Chrome plated finish, pendent type vertical sidewall style.	Tyco model WS, 5.6K-factor
Extended Coverage, Sidewall Type Sprinklers	Chrome plated finish with chrome plated, adjustable, semi-recessed escutcheon.	Victaulic Model V3415.
Dry Pendant Type Sprinklers	Chrome plated finish with chrome plated, adjustable, semi-recessed escutcheon.	Victaulic Model V3607.
Dry Horizontal Sidewall Type Sprinklers	Chrome plated finish with chrome plated, adjustable, semi-recessed escutcheon.	Victaulic Model V3609.
Quick-response Dry Pendant Type Sprinklers	Chrome plated finish with chrome plated, adjustable, semi-recessed escutcheon.	Victaulic Model V3608.
Quick-response Dry	Chrome plated finish with	Victaulic Model V3610.

Horizontal Sidewall Type Sprinklers	chrome plated, adjustable, semi-recessed escutcheon.	
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2.2 ALARM CHECK VALVES

A. Manufacturers:

1. Viking.
2. Tyco.
3. Victaulic.
4. Grinnell Corp.
5. Reliable Sprinkler Corp.
6. Substitutions: Section 01 60 00 - Product Requirements.

B. Wet Pipe Alarm Valve:

1. Check type valve with Nitrile seat o-ring aluminum bronze clapper with EPDM seal to automatically actuate electrically and hydraulically operated alarms, with pressure retard chamber and variable pressure trim. Valve internal components shall be replaceable without removing valve from the installed position. Valve shall be Series 751 as manufactured by Victaulic Co or engineer approved equal.
2. Provide retard chamber as part of wet alarm valve trim to allow for pressure fluctuations. Retard chamber shall be Victaulic Series 752 or engineer approved equal by manufacturers listed above. Provide all other trim as recommended by the manufacturer.
3. Alarm check valve assembly shall allow discharge of one or more sprinklers to activate electric and hydraulic alarms.

C. Dry Pipe Alarm Valve:

1. Latching differential type valve with air plate assembly with differential air to water seat design. Ductile iron, aluminum bronze clapper to automatically actuate electrically and hydraulically operated alarms. Minimum required air pressure is 13 psi. Maximum water pressure rating is 300 psi. Valve internal components shall be replaceable without removing valve from the installed position. Valve shall be externally resettable. Valve shall have groove by groove end connections for vertical installation only and shall be supplied completely pre-trimmed as a Vic-Quick riser with shut-off valve Series 776 low pressure actuator. Valve shall be FireLock NXT Series 768 as manufactured by Victaulic Co. or engineer approved equal.
2. Provide dry pipe valve riser with individual high/low pressure alarm.
3. Provide dry pipe valve riser with Victaulic Series 746-LPA accelerator.
4. Provide dry pipe valve riser with Victaulic Series 757P air pressure maintenance device.

2.3 AIR COMPRESSOR

A. Manufacturers:

1. Ingersoll-Rand.
2. Gast.

3. Emglo.
 4. General Air Products.
 5. Substitutions: Section 01 60 00 - Product Requirements Not Permitted.
- B. Single unit, electric motor driven, ASME rated horizontal receiver tank, air pressure operated electric switch, motor, motor starter with automatic mechanical alternator, safety valves, check valves, automatic tank drain, muffler-filter, belt guard, and controls.
- C. Performance: 660 scfm at 18 psi continuous operating pressure. Contractor shall verify capacity of air compressor when Contractor's hydraulic calculations are completed.
- D. Motor: 1/2 hp, 120 volt, single phase, 60 hz.
- E. High/Low Pressure Alarm: Provide a high/low pressure alarm for supervision of air pressure with contacts for remote alarm signal. High/low pressure alarm shall be Potter Electric Signal Company, Model No. PS40A.
- F. Furnish compressed air supply into dry system with Viking Dehydrators model 16854 or approved equal.
- G. Disconnect switch: Factory mounted on equipment.

2.4 PIPING SPECIALTIES

- A. Manufacturers:
1. Potter.
 2. Potter-Roemer.
 3. System Sensor.
 4. Victaulic.
 5. Viking.
- B. Electric Alarm: Electrically operated red enameled chrome plated gong with pressure alarm switch, 120 volt with weatherproof back box.
- C. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two form C contacts; rated 10 amp at 120 volt.
- D. Valve Tamper Supervisory Switch: Two form C contacts; rated 10 amp at 120 volt. UL listed and FM approved. Up to 2" – Potter Model PCVS-1. Over 2" switch shall be Potter Model OSYSU-2.
- E. Pressure Switch: ½ inch male pressure connection to alarm valve riser and actuated by any flow of water in excess of one sprinkler. Maximum pressure rating 175 psi, weather-proof with tamper resistant screws, rated 10 amps at 120 volt.
- F. Pressure Gage: Rated for 300 psi use, 3-1/2" in diameter.

2.5 FIRE DEPARTMENT CONNECTION

- A. Fire department connection shall be 4" storz, polished brass, type building mounted connection. Provide with polished brass identification plate.
- B. Clapper design shall allow for one or both inlets to be pressurized during operation.
- C. Provide polished brass cast aluminum alloy caps and chains for protection of the inlet.
- D. The fire department connection shall be constructed of cast brass with brass clapper, brass swivel couplings and a brass hinge pin. The words "AUTO SPKR" and "F.D. Conn" shall be cast in raised letters on the body.
- E. Fire department connection threads shall match the local fire departments standard.
- F. Drain: 3/4 inch automatic drip, install at low point after check valve, pipe to building exterior.
- G. Label: "Manual Standpipe/ Wet Sprinkler Sprinkler" - Fire Department Connection".
- H. Provide a 90-degree elbow with drain connection at each fire department connection to allow for drainage in areas exposed to the building exterior to prevent freezing. Elbow shall be Victaulic #10-DR.

PART 3 EXECUTION

3.1 PREPERATION

- A. Coordinate work of this Section with other affected work.
- B. Prepare piping connections to equipment with grooved joint couplings, flanges, or unions.

3.2 INSTALLATION

- A. Install equipment in accordance with manufacturer's instructions.
- B. Install fire protection systems in accordance with NFPA 13 for sprinkler systems, and NFPA 24 for service mains.
- C. The Contractor shall provide a complete and fully code compliant fire suppression system throughout the entire building.
- D. The Contractor shall notify the owner's representative before impairing any fire protection equipment.
- E. The Contractor shall maintain a clean and orderly site during the installation of the sprinkler system. Materials shall not be stored in the halls or other public areas.

- F. Cutting, welding and other hot work shall not be permitted without permission from the building owner. Contractor shall provide a fire watch for one hour after all welding
- G. The required tests shall be witnessed by the Fire Marshall, authority having jurisdiction, Owner's insurance underwriter and Architect/Engineer.
- H. Provide backflow preventer assembly Double check valve assembly at with detector check assembly sprinkler system water source connection. Install a drain line from the air gap fitting and terminate at the nearest floor drain. The backflow preventer shall be installed at a minimum height to allow installation of the air gap fitting, but shall not be installed at more than 5'0" above finished floor for maintenance.
- I. Locate fire department connection with sufficient clearance from walls, obstructions, etc., to allow full swing of fire department wrench handle. Coordinate the exact location of the fire department connection with the local fire officials. Installation shall conform to the local fire official's requirements.
- J. Installation of Alarm Valves: Install a drain line from the drain connection to the nearest floor drain. Install a test line from the test connection to the exterior of the building. Provide a splash block. Provide gate valves at each line. Minimum alarm valve riser shall be 4-inch.
- K. Locate outside alarm bell on building wall.
- L. Center heads in two directions in ceiling tile and provide piping offsets as required. one direction only in ceiling tile with location in other direction variable, dependent upon spacing and coordination with ceiling elements.
- M. Where ceilings, ceiling features or construction techniques permit the passage of heat from one plane or elevation to another, the contractor shall provide sprinklers both at the lower ceiling level and above the lower ceiling or feature level or plane. Refer to architectural drawings for ceiling types and locations.
- N. Sprinkler Bulb protector must remain in place until the sprinkler is completely installed. Remove the bulb protector by hand after installation and before the system is placed in service. (Do not use any tools to remove the bulb protector.)
- O. Do not install sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs.
- P. Provide sprinklers below all stairs, as required in NFPA 13.
- Q. Coordinate flow switches, tamper switches, and all other sprinkler devices with the fire alarm system.
- R. Provide wire guards on sprinklers as indicated on drawings.
- S. Place pipe runs to minimize obstruction to other work.

- T. Install piping in concealed spaces above finished ceilings.
- U. Hydrostatically test entire system in accordance with the requirements of NFPA 13 (?).
- V. Require test be witnessed by Fire Marshall. Authority having jurisdiction. Owner's insurance underwriter. Architect/Engineer.

3.3 INTERFACE WITH OTHER PRODUCTS

- A. Verify signal devices are installed and connected to fire alarm system.

3.4 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Flush entire piping system of foreign matter.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

- A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.
- B. Apply masking tape or paper cover to protect concealed sprinklers, cover plates, and sprinkler escutcheons not receiving field paint finish. Remove after painting. Replace painted sprinklers with new.

3.6 IDENTIFICATION

- A. Provide and apply signs to control, drain, test and alarm valves to identify their purpose and function. Provide and permanently attach hydraulic calculations data nameplate at the controlling valve for the sprinkler system. Provide lettering size and style from NFPA's suggested styles.

3.7 TESTING

- A. Section 21 05 00 - Common Work Results for Fire Suppression.

END OF SECTION

SECTION 213000 - FIRE PUMPS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes fire pump package, fire pump, electric jockey pump, controllers and accessories.
- B. Related Sections:
 - 1. Section 21 05 00 - Common Work Results for Fire Suppression: Product requirements for Fire piping placement by this section.
 - 2. Section 21 05 13 - Common Motor Requirements for Fire-Suppression Equipment: Product requirements for fire pump motors for placement by this section.
 - 3. Section 21 05 16 – Expansion Fittings and Loops for Fire-Suppression Piping.
 - 4. Section 21 05 48 - Vibration and Seismic Controls for Fire-Suppression Piping and Equipment: Product requirements for pump isolators for placement by this section.
 - 5. Section 21 12 00 – Fire-Suppression Standpipes.
 - 6. Section 21 13 13 – Wet Pipe Sprinkler Systems.
 - 7. Section 21 04 00 – General Conditions for Fire Suppression Trades.
 - 8. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for pumps specified by this section.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. FM Global:
 - 1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.
- B. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 2. NEMA MG 1 - Motors and Generators.
- C. National Fire Protection Association:
 - 1. NFPA 13 - Installation of Sprinkler Systems 2010 Edition.
 - 2. NFPA 14 - Installation of Standpipe and Hose Systems 2010 Edition.
 - 3. NFPA 20 - Standard for the Installation of Centrifugal Fire Pumps 2010 Edition.
 - 4. NFPA 24 - Private Fire Service Mains and their Appurtenances 2010 Edition
 - 5. NFPA 70 – National Electric Code.
- D. Underwriters Laboratories Inc.:
 - 1. UL 448 - Pumps for Fire Protection Service.
 - 2. UL 778 - Motor Operated Water Pumps.
 - 3. UL 1478 - Fire Pump Relief Valves.
 - 4. UL - Fire Protection Equipment Directory.

1.5 SYSTEM DESCRIPTION

- A. Electric motor horizontal, in-line, fire pump with jockey pump. System will include electric controllers and automatic transfer switch.
- B. Piping and equipment arrangements indicated on the contract documents are diagrammatic. It is the responsibility of the Contractor to fully coordinate piping and equipment locations with all other trades. The completed system and equipment shall comply with NFPA 20 and the Connecticut State Fire Code.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Where the terms “authority having jurisdiction” is used within this specification, it is intended to include the Insurance Underwriter and all regulatory agencies having vested interest in this project.

- C. Shop Drawings: Indicate detailed layout, general assembly, components and accessories, dimensions, weights, clearances, and methods of assembly.
- D. Product Data: Provide manufacturers literature including general assembly, pump curves showing performance characteristics with pump and system, operating point indicated, NPSH curve, controls, wiring diagrams, and service connections.
- E. Manufacturer's Installation Instructions: Indicate support details, connection requirements, and start-up instructions for fire pump system.
- F. Manufacturer's Certificate: Certify that fire pumps meet or exceed specified requirements at specified operating conditions. Submit summary and results of shop tests performed in accordance with NFPA 20.
- G. Field Reports: Indicate summary of results of hydrostatic test and field acceptance tests performed in accordance with NFPA 20.
- H. All drawings shall bear the seal of a Professional Engineer licensed in the State of Connecticut
- I. Hydraulic calculations verifying the required size of the fire pump.
- J. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.7 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of components and accessories.
- C. Operation Data: Include manufacturer's instructions, start-up data, trouble-shooting check lists, for pumps, drivers, and controllers.
- D. Maintenance Data: Include manufacturer's literature, cleaning procedures, replacement parts lists, and repair data for pumps, drivers and controllers.
- E. Record actual locations of equipment and deviations of piping from drawings. Indicate drain and test locations.

1.8 QUALITY ASSURANCE

- A. Workmanship and Qualifications: All materials and equipment shall be installed in accordance with NFPA Standard 20 and all applicable local codes and ordinances. The Sprinkler Contractor shall be state licensed to install sprinkler systems. The Sprinkler Contractor shall make sure that all work and materials conform to the requirements set forth by this Specification. Fire protection equipment shall be installed to conform to NFPA Standard 20 as applicable, and devices used shall be listed and approved by Underwriters laboratories (UL) and/or Factory Mutual (FM).
- B. Codes and Standards: All work shall be equal or superior to that required by codes, regulations, ordinances, and laws imposed by the jurisdictional authorities. Nothing in the Specifications permit violations of such directives, and where conflict occurs, the directive shall govern, except where superior work is specified or indicated.
- C. In addition to complying with the above codes and regulations, comply with the requirements of the following:
 - 1. NFPA Standard 20.
 - 2. State Building and Fire Codes.
 - 3. Local Jurisdictional Authorities.
- D. Maintain one copy of document on site.
- E. Installer: Company specializing in performing work of this Section with minimum five years experience.
- F. Design fire pump and related appurtenances under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State where the project is located.
- G. All items of similar class shall be the products of the same manufacturer. All valves, accessory items, etc., shall be from the same source.

- H. High Performance Building Requirements:
1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.
- C. Design fire pump system under direct supervision of Professional Engineer experienced in design of this Work and licensed in the State of Connecticut

1.10 PRE-INSTALLATION MEETINGS

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

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Accept fire pumps and components on site in factory packing. Inspect for damage. Comply with manufacturers rigging and installation instructions.
- C. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.
- D. Fire Pump and all equipment, valves, alarms, gages and etc., shall be covered and protected from physical damage including effects of weather, water, and construction debris during the execution of the work. All equipment shall be protected from freezing. Labeling to remain in place.
- E. All unloading, hauling, and handling of materials shall be the responsibility of the Sprinkler Contractor.

- F. The Sprinkler Contractor can obtain information on available storage space on site from the Owner when making examination of the site.

1.12 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.13 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish two year manufacturer warranty for fire pumps.

1.14 MAINTENANCE SERVICE

- A. Section 01 70 00 - Execution and Closeout Requirements: Maintenance service.
- B. Furnish service and maintenance of fire pump, driver, and controller for two years from Date of Substantial Completion.
- C. EXTRA MATERIALS
- D. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- E. Furnish one set of gaskets screens seals for each pump type and model supplied.

PART 2 PRODUCTS

2.1 FIRE PUMPS

- A. Manufacturers:
 - 1. Peerless.
 - 2. Armstrong.
 - 3. Aurora.
 - 4. ITT A-C.
- B. Substitutions: Section 01 60 00 - Product Requirements.
- C. Horizontal base mounted pumps
 - 1. One Armstrong, SERIES 4600F, Size 8x6x16F double suction horizontal split case fire pump listed by UL/FM having a capacity of 750 GPM for a pressure boost of 73.0 psi. Suction pressure 40.0 psi.
 - 2. Pump casing shall be of cast iron, axially split with a 15° angle that will minimize NPSH requirements and dimensions

3. Lower half shall contain suction and discharge nozzles. Suction and discharge connections shall be on the same elevation.
4. Top half and rotating element shall be removable without disturbing the piping.
5. Casing shall be fitted with replaceable bronze wearing rings. Impeller shall be bronze, double suction, enclosed type fully balanced and keyed to an alloy steel shaft. Shaft shall to be fitted with replaceable bronze sleeves. Shaft shall be mounted in two dust tight deep grooves, sealed, and permanently greased ball bearings.
6. Bearings shall be mounted in cartridge type housing so that they shall be replaceable without opening pump casing.
7. Bearings shall be easily removable by rotating bearing removal nut. No special tools or bearing puller are to be necessary.
8. Each stuffing box shall be fitted with a three piece bronze gland. Stuffing box shall be fitted with a stuffing box extension to facilitate the packing rings removal. Packing rings shall be removable without disturbing wetted parts or the pump bearings. Water seal recirculation lines made from non-corroding material shall be piped to pump volute.

D. Pump shall be Armstrong, **HSC-8x6x16F-100 hp**

2.2 ELECTRIC MOTOR:

- A. The fire pump shall be directly coupled through flexible coupling to a horizontal electric motor with a maximum HP of 100 hp at 1800 rpm, 460 Volts, 3 Phase, 60 Cycle. Motor shall be UL Listed for fire pump service, open drip proof, premium efficiency with 1.15 service factor.

2.3 FIRE PUMP ACCESSORIES AND FITTINGS

- A. Eccentric suction reducer and OS&Y gate or butterfly valve on suction side of pump.
- B. Concentric increaser and check valve in pump discharge and OS&Y gate or butterfly valve on system side of check valve.
- C. Fire pump bypass fitted with OS&Y gate or butterfly valves and check valve.
- D. Main relief-valve, UL 1478, and enclosed open type waste cone.
- E. One (1) combination suction gauge 3.5 inch dial type with 0.25 inch cock and lever handle.
- F. One (1) discharge gauge, 3.5 inch dial type, with 0.25 inch cock and lever handle.

- G. One (1) air release valve.
- H. Casing inch relief valve.
- I. Float operated 3/4 inch 1 inch automatic air release valve.
- J. Hose valve manifold with 2-1/2 inch hose gate valves with caps and chains.
- K. Flow metering system for closed loop testing.

2.4 ELECTRIC FIRE PUMP CONTROLLER

- A. The fire pump controller shall be Autotransformer, or approved equal
 - 1. The fire pump manufacturer shall furnish a UL/FM fire pump controller as manufactured by Tornatech. The controller shall be listed. The controller shall be Soft Start/Stop, model: Tornatech-GPS-GPU-480/100/3/60. The main fire Pump controller shall be housed in a STD – Standard Enclosure Rated Enclosure.
- B. Automatic Transfer Switch: Fire Pump Controller and Automatic Transfer Switch Controller Combination shall be approved by UL/FM. The automatic transfer switch and the fire pump controller shall each be mounted in a separate enclosure, mechanically attached to form one unit and provide for protected interlock wiring. The automatic transfer switch shall be capable of automatic power transfer from normal to emergency power source in case of failure of normal supply and automatically re-transfer after restoration of normal power

2.5 PRESSURE BOOSTER (JOCKEY) PUMP

- A. Manufacturers:
 - 1. Peerless
 - 2. Armstrong
 - 3. Aurora
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
 - a. Supply and install as shown on plans and specifications Armstrong Series 4700 Vertical Multi Stage Pump. The pump shall have continuing rising curve from minimum head to shut off condition and shall have a motor installed that is suitable for the full range of the published performance curve.
 - b. All hydraulic components shall be manufactured from Type 304 stainless steel with a AISI 304 SS casing. The 316L stainless steel shaft shall be fitted with Tungsten Carbide intermediary bearing(s). The mechanical seal shall be suitable for the full pressure and temperature range of the pump and shall be fitted with Carbon rotating face and Silicon Carbide stationary face. The base mounted pump shall be assembled in a vertical shaft configuration with the suction and discharge connections being in-line at the bottom. Suction and discharge connections shall have same size flanges drilled for ANSI 250 lb rating.

- c. The motor pedestal shall be fitted with an integral thrust bearing on pumps where the motor is greater than 5 HP. The thrust bearing must be connected to the adapter and shaft coupling in such a manner as to eliminate pump axial loads from the motor, allowing standard NEMA design motors to be used. Supply a standard NEMA design, 'C face' 2-pole squirrel cage induction type motor with NEMA Premium (12.12) efficiency and ODP enclosure. Coupling shall be protected by a guard.
- d. Jockey Pump Controller: The fire pump manufacturer shall furnish a jockey pump controller as manufactured by Tornatech. The Jockey Pump shall be controlled by an automatic Jockey Pump Controller model: Tornatech-JP3-480/15/3/60.

2.6 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Motors: In accordance with Section 21 05 13.
- B. Disconnect Switch: Factory mount in control panel on equipment.

2.7 ACCESSORIES

- A. The following items shall be provided by the fire pump manufacturer or installing contractor.
 - 1. Hose Valve System – 6”x 3 valves, National Hose Thread
 - 2. Main Relief Valve – 4” angled Part# D975050-010
 - 3. Flow Meter – Global Vision 6” 750-F, 6” Venturi Type with Flanged Connections
 - 4. Remote Alarm Panel – Tornatech Model APE
 - 5. Pump Test Header: Potter Roemer model # 5864 or equal.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer’s instructions.
- B. Install fire pump system in accordance with NFPA 20.
- C. Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.
- D. Install fire suppression piping in accordance with Section 21 05 00. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For base mounted pumps, provide supports under elbows on pump suction and discharge.
- E. Provide drains for bases and seals, piped to and discharging into floor drains.

- F. Install pump on vibration isolators. Refer to Section 21 05 48.
- G. Lubricate pumps before start-up.
- H. Check, align, and certify base mounted pumps by qualified millwright prior to start-up.
- I. The fire pump shall be hydrostatically tested to twice the working pressure, but in no case, less than 250 psig.
- J. The fire pump shall be given a complete factory performance test and characteristics curves prepared from the test results shall be furnished.
- K. Provide Fire Pump remote annunciator, locate at main entrance to building or adjacent to fire alarm control panel as directed by the local authority having jurisdiction.
- L. Provide full size bypass with check valve and OS&Y gate valve on fire pump suction side to fire pump discharge side.
- M. Provide test loop separate from bypass, provide with flow meter and butterfly valve.

3.2 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Perform flow test on entire system in accordance with NFPA 20.
- C. Schedule test to be witnessed by Fire Marshall, authority having jurisdiction, Owner's insurance underwriter, Architect/Engineer, Pump Manufacturer Representative,

3.3 DEMONSTRATION AND TRAINING

- A. Demonstrate automatic operation of system including verification of pressure switch set points.

END OF SECTION

SECTION 220400 - GENERAL CONDITIONS FOR PLUMBING TRADES

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. This section applies to certain sections of Division 26, "Electrical," and this section applies to all sections of Division 22, "Plumbing" of this project specification unless specified otherwise in the individual sections.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 DESCRIPTION

- A. The General Conditions and Supplementary General Conditions are a part of this Division and are to be considered a part of this Contract.
- B. Where items of the General Conditions and Supplementary General Conditions are repeated in other Sections of the Specifications, it is merely intended to qualify or to call particular attention to them. It is not intended that any other parts of the General Conditions and Supplementary General Conditions shall be assumed to be omitted if not

repeated therein. This Section applies equally and specifically to all Contractors supplying labor and/or equipment and/or materials as required under each Section of this Division. Where conflicts exist between the drawings and the specifications or between this section of the specifications and other sections, the more stringent or higher cost option shall apply.

1.5 INTENT

- A. It is the intent of the Specifications and Drawings to call for finished work, tested and ready for operation.
- B. Any apparatus, appliance, material or work not shown on drawings but mentioned in the specifications, or vice versa, or any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation as determined by good trade practice even if not particularly specified, shall be furnished, delivered and installed under their respective Divisions without any additional expense to the Owner.
- C. Minor details not usually shown or specified but necessary for proper installation and operation shall be included in the work as though they were hereinafter shown or specified.
- D. Work under each Section shall include giving written notice to the Owner and Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, it is mutually agreed that work under each Section includes the cost of all required items for the accepted, satisfactory functioning of the entire system without extra compensation.

1.6 DEFINITIONS

- A. Approve: The term "approved," where used in conjunction with the Engineer's action on the Contractor's submittals, applications, and requests, is limited to the Engineer's duties and responsibilities as stated in General and Supplementary Conditions.
- B. "Approved equal" mean any product which in the opinion of the Engineer is equal in quality, arrangement, appearance, and performance to the product specified.
- C. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Engineer," "requested by the Engineer," and similar phrases.
- D. "Finished" refers to all rooms and areas to be specified to receive architectural treatment as indicated on the drawings. All rooms and areas not covered, including underground tunnels and areas above ceilings shall be considered not finished, unless otherwise noted.
- E. "Furnish" or "supply" shall mean purchase, deliver to, and off-load at the job site, ready to be installed including where appropriate all necessary interim storage and protection.

- F. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, other paragraphs or schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.
- G. "Install" shall mean set in place complete with all mounting facilities and connections as necessary ready for normal use or service.
- H. "Product" shall mean any item of equipment, material, fixture, apparatus, appliance or accessory installed under this Division.
- I. "Provide" shall mean furnish (or supply) and install as necessary.
- J. Regulation: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.
- K. Remove: The term "remove" means "to disconnect from its present position, remove from the premises and to dispose of in a legal manner."
- L. Special Warranties: The term "Special Warranties" are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.
- M. Standard Product Warranties: The term "Standard Product Warranties" are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.
- N. "Subcontractor" means specifically the subcontractor working under this Division. Other Contractors are specifically designated "Plumbing Subcontractor", "General Contractor" and so on. Note: Take care to ascertain limits of responsibility for connecting equipment which requires connections by two or more trades.
- O. Substitutions: Requests for changes in products, materials, equipment, and methods of construction proposed by the Contractor are considered requests for "substitutions."
- P. "Wiring" shall mean cable assembly, raceway, conductors, fittings and any other necessary accessories to make a complete wiring system.

1.7 DRAWINGS

- A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. Consult the Architectural Drawings and Details for exact location of fixtures and equipment; where same are not definitely located, obtain this information from the Architect. (Do not scale the drawings)
- B. Work under each Section shall closely follow Drawings in layout of work; check Drawings of other Divisions to verify spaces in which work will be installed. Maintain

maximum headroom; where space conditions appear inadequate, Owner and Engineer shall be notified before proceeding with installations.

- C. The Owner may, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades and/or for proper execution of the work.
- D. Where variances occur between the Drawings and Specifications or within either of the Documents, the item or arrangement of better quality, shall be included in the Contract price. The Owner and Engineer shall decide on the item and the manner in which the work shall be installed.

1.8 SURVEYS AND MEASUREMENTS

- A. Before submitting his Bid, the Contractors shall visit the site and become thoroughly familiar with all existing conditions under which work will be installed. This Contract includes all modifications of existing systems required for the installation of new equipment. This Contract includes all necessary offsets, transitions and modifications required to install all new equipment in existing spaces. All new and existing equipment and systems shall be fully operational under this Contract before the job is considered complete. The Contractors shall be held responsible for any assumptions he makes, any omissions or errors he makes as a result of his failure to become fully familiar with the existing conditions at the site and the Contract Documents.
- B. The Contractor shall base all measurements, both horizontal and vertical, from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.
- C. Should the Contractor discover any discrepancies between actual measurements and those indicated which prevent following good practice or which interfere with the intent of the Drawings and Specifications, the Engineer will be notified and work will not proceed until instructions from the Engineer are received.
- D. The Contractor shall review the entire project Architectural, Site/Civil, Kitchen (Food Service) Electrical and Mechanical and Equipment drawings and specifications for coordination items and or piping, fixtures and trim to be furnished by or installed by the plumbing contractor. Any additional work items shall be furnished and installed at no additional cost to the owner.

1.9 CODES AND STANDARDS

- A. Reference Standard Compliance
 - 1. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), and Underwriters Laboratories Inc. (UL), submit proof of such compliance. The

label or listing by the specified organization will be acceptable evidence of compliance.

2. Independent Testing Organization Certificate: In lieu of the label or listing indicated above, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Engineer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

- B. The Following Codes and Standards listed below apply to all mechanical work. Wherever Codes and/or Standards are mentioned in these Specifications, the latest applicable edition or revision shall be followed:

Connecticut State Building Code - Connecticut Supplement 2016

The International Building Code 2012

The International Mechanical Code 2012

The International Plumbing Code 2012

The International Energy Conservation Code 2012

The National Electrical Code 2014

NFPA 101 Life Safety

ASHRAE 90.1 and International Energy Conservation Code 2010

- C. The following Standards shall be used where referenced by the following abbreviations:

ACGIH	American Conference of Governmental Industrial Hygienists
AGA	American Gas Association
AIA	American Institute of Architects
ANSI	American National Standards Institute
API	American Petroleum Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASSE	American Society of Sanitary Engineers
ASTM	American Society of Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
CGA	Compressed Gas Association
CISPI	Cast Iron Soil Pipe Institute
EJMA	Expansion Joint Manufacturing Association
EPA	Environmental Protection Agency
FM	Factory Mutual
FSSC	Federal Specification
HIS	Hydraulic Institute Standards
IEEE	Institute of Electrical and Electronics Engineers
IRI	Industrial Risk Insurers
ISO	Insurance Services Office
MCAA	Mechanical Contractors Association of America
NBS	National Bureau of Standards
NEBB	National Environmental Balancing Bureau
NEMA	National Electrical Manufacturers Association

NFPA	National Fire Protection Association
NSC	National Safety Council
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Administration
PDI	Plumbing and Drainage Institute
SBI	Steel Boiler Industry (Division of Hydronics Institute)
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
STI	Steel Tank Institute
UL	Underwriters' Laboratories

- D. All materials furnished and all work installed shall comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction and the requirements of all Governmental departments having jurisdiction.
- E. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and Drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether shown on Drawings and/or specified or not.

1.10 PERMITS AND FEES

- A. The Contractor shall give all necessary notices, obtain all permits; and pay all Government and State sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the work, file all necessary Drawings, prepare all documents and obtain all necessary approvals of all Governmental and State departments having jurisdiction, obtain all required certificates of inspection for his work, and deliver a copy to the Owner and Engineer before request for acceptance and final payment for the work.

1.11 EQUIPMENT SUBSTITUTIONS

- A. In these Contract Documents, one or more makes of materials, apparatus or appliances may have been specified for use in this installation. These describe the basis of design and approved equivalents. This has been done for convenience in fixing the standard of workmanship, finish and design required for installation without consideration of any or all costs associated but not limited to (structural, mechanical, or electrical feeder, breaker, or transformer requirements). The Contractor acknowledges that not all requirements are shown for either alternate acceptable manufacturers listed or those alternates requiring a request for substitution and it is their responsibility to coordinate all requirements necessary to accommodate any change from the basis of design listed or scheduled. The contractor is required to submit any and all costs (including costs associated or required by all trades) along with performance differences as part of their request for substitution. The details of workmanship, finish and design, and the guaranteed performance of any material, apparatus or appliance which the Contractor desires to deviate for those mentioned herein shall also conform to these standards.
- B. Where no specific make of material, apparatus or appliance is mentioned, any first-class product made by a reputable manufacturer may be submitted for the Engineers review.

- C. Where two or more names are given as approved manufacturers of equivalents, the Contractor must use the specified item or one of the named equivalents which still must meet all of the performance characteristics of the basis of design make and model. Where one name only is used and is followed by the words “or approved equal”, the Contractor must use the item named or he is required to apply for a substitution. Where one name only is used, the Contractor must use that item named.
- D. Where the Contractor proposes to deviate (provide an equivalent or request for substitution) from the equipment or materials as hereinafter specified, they are required to submit a requested for substitution in writing. The Contractor shall state in their request whether it is a substitution or a non approved equivalent to that specified and the amount of credit or extra cost involved. A copy of said request shall be included in the Base Bid with manufacturer’s equipment cuts. The Base Bid shall be based on using the materials and equipment as specified with no exceptions.
- E. Where the Contractor proposes to use an item of equipment other than specified or detailed on the Drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout, all such redesign and all new drawings and detailing required therefore shall be prepared by the Engineers/Architects of Record at the expense of the Contractor and at no additional cost to the Owner.
- F. Where such accepted deviation resulting from using an approved equivalent or substitution requires a different quantity and arrangement of piping, ductwork, valves, pumps, insulation, wiring, conduit and equipment from that specified or indicated on the Drawings, the Contractor shall, after acceptance by the Engineer, furnish and install any such additional equipment required by the system at no additional cost to the Owner, including any costs added to other trades due to the deviation.
- G. Equipment, material or devices submitted for review as an “equivalent” shall meet the following requirements:
1. The equivalent shall have the same construction features such as, but not limited to:
 - a. Material thickness, gauge, weight, density, etc.
 - b. Welded, riveted, bolted, etc., construction
 - c. Finish, undercoating, corrosion protection
 2. The equivalent shall perform with the same or better operating efficiency.
 3. The equivalent shall be locally represented by the manufacturer for service, parts and technical information.
 4. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as UL or NEMA labels.
- H. Equipment, material or devices submitted for review as a “substitution” shall meet the following requirements:
1. Substitution Request Submittal: Requests for substitution will be considered if received in writing 14 days before the bid date. Requests received later than 14 days before the bid date may be considered or rejected at the discretion of the Engineer/Owner. Once the Contractor submits a complete request for substitution as determined by the engineer, the engineer reserves the right to

request the time necessary to evaluate the request for substitution and review it with the Owner.

2. Submit three (3) copies of each request for substitution for consideration.
3. Identify the product, or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
 - a. Product Data, including Drawings and descriptions of products, fabrication and installation procedures.
 - b. Samples, where applicable or requested.
 - c. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect.
 - d. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate Contractors, that will become necessary to accommodate the proposed substitution.
 - e. A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
 - f. Cost information, including a proposal of the net change, if any in the Contract Sum.
 - g. Certification by the Contractor that the substitution proposed is equal-to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the Contractor's waiver of rights to additional payment or time, that may subsequently become necessary because of the failure of the substitution to perform adequately.
 - h. Engineer's Action: Within one week of receipt of the request for substitution, the Engineer will notify the Contractor of acceptance or rejection of the proposed substitution. If a decision on use of a proposed substitute cannot be made or obtained within the time allocated, use the product specified by name. Acceptance of a product substitution will be in the form of an Addendum.
 - i. Other Conditions: The Contractor's substitution request will be received and considered by the Engineer when one or more of the following conditions are satisfied, as determined by the Engineer; otherwise requests will be returned without action except to record noncompliance with these requirements.
 - 1) The request is directly related to an "or equal" clause or similar language in the Contract Documents.
 - 2) The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.

- 3) A substantial advantage is offered the Owner, in terms of cost, time, energy conservation or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear. Additional responsibilities for the Owner may include additional compensation to the Engineer for redesign and evaluation services, increased cost of other construction by the Owner or separate Contractors, and similar considerations.

1.12 SUBMITTAL PROCEDURES

- A. Provide Submittals in accordance with the requirements of Division 1 and as indicated in the following.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.
 2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for resubmittals.
 1. Allow two weeks for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The Engineer will promptly advise the Contractor when a submittal being processed must be delayed for coordination.
 2. If an intermediate submittal is necessary, process the same as the initial submittal.
 3. Allow two weeks for reprocessing each submittal.
 4. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing.
- D. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block. Submittals shall be arranged in order of specification sections.
 1. Include the following information on the label for processing and recording action taken.
 - a. Project name.
 - b. Date.
 - c. Name and address of Engineer.
 - d. Name and address of Contractor.
 - e. Name and address of subcontractor.
 - f. Name and address of supplier.
 - g. Name of manufacturer.

- h. Number, title and paragraph of appropriate Specification Section.
 - i. Drawing number and detail references, as appropriate.
- E. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to Engineer using a transmittal form. Submittals received from sources other than the Contractor will be returned without action. On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.
- F. Except for submittals for record, information or similar purposes, the Engineer will review each submittal, mark to indicate action taken, and return promptly. Compliance with specified characteristics is the Contractor's responsibility.
- G. Action Stamp: The Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, to indicate the action taken.

1.13 SHOP DRAWINGS

- A. Submit neatly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.
- B. The Contractor shall submit for review detailed shop drawings of all equipment and material specified in each section and coordinated ductwork layouts. No material or equipment may be delivered to the job site or installed until the Contractor has received shop drawings for the particular material or equipment which have been properly reviewed. Shop drawings shall be submitted within 60 days after award of Contract before any material or equipment is purchased. The Contractor shall submit for review copies of all shop drawings to be incorporated in the Mechanical Contract. Refer to Division 1 for the quantity of copies required for submission. Where quantities are not specified, provide seven (7) copies for review.
- C. Provide shop drawings for all devices specified under equipment specifications for all systems. Shop drawings shall include manufacturers' names, catalog numbers, cuts, diagrams, dimensions, identification of products and materials included, compliance with specified standards, notation of coordination requirements, notation of dimensions established by field measurement and other such descriptive data as may be required to identify and accept the equipment. A complete list in each category (example: all fixtures), of all shop drawings, catalog cuts, material lists, etc., shall be submitted to the Engineer at one time. No consideration will be given to a partial shop drawing submittal.
- D. When a submittal could involve more than one trade, e.g., valves, piping, etc., the submitted shall be separated by traded involved, ie. HVAC, plumbing, fire protection, etc.

- E. Where multiple quantities or types of equipment are being submitted, provide a cover sheet (with a list of contents) on the submittal identifying the equipment or material being submitted.
- F. The Contractor shall furnish all necessary templates, patterns, etc., for installation work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.
- G. "No Exception Taken" rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, review does not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the Contract Drawings and Specifications. Verify available space prior to submitting shop drawings. Review of shop drawings shall not apply to quantity of material.
- H. After shop drawings have been reviewed, with no exceptions taken, no further changes will be allowed without the written consent of the Engineer.
- I. Shop drawing submittal sheets which may show items that are not being furnished shall have those items crossed off to clearly indicate which items will be furnished.
- J. Bidders shall not rely on any verbal clarification of the Drawings and/or Specifications. Any questions shall be referred to the Engineer in writing at least five (5) working days prior to Bidding to allow for issuance of an Addendum.
- K. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.
- L. Prepare sheet metal and sprinkler shop drawings drawn in the latest AutoCAD version to a minimum scale of 1/4" = 1' - 0". Final approved drawings shall be turned over to the Owner on floppy disk or CD Rom.
- M. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.

4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).
5. QUALITY ASSURANCE

1.14 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.15 COORDINATION DRAWINGS

- A. Prepare coordination drawings drawn in the latest AutoCAD version in accordance with Division 1 to a minimum scale of 1/4"=1'-0" detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
 1. The Contractor shall indicate the proposed locations of piping, conduit, ductwork, equipment, and materials. Include the following:
 - a. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
 - b. Equipment connections and support details.
 - c. Exterior wall and foundation penetrations.
 - d. Fire-rated wall and floor penetrations.
 - e. Sizes and locations of required concrete pads and bases.
- B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
- C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

- D. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.
- E. The Contractor and each subcontractor shall sign and date each coordination drawing prior to submission.
- F. Work shall not be performed until coordination drawings have been approved by the architect and engineer.
- G. Electronic copies of the MEP floor plans are available to use as a basis for preparing coordination drawings and can be provided by the Engineer. The cost for these floor plans is a lump sum fee of \$ 500.00. If the Contractor elects to obtain the Engineers electronic files a CADD File Release Form must be submitted with payment. This form must be signed by the Contractor, Owner, and Architect. Upon receipt of a signed copy of the CADD File Release Form, and payment, the Engineer will provide copies of the electronic files for the Contractor's use. A copy of the CADD File Release Form is appended to the end of this specification section

1.16 COORDINATION WITH OTHER DIVISIONS

- A. All work shall be carried out in conjunction with other trades and full cooperation shall be given in order that all work may proceed with a minimum of delay and interference. Particular emphasis is placed on timely installation of major apparatus and furnishing other Contractors, especially the Contractor or Construction Manager, with information as to openings, chases, sleeves, bases, inserts, equipment locations, panels, etc., required by other trades.
- B. The Contractors are required to examine all of the Project Drawings and mutually arrange work so as to avoid interference with the work of other trades. In general, ductwork, HVAC piping, sprinkler piping and drainage lines take precedence over water, gas and electrical conduits. The Engineer shall make final decisions regarding the arrangement of work which cannot be agreed upon by the Contractors.
- C. Where the work of the Contractor will be installed in close proximity to or will interfere with work of other trades, the Contractors will cooperate in working out space conditions to make a satisfactory adjustment.
- D. If the work under a Section is installed before coordinating with other Divisions or Sections or so as to cause interference with work of other Sections, the necessary changes to correct the condition shall be made by the Contractor causing the interference without extra charge to the Owner.
- E. The Plumbing Contractor shall coordinate with the electrical contractor, so that all plumbing fixtures, trim, equipment, devices, accessories, panels, alarms etc are provided with the correct power supply. All items noted shall be furnished with power at no additional cost to the owner.

1.17 WORKMANSHIP

- A. Service Support: The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.
- B. Modification of References: In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.
- C. The Contractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work together with all skilled workmen, fitters, metal workers, welders, helpers and laborers required to unload, transfer, erect, connect, adjust, start, operate and test each system.
- D. Unless otherwise specifically indicated on the Drawings or Specifications, all equipment and materials shall be installed with the acceptance of the Engineer and in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.
- E. All labor for installation of plumbing systems shall be performed by experienced, skilled tradesmen under the supervision of a licensed journeyman foreman. All work shall be of a quality consistent with good trade practice and shall be installed in a neat, workmanlike manner. The Engineer reserves the right to reject any work which, in his opinion, has been installed in a substandard, dangerous or unserviceable manner. The Contractor shall replace said work in a satisfactory manner at no extra cost to the Owner.

1.18 SHUTDOWNS

- A. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such time as designated by the Owner.
- B. The Engineer and the Owner shall be notified in writing of the estimated duration of the shutdown period at least ten (10) days in advance of the date the work is to be performed.
- C. Work shall be arranged for continuous performance whenever possible. The Contractor shall provide all necessary labor, including overtime if required, to assure that operating services will be shut down only during the time actually required to make necessary connections.

1.19 TEMPORARY UTILITIES

- A. General: Provide new materials and equipment; if acceptable to the Engineer, undamaged previously used materials in serviceable condition may be used. Provide materials suitable for the use intended. Provide temporary piping, valves, pumps and equipment as required to maintain existing systems throughout construction.

- B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload facilities, or permit them to interfere with progress. Do not allow hazardous dangerous or unsanitary conditions, or public nuisances to develop or persist on the site.
- C. First Aid Supplies: Comply with governing regulations.
- D. Fire Extinguishers: Provide hand-carried, portable UL-rated, class "A" fire extinguishers for temporary offices and similar spaces. In other locations provide hand-carried, portable, UL-rated, class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposures.
- E. Utilities: Engage the appropriate local utility company to install temporary service or connect to existing service. Where the company provides only part of the service, provide the remainder with matching, compatible materials and equipment; comply with the company's recommendations.
 - 1. Use Charges: Cost or use charges for temporary facilities are not chargeable to the Owner or Engineer, and will not be accepted as a basis of claims for a Change Order.
- F. Water Service: Install water service and distribution piping of sizes and pressures adequate for construction until permanent water service is in use.
- G. Temporary Heat-Cool-Dehumidification: Provide temporary services required by construction activities, for curing or drying of completed installations or protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate temporary services to produce the ambient condition required and minimize consumption of energy. The building's permanent HVAC systems shall not be used for these purposes.
- H. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons or firms near the site.
- I. Termination and Removal: Unless the Engineer requires that it be maintained longer, remove each temporary facility when the need has ended, or when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces and replace construction that cannot be satisfactorily repaired. Materials and facilities that constitute temporary facilities are property of the Contractor. The Owner reserves the right to take possession of Project identification signs.

1.20 PROJECT PHASING

- A. Work under each Section shall include all necessary temporary connections, equipment, piping, heating, temperature control work, fire stopping, water heaters, labor, and material as necessary to accommodate the phasing of Construction as developed by the General Contractor or Construction Manager and approved by the Owner. All existing systems that pass-thru an area of the building shall remain operational during all phases of construction. No extra compensation shall be granted the Contractor for work required to maintain existing systems operational or to accommodate the construction phasing of the project.

1.21 PROTECTION OF MATERIALS AND EQUIPMENT

- A. Work under each Section shall include protecting the work and material of all other Sections from damage by work or workmen and shall include making good all damage thus caused.
- B. The Contractor shall be responsible for work and equipment until the facility has been accepted by the Owner. Protect work against theft, injury or damage and carefully store material and equipment received on site which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of foreign material.
- C. Work under each Section includes receiving, unloading, uncrating, storing, protecting, setting in place and completely connecting equipment supplied under each Section. Work under each Section shall also include exercising special care in handling and protecting equipment and fixtures, and shall include the cost of replacing any of the equipment and fixtures which are missing or damaged.
- D. Equipment and material stored on the job site shall be protected from the weather, vehicles, dirt and/or damage by workmen or machinery. Insure that all electrical or absorbent equipment or material is protected from moisture during storage.

1.22 ADJUSTING AND TESTING

- A. After all the equipment and accessories to be furnished are in place, they shall be put in final adjustment and subjected to such operating tests so as to assure the Engineer that they are in proper adjustment and in satisfactory, permanent operating condition.
- B. Where requested by the Engineer, a factory-trained service representative shall inspect the installation and assist in the initial startup and adjustment to the equipment. The period of these services shall be for such time as necessary to secure proper installation and adjustments. After the equipment is placed in permanent operation, the service representative shall supervise the initial operation of the equipment and instruct personnel responsible for operation and maintenance of the equipment. The service representative shall notify the Contractor in writing, that the equipment was installed according to manufacturers recommendations and is operating as intended by the manufacturer.

1.23 CLEANING

- A. The Contractor shall thoroughly clean and flush all piping and equipment of all foreign substances, oils, burrs, solder, flux, etc., inside and out before being placed in operation.
- B. If any part of a system should be stopped or damaged by any foreign matter after being placed in operation, the system shall be disconnected, cleaned and reconnected wherever necessary to locate and/or remove obstructions. Any work damaged in the course of removing obstructions shall be repaired or replaced when the system is reconnected at no additional cost to the Owner.
- C. During the course of construction, all ducts and pipes shall be capped in an acceptable manner to insure adequate protection against the entrance of foreign matter.
- D. Upon completion of all work under the Contract, the Contractor shall remove from the premises all rubbish, debris and excess materials left over from his work. Any oil or grease stains on floor areas caused by the Contractor shall be removed and floor areas left clean.
- E. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.
 - 1. Remove labels that are not permanent labels.
 - 2. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compound and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
 - 3. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean. Vacuum carpeted surfaces.
 - 4. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition. Clean light fixtures and lamps.
- F. Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful or dangerous materials into drainage systems. Remove and dispose of ALL waste materials, packaging material, skids etc. from the site and dispose of in a lawful manner in accordance with municipal, state and federal regulations.
- G. Where extra materials of value remaining after completion of associated Work have become the Owner's property, arrange for disposition of these materials as directed.

1.24 OPERATING AND MAINTENANCE

- A. Upon completion of all work and tests, the Contractor shall furnish the necessary skilled labor and helpers for operating his system and equipment for a period specified under each applicable Section of this Division. During this period, he shall fully instruct the

Owner or the Owner's representative in the operation, adjustment and maintenance of all equipment furnished. The Contractor shall give at least seven (7) days notice to the Owner and the Engineer in advance of this period.

- B. The Contractor shall include the maintenance schedule for the principal items of equipment furnished under this Division.
- C. The Contractor shall physically demonstrate procedures for all routine maintenance of all equipment furnished under each respective Section to assure accessibility to all devices.
- D. An authorized manufacturer's representative shall attest in writing that the equipment has been properly installed prior to startup of any major equipment. The following equipment will require this inspection: pumps; air conditioning equipment, controls, air handling equipment, compressors, boilers etc. These letters shall be bound into the operating and maintenance books.
- E. Refer to individual trade Sections for any other particular requirements related to operating instructions.
- F. Demonstration shall be recorded on VHS audio/video tape with two (2) tapes turned over to the Owner.

1.25 OPERATING AND MAINTENANCE MANUALS

- A. Prepare operating and maintenance manuals in accordance with the requirements of Division 1 and as follows. The Contractor shall prepare six (6) copies of a complete maintenance and operating instructions manual, bound in booklet form. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty 3-ring vinyl-covered binders, with pocket folders for folded sheet information and designation partitions with identification tabs. Mark appropriate identification on front and spine of each binder.
- B. Manual shall include the following:
 - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 - 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 - 4. Servicing and operating instructions including lubrication charts and schedules.
 - 5. Emergency and safety instructions.
 - 6. Spare parts list.
 - 7. Copies of warranties.
 - 8. Wiring diagrams.
 - 9. Recommended "turn around" cycles.

10. Inspection procedures.
 11. Approved Shop Drawings and Product Data.
 12. Equipment Start-up Reports.
 13. Temperature control diagrams and written sequences of operations.
 14. Balance reports.
- C. Include in the manual, a tabulated equipment schedule for all equipment. Schedule shall include pertinent data such as: make, model number, serial number, voltage, normal operating current, belt size, filter quantities and sizes, bearing number, etc. Schedule shall include maintenance to be done and frequency.
- D. Maintenance and instruction manuals shall be submitted to the Owner at the same time as the seven (7) day notice is given prior to the instruction period.

1.26 ACCEPTANCES

- A. The equipment, materials, workmanship, design and arrangement of all work installed under the Mechanical Sections shall be subject to the review of the Engineer.
- B. Within 30 days after the awarding of a Contract, the Plumbing Contractor shall submit to the Engineer, for review, a list of manufacturers of equipment proposed for the work under the Plumbing Sections. The intent to use the exact manufacturers and models specified does not relieve the Contractor of the responsibility of submitting such a list.
- C. If extensive or unacceptable delivery time is expected on a particular item of equipment specified, the Contractor shall notify the Owner and Engineer, in writing, within 30 days of award of the Contract. In such instances, equipment substitutions may be made pending acceptance by the Engineer or the Owner's representative.
- D. Where any specific material, process or method of construction or manufactured article is specified by reference to the catalog number of a manufacturer, the Specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings. In all cases, the Plumbing Contractor shall verify the duty specified with the specific characteristics of the equipment offered for review. Equipment characteristics are to be used as mandatory requirements where the Contractor proposes to use an acceptable equivalent.
- E. If material or equipment is installed before it is reviewed and/or approved, the Contractor shall be liable for its removal and replacement at no extra charge to the Owner if, in the opinion of the Engineer, the material or equipment does not meet the intent of, or standard of quality implied by, the Drawings and Specifications.
- F. Failure on the part of the Engineer to reject shop drawings or to reject work in progress shall not be interpreted as acceptance of work not in conformance with the Drawings and/or Specifications. Work not in conformance with the Drawings and/or Specifications shall be corrected whenever it is discovered.

1.27 RECORD DRAWINGS

- A. General: Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Engineer's reference during normal working hours.
- B. Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately. Give particular attention to concealed elements that would be difficult to measure and record at a later date. Items to be indicated include but are not limited to:
 - 1. Dimensional change
 - 2. Revision to drawing detail
 - 3. Location and depth of underground utility
 - 4. Revision to pipe routing
 - 5. Revision to electrical circuitry
 - 6. Actual equipment location
 - 7. Pipe size and routing
 - 8. Location of concealed internal utility
 - 9. Changes made by Change Order
 - 10. Details not on original Contract Drawing
 - 11. Information on concealed elements which would be difficult to identify or measure later
- C. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.
- D. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.
- E. Note related Change Order numbers where applicable.
- F. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.
- G. These shall be clearly marked for Record Drawings on a clean set of reproducible mylar sepias at the completion of the work and turned over to the Owner.
- H. Final record documents shall be prepared in the latest AutoCad version and floppy disks or CD Rom of all drawings and a clean set of reproducible mylar sepias shall be turned over to the Owner at the completion of the work.

1.28 WARRANTIES AND BONDS

- A. The following general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturers standard warranties on products and special warranties are to be included:
 - 1. General close-out requirements included in Division 1.

2. Specific requirements for warranties for the Work and products and installation that are specified to be warranted, are included in the individual Sections of Divisions-2 through -16.
 3. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.
- B. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.
- C. Separate Prime Contracts: Each prime Contractor is responsible for warranties related to its own Contract.

1.29 WARRANTY REQUIREMENTS

- A. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.
- D. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, right and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.
- E. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- F. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.
- G. Submit written warranties to the Engineer prior to the date certified for Substantial Completion. If the Engineer's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the

Work, or a designated portion of the Work, submit written warranties upon request of the Engineer.

- H. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Engineer within fifteen days of completion of that designated portion of the Work.
- I. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner through the Engineer for approval prior to final execution.
 - 1. Refer to individual Sections of Divisions-2 through -16 for specific content requirements, and particular requirements for submittal of special warranties.
- J. Form of Submittal: At Final Completion compile two copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- K. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2" by 11" paper.
 - 1. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the installer.
 - 2. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS," the Project title or name, and the name of the Contractor.
 - 3. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

1.30 GUARANTEES

- A. The Contractor shall guarantee all material and workmanship under these Specifications and the Contract for a period of one (1) year from the date of final acceptance by Owner. During this guarantee period, all defects developing through faulty equipment, materials or workmanship shall be corrected or replaced immediately by this Contractor without expense to the Owner. Such repairs or replacements shall be made to the Engineer's satisfaction.
- B. Contractor shall provide name, address, and phone number of all contractors and subcontractors and associated equipment they provided.

1.31 PROJECT CLOSE-OUT

- A. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications and similar documents in accordance with Division 1.
- B. Deliver tools, spare parts, extra stock, and similar items.
- C. Complete start-up testing of systems, including measuring and documenting all required startup checklist requirements documented in installation and maintenance instructions by the equipment manufacturer, and instruction of the Owner's operating and maintenance personnel. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.
- D. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.
- E. Field Observation Procedures: On receipt of a request for an Engineers Field Observation, the Engineer will advise the Contractor of unfulfilled requirements. The Engineer will advise the Contractor of construction that must be completed or corrected before the certificate will be issued.
 - 1. The Engineer will repeat the Field Observation when requested and assured that the Work has been substantially completed.
 - 2. Results of the completed list of unfulfilled items will form the basis of requirements for final acceptance.

END OF SECTION

CADD File Release Form

DELIVERY OF CADD FILES FOR: _____
Project Name

In accepting and utilizing any drawings or other data on any form of electronic media generated and provided by the Design Professional, the Client covenants and agrees that all such drawings and data are instruments of service of the Design Professional, who shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

The Client further agrees not to use these drawings and data, in whole or in part, for any purpose or project other than the project which is the subject of this Agreement. The Client agrees to waive all claims against the Design Professional resulting in any way from any unauthorized changes or reuse of the drawings and data for any other project by anyone other than the Design Professional.

In addition, the Client agrees, to the fullest extent permitted by law, to indemnify and hold the Design Professional harmless from any damage, liability or cost, including reasonable attorneys' fees and costs of defense, arising from any changes made by anyone other than the Design Professional or from any reuse of the drawings and data without the prior written consent of the Design Professional.

Under no circumstances shall transfer of the drawings and other instruments of service on electronic media for use by the Client be deemed a sale by the Design Professional, and the Design Professional makes no warranties, either express or implied, of merchantability and fitness for any particular purpose.

Client's Signature

Date

Company - Title

Architects' Signature

Date

Firm - Title

Owner's Signature

Date

Company - Title

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Mechanical sleeve seals.
 - 3. Formed steel channel.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 SUBMITTALS

- A. Shop Drawings: Submit for piping and equipment identification list of wording, symbols, letter size, and color coding for pipe identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- B. Product Data for Pipe and Equipment Identification: Submit for mechanical identification manufacturers catalog literature for each product required. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:

1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.5 QUALITY ASSURANCE

- A. Maintain one copy of each document on site.
- B. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

PART 2 PRODUCTS

2.1 SLEEVES

- A. Sleeves for Pipes through Non-fire Rated Floors: 18 gage thick galvanized steel.
- B. Sleeves for Pipes through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
- C. Sealant: Acrylic; refer to Section 07 90 00.

2.2 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
 - 1. Thunderline Link-Seal, Inc.
 - 2. Link Seal
 - 3. Fernco
 - 4. Substitutions: Permitted.

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

2.3 FORMED STEEL CHANNEL

- A. Manufacturers:
 - 1. Allied Tube & Conduit Corp.
 - 2. B-Line Systems
 - 3. Unistrut Corp.
 - 4. Substitutions: Permitted.

- B. Product Description: Galvanized 12 gage) thick steel. With holes 1-1/2 inches on center.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify openings are ready to receive sleeves.

3.2 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with mechanical sleeve seals.
- B. Set sleeves in position in forms. Provide reinforcing around sleeves.
- C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- E. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent work with stuffing firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- F. Install chrome plated steel plastic stainless steel escutcheons at finished surfaces.

END OF SECTION

SECTION 220503 - PIPES AND TUBES FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Pipe and pipe fittings for the following systems:
 - 1. Domestic water piping, within 5 feet of building.
 - 2. Sanitary sewer piping, within 5 feet of building.
 - 3. Chemical resistant sewer piping.
 - 4. Storm water piping, within 5 feet of building.
 - 5. Equipment drains and over flows.
 - 6. Unions and flanges.
 - 7. Underground pipe markers.
 - 8. Bedding and cover materials.

- B. Related Sections:
 - 1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
 - 2. Section 08 31 13 - Access Doors and Frames
 - 3. Section 09 90 00 - Painting and Coating
 - 4. Section 22 04 00 – General Conditions for Plumbing Trades
 - 5. Section 22 05 00 – Common work results for Plumbing
 - 6. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping
 - 7. Section 22 05 23 - General-Duty Valves for Plumbing Piping
 - 8. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
 - 9. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment
 - 10. Section 22 05 53 – Identification for Plumbing Piping and Equipment
 - 11. Section 22 07 00 - Plumbing Insulation
 - 12. Section 22 15 00 – Specialty Plumbing Systems and Equipment
 - 13. Section 22 30 00 – Plumbing Specialties
 - 14. Section 22 34 00 – Fuel Fired Domestic Water Heaters
 - 15. Section 22 40 00 – Plumbing Fixtures

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 PHASE 2 SUPPORT REQUIREMENTS

- A. All mechanical systems including equipment, ductwork, piping and accessories being hung from above shall not be supported from the existing "space truss" roof structure unless noted otherwise. Systems shall be supported from new framing only. Refer to structural drawings for locations of new framing. Provide supplemental framing as required.

1.5 REFERENCES

- A. American Society of Mechanical Engineers:
1. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
 2. ASME B16.3 - Malleable Iron Threaded Fittings.
 3. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
 4. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 5. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings (DWV).
 6. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
 7. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
 8. ASME B31.9 - Building Services Piping.
 9. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.
 10. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.
- B. ASTM International:
1. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.
 2. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
 3. ASTM A536 - Standard Specification for Ductile Iron Castings.
 4. ASTM B32 - Standard Specification for Solder Metal.
 5. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.
 6. ASTM B75 - Standard Specification for Seamless Copper Tube.
 7. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
 8. ASTM B251 - Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
 9. ASTM B302 - Standard Specification for Threadless Copper Pipe, Standard Sizes.

10. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV).
 11. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
 12. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
 13. ASTM C1053 - Standard Specification for Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications.
 14. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
 15. ASTM D2464 - Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 16. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
 17. ASTM D2467 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 18. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
 19. ASTM D2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
 20. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
 21. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
 22. ASTM D2846/D2846M - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems.
 23. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
 24. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
 25. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
 26. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
 27. ASTM F679 - Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
 28. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
- C. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
 2. AWS D1.1 - Structural Welding Code - Steel.
- D. American Water Works Association:
1. AWWA C104 - American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 2. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.

3. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
 4. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 5. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
 6. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water Distribution.
- E. Cast Iron Soil Pipe Institute:
1. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
 2. 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.
- F. NSF International:
1. NSF 61 - Standard for Drinking Water System Components - Health Effects.
- G. Safe Drinking Water Act.
1. SDWA 1417 - Standard for Lead Free Drinking Water.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate layout of piping systems, including equipment, critical dimensions, and sizes. Submit shop drawings sealed by registered professional engineer.
- C. Product Data: Submit data on pipe materials and fittings. Submit manufacturers catalog information. Clearly indicate on submittal "Lead Free" where required.
- D. Design Data: Indicate pipe sizes. Indicate pipe sizing methods. Indicate calculations used. Submit sizing methods calculations sealed by registered professional engineer.
- E. Welders' Certificate: Include welders' certification of compliance with ASME Section IX. AWS D1.1.
- F. Booster Pump:
1. Product Data and Record Documents:
 2. Dimensional Drawings and product data for manufactured products and assemblies.
 3. Submit design, manufacturing and material data in sufficient detail to verify that the Domestic Water Booster system meet or exceed specification requirements.
 4. Submit manufacturer's operating maintenance and installation (IOM) instructions.
- G. Operation and Maintenance Data:

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11/17/2017

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BOARD OF EDUCATION CENTRAL OFFICES
BRANFORD, CONNECTICUT
State Project No.s: 014-0034 EA / 014-0035 BE-EA

1. At Substantial Completion, the contractor shall submit operation and maintenance data that includes Start-up and shutdown instructions, assembly Drawings, and recommended spare parts lists from the manufacturer.

- H. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- B. All cast iron soil pipe and fittings shall be marked with the collective trademark of the cast iron soil pipe institute.
- C. All couplings for hubless cast iron soil pipe and fittings shall meet the requirements of CISPI 310 and be certified by NSF International.
- D. All components of the potable domestic water system shall meet the requirements of SDWA-1417 & NSF 372 for compliance to Low Lead Content law
- E. To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by Victaulic or an Engineer Approved Equal. Grooving tools shall be supplied by the same manufacturer as the grooved components
- F. The International Association of Plumbing and Mechanical Officials
- G. Maintain one copy of each document on site.

- H. High Performance Building Requirements:
1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum years documented experience.
- C. Design piping systems pipe hangers and supports under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location.
- D. B. The booster pump manufacturer shall have fabricated Domestic water Booster systems for a minimum of ten (10) years.

1.9 PRE-INSTALLATION MEETINGS

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

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.11 WARRANTY

- A. Booster Pump warranty period: one (2) year parts and labor with warranty registration. Mechanical seals are not covered during the warranty period.

1.12 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not install underground piping when bedding is wet or frozen.

1.13 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.14 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Coordinate installation of buried piping with trenching.

PART 2 PRODUCTS

2.1 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Water Service Ductile Iron Pipe: AWWA C151 C104
 - 1. Fittings: AWWA C110, ductile iron, standard thickness.
 - 2. Joints: AWWA C111, rubber gasket with rods.
 - 3. Jackets: AWWA C105 polyethylene jacket.
- B. Buried Supply to fixtures or devices: Copper Tubing: ASTM B88, Type K, annealed.
 - 1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
 - 2. Joints: Compression connection or Brazed, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.
- C. Buried piping from trap primer: Polyethylene Pipe: ASTM D2239 SIDR 19, or ASTM D2447 Schedule 40.
 - 1. Fittings: ASTM D2609, Polyethylene.
 - 2. Joints: Mechanical with stainless steel clamps.

2.2 DOMESTIC WATER PIPING, ABOVE GRADE

- A. Copper Tubing: ASTM B88, Type L, drawn.
 - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - 2. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, lead free solder AWS A5.8 Classification BCuP-3 or BCuP-4 silver braze.
- B. Copper Tubing: ASTM B88, Type L, drawn.
 - 1. Fittings: ASME B16.18, cast bronze, or ASME B16.22, wrought copper and bronze or extruded tee connections conforming to ASTM F2014-00.

2. Joints: ASTM B32, solder, Grade 95TA or extruded tee connections brazed in compliance with the manufacturer's written instructions.
3. Other Acceptable Joining Methods:
 - a. Victaulic Copper Connection System sizes 2" to 8" with Victaulic style 607 coupling for copper tubing.
 - 1) Grooved Fittings: ASME B16.18, cast bronze, or ASME B16.22, wrought copper, with copper-tubing sized grooved ends. (Flaring of tube or fittings ends to IPS sizes is not permitted.
 - 2) Style 607 coupling with offsetting, angle-pattern bolt pads for direct metal-to-metal bolt pad contact with no torque requirement.
 - 3) Gaskets shall be grade 'EHP' EPDM, UL classified in accordance with ANSI/NSF-61 for potable water service.
 - b. Press Fitting: Copper and copper alloy press fittings conforming to ASME B16.18 or ASME B16.22. Sealing elements for press fittings shall be EPDM and factory installed. Press ends shall have SC feature design (leakage path) to assure detection and easy identification of leakage of liquids from inside the system past the sealing element of an unpressed connection.

2.3 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. PVC Pipe: ASTM D2729, polyvinyl chloride (PVC) material, bell and spigot solvent sealed ends.
 1. Fittings: PVC, ASTM D2729.
 2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.4 SANITARY SEWER PIPING, ABOVE GRADE

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

2.5 CHEMICAL RESISTANT SEWER PIPING

- A. PVC Pipe: ASTM D2729 or ASTM D2665, polyvinyl chloride (PVC) material.
 1. Fittings: PVC, ASTM D2729 or ASTM D2665.
 2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
- B. PP Pipe: Polypropylene.
 1. Fittings: Polypropylene.
 2. Joints: Electrical resistance fusion.

2.6 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. PVC Pipe: ASTM D2665 or ASTM D3034 SDR 26, polyvinyl chloride (PVC) material.
 1. Fittings: PVC, ASTM D2665 or ASTM D3034.
 2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

- B. PVC Pipe: ASTM D2665, ASTM D3034, or ASTM F679, polyvinyl chloride (PVC) material.
 - 1. Fittings: PVC, ASTM D2665, ASTM D3034, or ASTM F679.
 - 2. Joints: ASTM F477, elastomeric gaskets.

2.7 STORM WATER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: ASTM A74 service weight, plain ends.
 - 1. Fittings: Cast iron, ASTM A74.
 - 2. Joints: ASTM C564, neoprene gasket system or lead and oakum.

2.8 UNIONS AND FLANGES

- A. Unions for Pipe 2 inches and Smaller:
 - 1. Ferrous Piping: Class 150, malleable iron, threaded.
 - 2. Copper Piping: Class 150, bronze unions with soldered brazed joints.
 - 3. Dielectric Connections: Union or waterways with galvanized or plated steel or copper-silicon casting with threaded end, copper solder end, grooved end, lead free, water impervious isolation barrier.
 - 4. PVC Piping: PVC.
 - 5. CPVC Piping: CPVC.
- B. Flanges for Pipe 2-1/2 inches and Larger:
 - 1. Ferrous Piping: Class 150, forged steel, slip-on flanges or grooved joint flange adapters.
 - 2. Copper Piping: Class 150, slip-on bronze flanges or grooved joint flange adapters.
 - 3. PVC Piping: PVC flanges.
 - 4. CPVC Piping: CPVC flanges.
 - 5. Gaskets: 1/16 inch thick preformed neoprene gaskets.
 - 6. Dielectric Connections: Waterways with galvanized or plated steel or copper-silicon casting with grooved end, lead free, water impervious isolation barrier
- C. PVC Pipe Materials: For connections to equipment and valves with threaded connections, furnish solvent-weld socket to screwed joint adapters and unions, or ASTM D2464, Schedule 80, threaded, PVC pipe.

2.9 UNDERGROUND PIPE MARKERS

- A. Manufacturers:
 - 1. Seton
 - 2. Northtown
 - 3. Kolbi
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Domestic Water Service Sewer Service in large letters.

2.10 BEDDING AND COVER MATERIALS

- A. Bedding: Fill Type as specified in Division 31.
- B. Cover: Fill Type, as specified in Division 31.
- C. Soil Backfill from Above Pipe to Finish Grade: Soil Type S1 S2, as specified in Division 31, Subsoil with no rocks over 3 inches in diameter, frozen earth or foreign matter.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify excavations are to required grade, dry, and not over-excavated.
- C. Verify trenches are ready to receive piping.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel or groove 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.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - BURIED PIPING SYSTEMS

- A. Establish elevations of buried piping beyond building foot print with not less than three ft of cover for buried storm and sanitary and 48" of cover for buried domestic water supplies.
- B. Excavate pipe trench in accordance with Division 31.
- C. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches loose depth.
- D. Install pipe on prepared bedding.
- E. Route pipe in straight line.
- F. Install pipe to allow for expansion and contraction without stressing pipe or joints.

- G. Install shutoff and drain valves at locations indicated on Drawings in accordance with Section 22 05 23
- H. Install trace wire continuous over top of pipe when PVC piping is installed below grade or slab.
- I. Pipe Cover and Backfilling:
 - 1. Backfill trench in accordance with Division 31.
 - 2. Maintain optimum moisture content of fill material to attain required compaction density.
 - 3. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in 6 inches compacted layers to 6 inches minimum cover over top of jacket. Compact to 95 percent maximum density.
 - 4. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
 - 5. Do not use wheeled or tracked vehicles for tamping.

3.4 INSTALLATION - ABOVE GROUND PIPING

- A. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- B. Install piping to maintain headroom without interfering with use of space or taking more space than necessary.
- C. Group piping whenever practical at common elevations.
- D. Sleeve pipe passing through partitions, walls and floors. Refer to Section 22 05 29.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 05 16.
- F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 07 00.
- G. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Section 08 31 13.
- H. Install non-conducting dielectric connections wherever jointing dissimilar metals.
- I. Establish invert elevations, slopes for drainage to $\frac{1}{4}$ inch per foot for piping 2 $\frac{1}{2}$ " and smaller or $\frac{1}{8}$ inch per foot minimum for piping 3" and larger. Maintain gradients.
- J. Slope piping and arrange systems to drain at low points.
- K. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.
- L. Install piping penetrating roofed areas to maintain integrity of roof assembly.

- M. Install valves in accordance with Section 22 05 23.
- N. Install piping specialties in accordance with Section 22 30 00.
- O. Insulate piping. Refer to Section 22 07 00.
- P. Install pipe identification in accordance with Section 22 05 53.
- Q. The plumbing contractor shall furnish and install hot and cold water supplies to all plumbing fixtures and equipment throughout the project. All piping shall be supplied from the water source, mains, and branch piping.
- R. Shut off valves shall be provided on all supply piping where more than two fixtures are provided. Valve type shall be as determined by the engineer or as indicated on the drawings and specifications.
- S. Provide line sized balance valves at all connections between domestic hot water system and hot water recirculation system.

3.5 INSTALLATION - DOMESTIC WATER PIPING SYSTEMS

- A. Install domestic water piping system in accordance with SDWA - 1417.
- B. Install domestic water piping system in accordance with ASME B31.9.

3.6 INSTALLATION – PRESS STYLE FITTINGS

- A. Press connections: Copper and copper alloy press connections shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool(s) recommended by the manufacturer. Contractor shall be trained on the use and installation of the system by manufacturer's representative.

3.7 INSTALLATION - SANITARY WASTE AND VENT PIPING SYSTEMS

- A. Install sanitary waste and vent piping systems in accordance with ASME B31.9.
- B. Install sanitary waste and vent piping systems in accordance with local plumbing code.
- C. Install bell and spigot pipe with bell end upstream.
- D. Support cast iron drainage piping at every joint.
- E. Sanitary and vent piping shall be provided for all plumbing fixtures, devices and equipment throughout the project. All piping shall be installed in compliance with the adopted edition of the international Plumbing Code and State of Connecticut Amendments and Supplements.

- F. Vents from individual fixtures shall be combined and extend through the roof in multiple locations. Vent terminations at the roof shall not be installed within 25' of fresh air intakes for mechanical equipment.
- G. Sanitary piping from individual fixtures, devices and equipment shall combine into multiple buried laterals and exit the building below finished grade and connect to the one site piping network.
- H. The plumbing contractor must review the site and civil drawings for coordination with piping systems beyond the building footprint.
- I. Furnish and install cleanouts at all changes in direction greater than 45 degrees and not more than 75' foot intervals for horizontal runs. Provide finished grade cleanouts at lateral exiting the building.
- J. The project includes multiple approved techniques for venting, including but not limited to wet venting, circuit venting, combination drain and vent and island fixture vents. The contractor shall install the vent system accordingly to comply with the adopted edition of the International Plumbing Code.

3.8 INSTALLATION - STORM DRAINAGE PIPING SYSTEMS

- A. Install storm drainage piping systems piping in accordance with ASME B31.9.
- B. Install storm drainage piping systems in accordance with local plumbing code.
- C. Install bell and spigot pipe with bell end upstream.
- D. Support cast iron drainage piping at every joint.
- E. Storm piping shall be furnished and installed to all roof drains, overflow drains and canopy drains throughout the project and shall be combined and exit the building below finished grade in multiple locations.
- F. Furnish and install cleanouts at all changes in direction greater than 45 degrees and not more than 75' foot intervals for horizontal runs. Provide finished grade cleanouts at lateral exiting the building.
- G. The plumbing contractor must review the site and civil drawings for coordination with piping systems beyond the building footprint.

3.9 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Test domestic water piping system in accordance with applicable code local authority having jurisdiction

- C. Pressure test to identify un-pressed fittings: Utilizing air or water, the system shall be pressurized, not to exceed 85 psi. If there is a significant drop in pressure, the system shall be walked to check for un-pressed fittings. Should an un-pressed fitting be located, the pressure should be released from the system and the un-pressed fitting shall be pressed. If no un-pressed fitting is identified the system shall be pressurized to test pressures required by code, not to exceed 600 psi.
- D. Test sanitary waste and vent piping system in accordance with applicable code local authority having jurisdiction
- E. Test storm drainage piping system in accordance with applicable code local authority having jurisdiction

3.10 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Clean and disinfect domestic water distribution system in accordance with IPC 2012, local AHJ and Section 33 13 00

END OF SECTION

SECTION 220516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Each Contractor, Subcontractor and/or supplier providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 SUMMARY

- A. Section Includes:
 - 1. Flexible pipe connectors.
 - 2. Expansion joints.
 - 3. Expansion compensators.
 - 4. Pipe alignment guides.
 - 5. Swivel joints.
 - 6. Pipe anchors.

- B. Related Sections:
1. Section 22 04 00 – General Conditions for Plumbing Trades
 2. Section 22 05 00 – Common work results for Plumbing
 3. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment
 4. Section 22 05 23 - General-Duty Valves for Plumbing Piping
 5. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
 6. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment
 7. Section 22 05 53 – Identification for Plumbing Piping and Equipment
 8. Section 22 07 00 - Plumbing Insulation
 9. Section 22 21 23 – Plumbing Pumps
 10. Section 22 30 00 – Plumbing Specialties
 11. Section 22 34 00 – Fuel Fired Domestic Water Heaters
 12. Section 22 40 00 – Plumbing Fixtures

1.5 REFERENCES

- A. American Society of Mechanical Engineers:
1. ASME B31.9 - Building Services Piping.
 2. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.
- B. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.

1.6 DESIGN REQUIREMENTS

- A. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.
- B. Expansion Compensation Design Criteria:
1. Installation Temperature: 50 degrees F.
 2. Domestic Hot Water: 140 degrees F.
 3. Safety Factor: 30 percent.

1.7 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawings: Indicate layout of piping systems, including flexible connectors, expansion joints, expansion compensators, loops, offsets and swing joints. Submit shop drawings sealed by a registered professional engineer.
- C. Product Data:
1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.

2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
- D. Design Data: Indicate criteria and show calculations. Submit sizing methods and calculations sealed by a registered professional engineer.
- E. Manufacturer's Installation Instructions: Submit special procedures.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- G. Welders' Certificate: Include welders' certification of compliance with ASME Section IX. AWS D1.1.
- H. Manufacturer's Field Reports: Indicate results of inspection by manufacturer's representative.
- I. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.8 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.
- C. Operation and Maintenance Data: Submit adjustment instructions.

1.9 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- B. Maintain one copy of each document on site.
- C. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.10 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.
- C. Design expansion compensating system under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location.

1.11 PRE-INSTALLATION MEETINGS

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

1.12 DELIVERY, STORAGE, AND HANDLING

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

1.13 WARRANTY

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

1.14 EXTRA MATERIALS

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

PART 2 PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS

- A. Manufacturers:
 - 1. Metroflex
 - 2. Mason
 - 3. Vibration Eliminator
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Steel Piping:
 - 1. Inner Hose: Carbon Steel Stainless Steel Bronze.
 - 2. Exterior Sleeve: None single braided Double braided stainless steel bronze.
 - 3. Pressure Rating: F 200 psig WOG and 250 degrees F
 - 4. Joint: As specified in Section 22 05 03.
 - 5. Size: Use pipe-sized units.
 - 6. Maximum offset: 3/4 inch on each side of installed center line.
- C. Copper Piping:
 - 1. Inner Hose: Bronze.
 - 2. Exterior Sleeve: Braided bronze.
 - 3. Pressure Rating: 200 psig WOG and 250 degrees F.
 - 4. Joint: As specified in Section 22 05 03.
 - 5. Size: Use pipe sized units.
 - 6. Maximum offset: 3/4 inch on each side of installed center line.

2.2 EXPANSION JOINTS

- A. Manufacturers:
 - 1. Metroflex
 - 2. Mason
 - 3. Vibration Eliminator
 - 4. Substitutions: Section 01 60 00 - Product Requirements.

- B. Stainless Steel Bellows Type:
1. Pressure Rating: 200 psig WOG and 250 degrees F.
 2. Maximum Compression: 1-3/4 inch.
 3. Maximum Extension: 1/4 inch.
 4. Joint: As specified in Section 22 05 03.
 5. Size: Use pipe sized units.
 6. Application: Steel piping 3 inch and smaller.
- C. External Ring Controlled Stainless Steel Bellows Type:
1. Pressure Rating: 200 psig WOG and 250 degrees F.
 2. Maximum Compression: 1-1/4 inch.
 3. Maximum Extension: 3/8 inch.
 4. Maximum Offset: 5/16 inch.
 5. Joint: Flanged.
 6. Size: Use pipe sized units.
 7. Accessories: Internal flow liner.
 8. Application: Steel piping 3 inch and larger.
- D. Double Sphere, Flexible Compensators:
1. Body: Teflon Neoprene and nylon
 2. Working Pressure: 200 psi.
 3. Maximum Temperature: 250 degrees F.
 4. Maximum Compression: 1 inch.
 5. Maximum Elongation: 5/8 inch.
 6. Maximum Offset: 3/4 inch.
 7. Maximum Angular Movement: 30 degrees.
 8. Joint: Tapped steel flanges Galvanized flanges Galvanized unions.
 9. Size: Use pipe sized units.
 10. Accessories: Control rods Control cables.
 11. Application: Steel piping 2 inch and larger.
- E. Two-ply Bronze Bellows Type:
1. Construction: Bronze with anti-torque device, limit stops, internal guides.
 2. Pressure Rating: 200 psi WOG and 250 degrees F.
 3. Maximum Compression: 1-3/4 inch.
 4. Maximum Extension: 1/4 inch.
 5. Joint: As specified in Section 22 05 03.
 6. Size: Use pipe sized units.
 7. Application: Copper piping.
- F. Low Pressure Compensators with two-ply Bronze Bellows:
1. Working Pressure: 80 psig.
 2. Maximum Temperatures: 250 degrees F.
 3. Maximum Compression: 1/2 inch.
 4. Maximum Extension: 5/32 inch.
 5. Joint: Soldered.
 6. Size: Use pipe sized units.
 7. Application: Copper or steel piping 2 inch and smaller.

- G. Copper with Packed Sliding Sleeve:
 - 1. Maximum Temperature: 250 degrees F.
 - 2. Joint: As specified in Section 22 05 03.
 - 3. Size: Use pipe sized units.
 - 4. Copper or steel piping 2 inches and larger.
 - 5. Application: Copper or steel piping 2 inch and larger.

2.3 ACCESSORIES

- A. Manufacturers:
 - 1. Metroflex
 - 2. Mason
 - 3. Vibration Eliminator
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Pipe Alignment Guides: Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inch travel.
- C. Swivel Joints: Fabricated steel Cast steel body, double ball bearing race, field lubricated, with rubber (Buna-N) o-ring seals.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install Work in accordance with ASME B31.9
- B. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Refer to Section 22 05 48. Provide line size flexible connectors.
- C. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
- D. Rigidly anchor pipe to building structure. Provide pipe guides to direct movement only along axis of pipe. Erect piping so strain and weight is not on cast connections or apparatus.
- E. Provide support and anchors for controlling expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required as indicated on Drawings. Refer to Section 22 05 29 for pipe hanger installation requirements.
- F. Provide grooved piping systems with minimum one joint per inch pipe diameter instead of flexible connector supported by vibration isolation. Grooved piping systems need not be anchored.

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- G. Provide expansion loops throughout building for all plumbing systems at expansion joints as indicated on structural and architectural Drawings. All assemblies provided for vibration, and expansion shall be listed for such use.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Section 01 40 00 - Quality Requirements: Manufacturers' field services.
- B. Furnish inspection services by flexible pipe manufacturer's representative for final installation and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Gate valves.
2. Ball valves.
3. Butterfly valves.
4. Check valves.
5. Globe.
6. Pressure reducing.
7. Pressure relief.
8. Strainers.
9. Flow control devices.
10. Balancing valves.
11. Reduced pressure backflow preventers.
12. Thermostatic mixing valves

B. Related Sections:

1. Section 22 04 00 – General Conditions for Plumbing Trades
2. Section 22 05 00 – Common work results for Plumbing
3. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment
4. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping
5. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment
6. Section 22 05 53 – Identification for Plumbing Piping and Equipment
7. Section 22 07 00 - Plumbing Insulation
8. Section 22 21 23 – Plumbing Pumps
9. Section 22 30 00 – Plumbing Specialties
10. Section 22 34 00 – Fuel Fired Domestic Water Heaters
11. Section 22 40 00 – Plumbing Fixtures

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. ASTM International:
 - 1. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
 - 2. ASTM D4101 - Standard Specification for Propylene Injection and Extrusion Materials.
- B. Manufacturers Standardization Society of the Valve and Fittings Industry:
 - 1. MSS SP 67 - Butterfly Valves.
 - 2. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
 - 3. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
 - 4. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
 - 5. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
 - 6. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
- C. Safe Drinking Water Act:
 - 1. SDWA 1417 - Reduction of Lead in Drinking Water.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit manufacturers catalog information with valve data and ratings for each service.
- C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- E. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:

- a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of valves.
- C. Operation and Maintenance Data: Submit installation instructions, spare parts lists, exploded assembly views.

1.7 QUALITY ASSURANCE

- A. For drinking water service, provide valves complying with NSF 61.
- B. All valves installed on the domestic water distribution system shall comply with SDWA 1417. Exception shall be main shut-off valve at domestic water service entrance that is 2-inches or larger.
- C. All valve manufacturers shall demonstrate that valve products have been certified per NSF/ANSI Standard 372.
- D. All valves installed on the domestic water system shall have labeling of lead content engraved on the valve body.
- E. Maintain one copy of document on site.
- F. To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by Victaulic or an Engineer Approved Equal

- G. High Performance Building Requirements:
1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum years documented experience.

1.9 PRE-INSTALLATION MEETINGS

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

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not install valves underground when bedding is wet or frozen.

1.12 WARRANTY

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

1.13 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for extra materials.
- B. Furnish two packing kits for each size valve.

PART 2 PRODUCTS

2.1 GATE VALVES

- A. Manufacturers:
 - 1. Apollo
 - 2. Milwaukee Valve Co.
 - 3. NIBCO, Inc.
 - 4. American Valve Co.
 - 5. Watts
 - 6. Substitutions: Section 01 60 00 - Product Requirements.
- B. 2 inches and Smaller: MSS SP 80, Class 300, bronze body, bronze trim, lead free, threaded bonnet, non-rising stem, hand-wheel, inside screw, solid wedge disc, solder ends, Milwaukee Valve Company Model # UP115.
- C. 2 1/2 inches and Larger: MSS SP 70, Class 175, cast iron body, bronze trim, bolted bonnet, rising stem, hand-wheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends, Milwaukee Valve Company F-2885-FP. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.2 BALL VALVES

- A. Manufacturers:
 - 1. Apollo
 - 2. Milwaukee Valve Co.
 - 3. NIBCO, Inc.
 - 4. American Valve Co.
 - 5. Watts
 - 6. Substitutions: Section 01 60 00 - Product Requirements.
- B. 2 inches and Smaller: MSS SP 110, 600 psi WOG, two piece bronze body, lead free, type 316 stainless steel ball, full port, teflon seats, stainless steel blow-out proof stem, solder ends with lever handle, Milwaukee Valve Company Model #UPBA450S.
- C. 2 inches and Smaller: MSS SP 110, Class 600, bronze, three piece body, lead free, type 316 stainless steel ball, full port, teflon seats, blow-out proof stem, solder ends, lever handle, Milwaukee Valve Company Model #UPBA350S.

2.3 BUTTERFLY VALVES

- A. Manufacturers:
1. Victaulic
 2. Milwaukee Valve Company
 3. NIBCO, Inc.
 4. American Valve Co.
 5. Watts
 6. Substitutions: Section 01 60 00 - Product Requirements.
- B. 2-inches and Larger: MSS SP 67, Class 200.
1. Body: Cast bronze, lug ends, stainless steel stem, extended neck.
 2. Disc: Aluminum bronze.
 3. Seat: Resilient replaceable EPDM or Fluoroelastomer.
 4. Handle and Operator: 10 position lever handle. Furnish gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.
 5. Milwaukee Valve Company Model # ML 233E.
- C. 2-1/2 inches and Larger: MSS SP 67, 300 CWP.
1. Body: Cast bronze, grooved ends
 2. Disc: Offset ductile iron
 3. Seat: Resilient replaceable Fluoroelastomer
 4. Handle and Operator: 10 position lever handle. Furnish chain-wheel operators for valves mounted over 8 feet above floor
 5. Victaulic Model #608N.

2.4 CHECK VALVES

- A. Horizontal Swing Check Valves:
1. Manufacturers:
 - a. Apollo
 - b. Milwaukee Valve Co.
 - c. NIBCO, Inc.
 - d. American Valve Co.
 - e. Watts
 - f. Substitutions: Section 01 60 00 - Product Requirements.
 2. 2 inches and Smaller: MSS SP 80, Class 300, bronze body and cap, bronze seat, brass disc, solder ends, Milwaukee Valve Co. Model # 1509.
 3. 2-1/2 inches and Larger: MSS SP 71, Class 125 cast iron body, bolted cap, bronze or cast iron disc, renewable disc seal and seat, flanged ends.
- B. Spring Loaded Check Valves:
1. Manufacturers:
 - a. Apollo
 - b. Milwaukee Valve Company
 - c. NIBCO, Inc.
 - d. American Valve Co.
 - e. Watts

- f. Substitutions: Section 01 60 00 - Product Requirements.
- 2. 2 inches and Smaller: MSS SP 80, Class 250 bronze body, in-line spring lift check, silent closing, Buna-N disc, integral seat, solder or threaded ends.
- 3. 2-1/2 inches and Larger: MSS SP 125, Class 125, lead free, wafer style, cast iron body, bronze seat, center guided bronze disc, stainless steel spring and screws, flanged ends, Nibco Model # F-910-LF.

2.5 GLOBE VALVES

- A. Up to and including 2-inch:
 - 1. Bronze body, bronze trim, screwed bonnet, non-asbestos packing, rising stem, handwheel, inside screw, renewable composition disc and bronze seat, Class 125,
- B. Over 2-inch:
 - 1. Iron body, bronze trim, bolted bonnet, rising stem, non-asbestos packing, handwheel, outside screw and yoke, rotating plug-type disc with renewable seat ring and disc, Class 125, flanged ends, MSS-SP-85. Provide chain wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.6 WATER PRESSURE REDUCING VALVES

- A. Watts Model 223:
 - 1. Up to 2 Inches (50 mm): Bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, threaded ends, with strainer.
 - 2. Over 2 Inches (50 mm): Cast iron body, bronze fitted, elastomeric diaphragm and seat disc, flanged, with strainer, MSS-SP-80.

2.7 TEMPERATURE AND PRESSURE RELIEF VALVES

- A. Watts Model 40, 140, N240, 340:
 - 1. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.

2.8 STRAINERS

- A. Watts series 77:
 - 1. Size 2 inch (50 mm) and Under: Screwed brass or iron body for 175 psig (1200 kPa) working pressure, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.
 - 2. Size 2-1/2 inch (65 mm) to 4 inch (100 mm): Flanged cast iron body, Class 125 for 200 psig (1370 kPa) working pressure, Y pattern with 3/64 inch (1.2 mm) stainless steel perforated screen.

2.9 FLOW CONTROL VALVES

- A. FDI Series ICSS.
 - 1. Construction: series 300 stainless steel body with nickel plated union nut.
 - 2. Threaded inlet and outlet connection.

3. Automatic flow cartridge, stainless steel with machined piston, stainless steel spring, factory set calibration.
4. Maximum operating temperature: 180 degrees F.
5. NSF 61 certification.

B. Victaulic/TA Series 76X:

1. Construction: series 300 stainless steel body with nickel plated union nut.
2. Threaded inlet and outlet connection.
3. Automatic flow cartridge, stainless steel with machined piston, stainless steel spring, factory set calibration.
4. Maximum operating temperature: 180 degrees F.
5. NSF 61 certification.

2.10 BALANCING VALVES

A. Bell & Gossett CB Series:

1. Construction: Brass or bronze body with union on inlet, temperature and pressure test plug on inlet and outlet.
2. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control.

2.11 BACKFLOW PREVENTERS

- A. Reduced Pressure Backflow Preventers: ANSI/ASSE 1013, AWWA C506; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; test cocks, Watts 909 or equal.

2.12 THERMOSTATIC MIXING VALVES

- A. Manufacturers: Powers model as scheduled on the drawings.

B. Other acceptable manufacturers offer equivalent products:

1. Lawler
2. Leonard
3. Powers
4. Acorn

C. Accessories:

1. Check valves on inlets.
2. Volume control shut-off valve on outlet.
3. Stem thermometer on outlet.
4. Strainer stop checks on inlets.

- D. Temp control thermostatic controller with swivel action check stops, removable cartridge with strainer, stainless steel piston and liquid filled motor with bellows mounted out of water, rough brass finish

- E. Valve body: lead free bronze or brass.
- F. Cabinet: 16 gage (1.5 mm) prime coated steel, for surface mounting with keyed lock.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify piping system is ready for valve installation.

3.2 INSTALLATION

- A. Install valves with stems upright or horizontal, not inverted.
- B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- C. Install 3/4 inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.
- D. Install valves with clearance for installation of insulation and allowing access.
- E. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Section 08 31 13.
- F. Refer to Section 22 05 29 for pipe hangers.
- G. Refer to Section 22 07 00 for insulation requirements for valves.
- H. Refer to Section 22 05 03 for piping materials applying to various system types.

3.3 VALVE APPLICATIONS

- A. Install shutoff and drain valves at locations indicated on Drawings in accordance with this Section.
- B. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- C. Install globe valves for throttling, bypass, or manual flow control services.
- D. Install spring loaded check valves on discharge of water pumps.
- E. Install lever and weight lever and spring check valves on discharge of pumps in pumped sanitary piping.

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- F. Install lug or grooved end butterfly valves adjacent to equipment when functioning to isolate equipment.
- G. Install flow control valves at the remote part of the domestic hot water return system. Valve size shall be minimum of 3/4-inch
- H. Provide line sized isolation valves on all domestic water branches greater than 3/4" when more than two fixtures are supplied.
- I. Install butterfly valves in domestic water systems for shut-off service.

END OF SECTION

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Pipe hangers and supports.
 2. Hanger rods.
 3. Inserts.
 4. Flashing.
 5. Sleeves.
 6. Mechanical sleeve seals.
 7. Formed steel channel.
 8. Firestopping relating to plumbing work.
 9. Firestopping accessories.
 10. Equipment bases and supports.
- B. Related Sections:
1. Section 03 10 00 - Concrete Forming and Accessories: Execution requirements for placement of inserts sleeves in concrete forms specified by this section.
 2. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for placement of concrete housekeeping pads specified by this section.
 3. Section 22 04 00 – General Conditions for Plumbing Trades
 4. Section 22 05 00 – Common work results for Plumbing
 5. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment
 6. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping
 7. Section 22 05 23 - General-Duty Valves for Plumbing Piping
 8. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment
 9. Section 22 05 53 – Identification for Plumbing Piping and Equipment
 10. Section 22 07 00 - Plumbing Insulation
 11. Section 22 15 00 – Specialty Plumbing Systems and Equipment
 12. Section 22 30 00 – Plumbing Specialties
 13. Section 22 34 00 – Fuel Fired Domestic Water Heaters
 14. Section 22 40 00 – Plumbing Fixtures

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest

extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 PHASE 2 SUPPORT REQUIREMENTS

- A. All mechanical systems including equipment, ductwork, piping and accessories being hung from above shall not be supported from the existing "space truss" roof structure unless noted otherwise. Systems shall be supported from new framing only. Refer to structural drawings for locations of new framing. Provide supplemental framing as required.

1.5 REFERENCES

- A. American Society of Mechanical Engineers:
 - 1. ASME B31.1 - Power Piping.
 - 2. ASME B31.5 - Refrigeration Piping.
 - 3. ASME B31.9 - Building Services Piping.
- B. ASTM International:
 - 1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 3. ASTM E814 - Standard Test Method for Fire Tests of Through Penetration Fire Stops.
 - 4. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
 - 5. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
- C. American Welding Society:
 - 1. AWS D1.1 - Structural Welding Code - Steel.
- D. FM Global:
 - 1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

- E. Manufacturers Standardization Society of the Valve and Fittings Industry:
 - 1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 - 2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
 - 3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- F. Underwriters Laboratories Inc.:
 - 1. UL 263 - Fire Tests of Building Construction and Materials.
 - 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
 - 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
 - 4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
 - 5. UL - Fire Resistance Directory.
- G. Intertek Testing Services (Warnock Hersey Listed):
 - 1. WH - Certification Listings.

1.6 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.7 SYSTEM DESCRIPTION

- A. Firestopping Materials: ASTM E119 ASTM E814 UL 263 UL 1479 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating.
- B. Firestopping Materials: ASTM E119, ASTM E814, UL 263, UL 1479, to achieve fire ratings of adjacent construction noted in Schedule at end of this section. in accordance with FM UL WH noted in Schedule at end of this section.
- C. Firestop interruptions to fire rated assemblies, materials, and components.

1.8 PERFORMANCE REQUIREMENTS

- A. Firestopping: Conform to applicable code FM UL WH for fire resistance ratings and surface burning characteristics.
- B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.9 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.

- C. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
 - 2. Firestopping: Submit data on product characteristics, performance and limitation criteria.

- D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.

- E. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers. Submit sizing methods calculations sealed by a registered professional engineer.

- F. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.
 - 2. Firestopping: Submit preparation and installation instructions.

- G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

- H. Engineering Judgements: For conditions not covered by UL or WH listed designs, submit judgements by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

- I. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.10 QUALITY ASSURANCE

- A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 - 1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
 - 2. Floor and Roof Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 - a. Floor Penetrations within Wall Cavities: T-Rating is not required.
- B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
 - 1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
 - 2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.
- C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.
- D. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.
- E. Surface Burning Characteristics: Maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
- F. Perform Work in accordance with applicable authority AWS D1.1 for welding hanger and support attachments to building structure.
- G. Maintain one copy of each document on site.
- H. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.11 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum years documented experience.

1.12 PRE-INSTALLATION MEETINGS

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

1.13 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.14 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.
- C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.
- D. Provide ventilation in areas to receive solvent cured materials.

1.15 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.16 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for pipe hangers and supports.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:

1. Nibco
2. Empire
3. Flex-Weld, Inc.
4. Glope Pipe Hanger Products Inc.
5. Michigan Hanger Co.
6. Superior Valve Co.
7. Substitutions: Section 01 60 00 - Product Requirements.

B. Plumbing Piping - DWV:

1. Conform to ASME B31.9 ASTM F708 MSS SP58 MSS SP69 MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron Carbon steel, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
6. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Copper-plated, carbon-steel adjustable, ring.

C. Plumbing Piping - Water:

1. Conform to ASME B31.9 ASTM F708 MSS SP58 MSS SP69 MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron Carbon steel, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
6. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
7. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
8. Vertical Support: Steel riser clamp.
9. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
10. Floor Support for Hot Pipe Sizes 4 inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
11. Copper Pipe Support: Copper-plated, Carbon-steel ring.

2.2 ACCESSORIES

- A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.3 INSERTS

- A. Manufacturers:
 - 1. Thunderline
 - 2. Link Seal
 - 3. Fernco
 - 4. BWM
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

- A. Metal Flashing: 26 gage thick galvanized steel.
- B. Metal Counterflashing: 22 gage thick galvanized steel.
- C. Lead Flashing:
 - 1. Waterproofing: 5 lb./sq. ft sheet lead.
 - 2. Soundproofing: 1 lb./sq. ft sheet lead.
- D. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.
- E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.5 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
- C. Sealant: Acrylic; refer to Section 07 90 00.

2.6 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
 - 1. Thunderline Link-Seal, Inc.
 - 2. NMP Corporation
 - 3. Fernco
 - 4. BWM Model
 - 5. Substitutions: Section 01 60 00 - Product Requirements.

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

2.7 FORMED STEEL CHANNEL

- A. Manufacturers:
1. Allied Tube & Conduit Corp.
 2. B-Line Systems
 3. Midland Ross Corporation, Electrical Products Division
 4. Unistrut Corp.
 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Galvanized 12 gage) thick steel. With holes 1-1/2 inches on center.

2.8 FIRESTOPPING

- A. Manufacturers:
1. Dow Corning Corp.
 2. Fire Trak Corp.
 3. Hilti Corp.
 4. International Protective Coating Corp.
 5. 3M fire Protection Products
 6. Specified Technology, Inc.
 7. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
1. Silicone Firestopping Elastomeric Firestopping: Single component silicone elastomeric compound and compatible silicone sealant.
 2. Foam Firestopping Compounds: Single component foam compound.
 3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
 4. Fiber Stuffing and Sealant Firestopping: Composite of mineral fiber stuffing insulation with silicone elastomer for smoke stopping.
 5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
 6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
 7. Firestop Pillows: Formed mineral fiber pillows.
- C. Color:As selected from manufacturer's full range of colors.

2.9 FIRESTOPPING ACCESSORIES

- A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.
- B. Dam Material: Permanent:
 - 1. Mineral fiberboard.
 - 2. Mineral fiber matting.
 - 3. Sheet metal.
 - 4. Plywood or particle board.
 - 5. Alumina silicate fire board.
- C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.
- D. General:
 - 1. Furnish UL listed products or products tested by independent testing laboratory.
 - 2. Select products with rating not less than rating of wall or floor being penetrated.
- E. Non-Rated Surfaces:
 - 1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
 - 2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify openings are ready to receive sleeves.
- C. Verify openings are ready to receive firestopping.

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
- B. Remove incompatible materials affecting bond.
- C. Install damming materials to arrest liquid material leakage.
- D. Obtain permission from Architect/Engineer before using powder-actuated anchors.
- E. Obtain permission from Architect/Engineer before drilling or cutting structural members.

3.3 INSTALLATION - INSERTS

- A. Install inserts for placement in concrete forms.
- B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above flush with top of recessed into and grouted flush with slab.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.1 ASME B31.5 ASME 31.9 ASTM F708 MSS SP 58 MSS SP 69 MSS SP 89.
- B. Support horizontal piping as scheduled.
- C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Use hangers with 1-1/2 inch minimum vertical adjustment.
- F. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.
- G. Support vertical piping at every other floor. Support vertical cast iron pipe at each floor at hub.
- H. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
- I. Support riser piping independently of connected horizontal piping.
- J. Provide copper plated hangers and supports for copper piping sheet lead packing between hangers or support and piping.
- K. Design hangers for pipe movement without disengagement of supported pipe.
- L. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

- M. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 22 07 00.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment Refer to Section 03 30 00.
- B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members formed steel channel steel pipe and fittings Brace and fasten with flanges bolted to structure.
- D. Provide rigid anchors for pipes after vibration isolation components are installed. Refer to Section 22 05 48.

3.6 INSTALLATION - FLASHING

- A. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs.
- B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked 1 inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter-flash, and seal.
- C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.
- D. Seal floor, shower, mop sink drains watertight to adjacent materials.
- E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.7 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with mechanical sleeve seals.
- B. Set sleeves in position in forms. Provide reinforcing around sleeves.
- C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- E. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent work with firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

F. Install chrome plated steel or stainless steel escutcheons at finished surfaces.

3.8 INSTALLATION - FIRESTOPPING

A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items, requiring firestopping. Refer to Section 07 84 13

3.9 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.10 CLEANING

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

B. Clean adjacent surfaces of firestopping materials.

3.11 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect adjacent surfaces from damage by material installation.

3.12 SCHEDULES

PIPE HANGER SPACING		
PIPE MATERIAL	MAXIMUM HANGER SPACING Feet	HANGER ROD DIAMETER Inches
Cast Iron (All Sizes)	5	5/8
Cast Iron (All Sizes) with 10 foot length of pipe	10	5/8
Copper Tube, 1-1/4 inches and smaller	6	1/2
Copper Tube, 1-1/2 inches and larger	10	1/2
Polybutylene	2.67	3/8
Polypropylene	4	3/8
PVC (All Sizes)	4	3/8
Steel, 3 inches and smaller	12	1/2
Steel, 4 inches and larger	12	5/8

END OF SECTION

SECTION 220548 - VIBRATION AND SEISMIC CONTROLS FOR
PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 INTENT

- A. All plumbing equipment and piping as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
- B. All isolators and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.
- C. It is the intent of the seismic portion of this specification to keep all mechanical and electrical building system components in place during a seismic event.
- D. All such systems must be installed in strict accordance with seismic codes, component manufacturer's recommendations and building construction standards. Whenever a conflict occurs between the manufacturer's recommendations or construction standards, the most stringent shall apply.
- E. This specification is considered to be minimum requirements for seismic consideration and is not intended as a substitute for legislated, more stringent, national, state or local construction requirements.
- F. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 SUMMARY

- A. Section Includes:
1. Certification of seismic restraint designs and installation supervision.
 2. Certification of seismic attachment of housekeeping pads.
 3. NOTE: For all mechanical and electrical systems. Equipment buried underground is excluded but entry of services through the foundation wall is included.
 4. Seismic restraint products
 - a. Vibration isolation elements.
 - b. Equipment isolation bases.
 - c. Piping flexible connections.
 - d. Seismic restraints for isolated and non-isolated mechanical and electrical items.
 5. Inertia bases.
- B. Related Sections:
1. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for placement of isolators in floating floor slabs specified by this section and product requirements for concrete for placement by this section.
 2. Section 07 90 00 - Joint Protection: Product requirements for joint sealers specified for placement by this section.
 3. Section 23 04 00 – General Conditions for Mechanical Trades
 4. Section 22 04 00 – General Conditions for Plumbing Trades
 5. Section 22 05 00 – Common work results for Plumbing
 6. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment
 7. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping
 8. Section 22 05 23 - General-Duty Valves for Plumbing Piping
 9. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
 10. Section 22 05 53 – Identification for Plumbing Piping and Equipment
 11. Section 22 07 00 - Plumbing Insulation
 12. Section 22 21 23 – Plumbing Pumps
 13. Section 22 30 00 – Plumbing Specialties
 14. Section 22 34 00 – Fuel Fired Domestic Water Heaters
 15. Section 22 40 00 – Plumbing Fixtures

1.5 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI S1.4 - Sound Level Meters.
 - 2. ANSI S1.8 - Reference Quantities for Acoustical Levels.
 - 3. ANSI S12.36 - Survey Methods for the Determination of Sound Power Levels of Noise Sources.
- B. Air-Conditioning and Refrigeration Institute:
 - 1. ARI 575 - Method of Measuring Machinery Sound within Equipment Space.
- C. American Society of Heating, Refrigerating and:
 - 1. ASHRAE Handbook - HVAC Applications.

1.6 RELATED WORK

- A. Housekeeping Pads
 - 1. Housekeeping pad reinforcement and monolithic pad attachment to the structure details and design shall be prepared by the restraint vendor if not already indicated on the drawings.
 - 2. Housekeeping pads shall be coordinated with restraint vendor and sized to provide a minimum edge distance of ten (10) bolt diameters all around the outermost anchor bolt to allow development of full drill-in wedge anchor ratings. If cast-in anchors are to be used, the housekeeping pads shall be sized to accommodate the ACI requirements for bolt coverage and embedment.
- B. Supplementary Support Steel
 - 1. Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc. including roof mounted equipment, as required or specified.
- C. Attachments
 - 1. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the vibration vendor's calculations.

1.7 SEISMIC FORCE LEVELS

- A. Installations shall be designed to safely accept external forces determined in accordance with the International Building Code –2012, Section 16 in any direction for all rigidly supported equipment without failure and permanent displacement of the equipment. Seismic restraints shall not short circuit vibration isolation systems or transmit objectionable vibration or noise.

1.8 PERFORMANCE REQUIREMENTS

- A. Provide vibration isolation on motor driven equipment over 0.5 hp, plus connected piping.

- B. Provide minimum static deflection of isolators for equipment as follows:
1. Basement, Under 20 hp
 - a. 400 - 600 rpm: 1 inch
 - b. 600 - 800 rpm: 0.5 inch
 - c. 800 - 900 rpm: 0.2 inch
 - d. 1100 - 1500 rpm: 0.14 inch
 - e. Over 1500 rpm: 0.1 inch
 2. Basement, Over 20 hp
 - a. 400 - 600 rpm: 2 inch
 - b. 600 - 800 rpm: 1 inch
 - c. 800 - 900 rpm: 0.5 inch
 - d. 1100 - 1500 rpm: 0.2 inch
 - e. Over 1500 rpm: 0.15 inch
- C. Use concrete inertia bases for motors in excess of 40 hp and on base mounted pumps over 10 hp.
- D. Maintain sound level of spaces at levels not to exceed those listed below by utilizing acoustical devices.
- E. Maintain rooms at following maximum sound levels, in Noise Criteria (NC) Room Criteria (RC) as defined by ASHRAE Handbook., HVAC Applications, ANSI S1.8.
1. Offices
 - a. Executive: 30
 - b. Conference rooms: 30
 - c. Private: 35
 - d. Open-plan areas: 40
 - e. Computer/business machine areas: 45
 - f. Public circulation: 45
 2. Schools
 - a. Lecture and classrooms: 30
 - b. Open-plan classrooms: 35
 3. Libraries: 35
 4. Concert Halls and Legitimate Theaters
 - a. Theater: 25
 - b. Stage house: 25
 - c. Trap room: 25
 - d. Orchestra pit: 25
 - e. Rehearsal rooms: 25
 - f. Teaching studios: 30
 - g. Practice rooms: 30
 - h. Ensemble rooms: 30
 - i. Shop: 45

1.9 DEFINITIONS

- A. Life Safety Systems:
1. All systems involved with and/or connected to emergency power supply including all generators, transfer switches, transformers and all flow paths to fire protection and/or emergency lighting systems.
 2. All medical and life support systems.
- B. Positive Attachment:
1. A positive attachment is defined as a cast-in anchor, a drill-in wedge anchor, a double sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure. Single sided "C" type beam clamps for support rods of overhead piping, ductwork, fire protection, electrical conduit, bus duct, or cable trays, or any other equipment are not acceptable on this project as seismic anchor points.
- C. Transverse Bracing:
1. Restraint(s) applied to limit motion perpendicular to the centerline of the pipe, duct or conduit.
- D. Longitudinal Bracing:
1. Restraint(s) applied to limit motion parallel to the centerline of the pipe, duct or conduit.
- E. Failure
1. For the purposes of this project, failure is defined as the discontinuance of any attachment point between equipment or structure, vertical permanent deformation greater than 1/8" (3mm) and/or horizontal permanent deformation greater than 1/4" (6mm).

1.10 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings:
1. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
 2. Provide Drawings showing methods of suspension and support guides for conduit, piping and ceiling hung equipment.
 3. Record actual locations and installation of vibration isolators and seismic restraints including attachment points.
 4. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
 5. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.

6. Drawings showing methods for isolation of conduits and pipes penetrating walls and floor slabs.
 7. Specific details of restraints including anchor bolts for mounting and maximum loading at each location, for each piece of equipment and/or pipe locations.
- C. Product Data: Submit schedule of vibration isolator type with location and load on each. Submit catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.
- D. Seismic Certification and Analysis:
1. Seismic restraint calculations must be provided for all connections of equipment to the structure. Calculations must be stamped by a registered professional engineer with at least five years of seismic design experience, licensed in the state of the job location.
 2. All restraining devices shall have a preapproval number from some other recognized government agency showing maximum restraint ratings. Preapprovals based on independent testing are preferred to preapprovals based on calculations. Where preapproved devices are not available, submittals based on independent testing are preferred. Calculations (including the combining of tensile and shear loadings) to support seismic restraint designs must be stamped by a registered professional engineer with at least five years of seismic design experience and licensed in the state of the job location. Testing and calculations must include both shear and tensile loads as well as one test or analysis at 45 degrees to the weakest mode.
 3. Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, the forces detailed in section 1.06 acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.
- E. Design Data: Submit calculations indicating maximum room sound levels are not exceeded. Use sound power levels of actual equipment to be installed on project. Analysis shall include breakout noise calculations. In the absence of specified background sound level criteria, the guidelines as express in Table 34 of Chapter 47, "Sound and Vibration Control" of the 2015 ASHRAE Handbook – HVAC Applications, shall be used.
- F. Test Reports: Indicate dynamic insertion loss and noise generation values of silencers. Acoustic housings meet or exceed specified sound transmission loss values.
- G. Manufacturer's Installation Instructions: Submit special procedures and setting dimensions. Indicate installation requirements maintaining integrity of sound isolation.
- H. Manufacturer's Certificate: Certify isolators meet or exceed specified requirements.
- I. Manufacturer's Field Reports: Indicate sound isolation installation is complete and in accordance with instructions.

- J. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.11 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of hangers including attachment points.

1.12 QUALITY ASSURANCE

- A. Perform Work in accordance with ARI 575 ANSI S12.36.
- B. Maintain one copy of each document on site.
- C. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.13 QUALIFICATIONS

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

1.14 PRE-INSTALLATION MEETINGS

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

1.15 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.16 CONTRACTOR'S RESPONSIBILITIES

- A. Contractor shall have the following responsibilities:
 - 1. Determine vibration isolation and seismic restraint sizes and locations per specifications.
 - 2. Provide and install isolation systems and seismic restraints as scheduled or specified.
 - 3. Guarantee specified isolation system deflection.
 - 4. Provide installation instructions, drawings and field supervision to assure proper installation and performance.
 - 5. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.
 - 6. Substitution of "Internally Isolated" mechanical equipment in lieu of the specified isolation of this section is acceptable

1.17 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for inertia bases.

PART 2 PRODUCTS

2.1 INERTIA BASES

- A. Manufacturers:
 - 1. Mason
 - 2. Vibration Eliminator
 - 3. Vibro-Acoustics Ltd.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.

- B. Structural Bases:
 - 1. Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers.
 - 2. Construction: Welded structural steel with gusset brackets, supporting equipment and motor with motor slide rails.

- C. Concrete Inertia Bases:
 - 1. Mass: Minimum of 1.5 times weight of isolated equipment.
 - 2. Construction: Structured steel channel perimeter frame, with gusset brackets and anchor bolts, adequately reinforced, concrete filled.
 - 3. Connecting Point: Reinforced to connect isolators and snubbers to base.
 - 4. Concrete: Reinforced 3,000 psi concrete.

2.2 VIBRATION ISOLATORS

- A. Manufacturers:
 - 1. Mason
 - 2. Vibration Eliminator
 - 3. Amber Booth
 - 4. Substitutions: Section 01 60 00 - Product Requirements.

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

- C. Restrained Spring Isolators:
 - 1. Spring Isolators:
 - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.

- b. Code: Color code springs for load carrying capacity.
 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 3. Spring Mounts: Furnish with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
 4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
 5. Restraint: Furnish mounting frame and limit stops.
- D. Closed Spring Isolators:
1. Spring Isolators:
 - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
 3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance.
- E. Restrained Closed Spring Isolators:
1. Spring Isolators:
 - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
 3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance and limit stops.
- F. Spring Hanger:
1. Spring Isolators:
 - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
 - b. Code: Color code springs for load carrying capacity.
 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators rubber hanger with threaded insert.
 4. Misalignment: Capable of 20 degree hanger rod misalignment.
- G. Neoprene Pad Isolators:
1. Rubber or neoprene-waffle pads.
 - a. 30 durometer.
 - b. Minimum 1/2 inch thick.

- c. Maximum loading 40 psi.
 - d. Height of ribs: not to exceed 0.7 times width.
- 2. Configuration: Single layer.

- H. Rubber Mount or Hanger: Molded rubber designed for 0.5 inches deflection with threaded insert.

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

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

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify equipment and piping is installed before work in this section is started.

3.2 INSTALLATION

- A. Install isolation for motor driven equipment.
- B. Bases:
 - 1. Set steel bases for 1 inch clearance between housekeeping pad and base.
 - 2. Set concrete inertia bases for 2 inch clearance between housekeeping pad and base.
- C. Adjust equipment level.
- D. Install spring hangers without binding.
- E. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
- F. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
- G. Provide pairs of horizontal limit springs on fans with more than 6.0 inch static pressure, and on hanger supported, horizontally mounted axial fans.

- H. Provide resiliently mounted equipment and piping with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.05 inch maximum clearance. Provide other snubbers with clearance between 0.15 inch and 0.25 inch.
- I. Support piping connections to isolated equipment resiliently to nearest flexible pipe connector. as follows:
 - 1. Up to 4 inch Diameter: First three points of support.
 - 2. 5 to 8 inch Diameter: First four points of support.
 - 3. 10 inch Diameter and Over: First six points of support.
 - 4. Select three hangers closest to vibration source for minimum 1.0 inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch static deflection or 1/2 static deflection of isolated equipment.

3.3 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect isolated equipment after installation and submit report. Include static deflections.
- C. After start-up, final corrections and balancing of systems take octave band sound measurements over full audio frequency range in areas adjacent to plumbing equipment rooms, duct and pipe shafts, and other critical locations. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements. Submit complete report of test results including sound curves.
- D. Furnish services of testing agency to take noise measurement. Use meters meeting requirements of ANSI S1.4.

3.4 SCHEDULES

- A. Pipe Isolation Schedule:

Pipe Size Inch	Isolated Distance from Equipment
1	120 diameters
2	90 diameters
3	80 diameters
4	75 diameters
6	60 diameters
8	60 diameters
10	54 diameters
12	50 diameters

3.5 VIBRATION ISOLATION AND SEISMIC RESTRAINT INSTALLATION

- A. Horizontal pipe isolation: The first three pipe hangers in the main lines near the mechanical equipment shall be as described in specification 11. Specification 11 hangers must also be used in all transverse braced isolated locations. Brace hanger rods with SRC clamps specification 14. Horizontal runs in all other locations throughout the building shall be isolated by hangers as described in specification 10. Floor supported piping shall rest on isolators as described in specification 6. Heat exchanger's and expansion tanks are considered part of the piping run. The first three isolators from the isolated equipment will have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment located in basements and hangs from ceilings under occupied spaces the first three hangers shall have 0.75" (19mm) deflection for pipe sizes up to and including 3" (75mm), 1 1/2" (38mm) deflection for pipe sizes up to and including 6" (150mm), and 2 1/2" (64mm) deflection thereafter. Hangers shall be located as close to the overhead structure as practical. Where piping connects to mechanical equipment install specification 23 expansion joints or specification 24 stainless hoses if 23 is not suitable for the service.
- B. Riser isolation: Risers shall be suspended from specification 10 hangers or supported by specification 5 mountings, anchored with specification 25 anchors, and guided with specification 26 sliding guides. Steel springs shall be a minimum of 0.75" (19mm) except in those expansion locations where additional deflection is required to limit load changes to $\pm 25\%$ of the initial load. Submittals must include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and seismic loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.
- C. Seismic Restraint of Piping
1. Seismically restrain all piping listed as a, b or c below. Use specification 12 cables if isolated. Specification 12 or 13 restraints may be used on unisolated piping.
 - a. Fuel oil piping, gas piping, medical gas piping, and compressed air piping that is 1" (25mm) I.D. or larger.
 - b. Piping located in boiler rooms, mechanical equipment rooms, and refrigeration equipment rooms that is 1 1/4" (32mm) I.D. and larger.
 - c. All other piping 2 1/2" (64mm) diameter and larger.
 2. Transverse piping restraints shall be at 40' (12m) maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
 3. Longitudinal restraints shall be at 80' (24m) maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
 4. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.
 5. For fuel oil and all gas piping transverse restraints must be at 20' (6m) maximum and longitudinal restraints at 40' (12m) maximum spacing.
 6. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is

installed within 24" (600mm) of the elbow or TEE or combined stresses are within allowable limits at longer distances.

7. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
8. Branch lines may not be used to restrain main lines.
9. Cast iron pipe of all types, glass pipe and any other pipes joined with a four band shield and clamp assembly in Zones 2B, 3 and 4 shall be braced as in sections 3.2.D.2 and 3. For Zones 0, 1 and 2A, 2 band clamps may be used with reduced spacings of 1/2 of those listed in sections 3.2.D.2 and 3.

D. Vibration Isolation and Seismic Restraint of Plumbing Equipment

1. All equipment shall be vibration isolated and seismically restrained as per the schedules in part 3.5 of this specification.
2. Equipment mounted on housekeeping pads: Pads shall be properly doweled or expansion shielded to deck to meet acceleration criteria.
3. Requirements for installation on concrete inertia bases shall be as follows:
 - a. Minimum operating clearance between concrete inertia and base and housekeeping pad or floor shall be 2".
 - b. The equipment structural steel or concrete inertia base shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the machine or isolators.
 - c. The isolators shall be installed without raising the machine and frame assembly.
 - d. After the entire installation is complete and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. When all isolators are properly adjusted, the blocks or shims shall be barely free and shall be removed.
 - e. Install equipment with flexibility in wiring connection.
 - f. Verify that all installed isolator and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to flexibly limit start-up equipment lateral motion to 1/4".
 - g. Prior to start-up, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base, isolators, or seismic restraints.

3.6 SEISMIC RESTRAINT EXCLUSIONS

- A. General: All mechanical and electrical components and systems that are considered exempt from the requirement for seismic restraint, in accordance with The International Building Code – 2012, Section.16 and all related State of Connecticut Supplements, shall not require seismic restraint.
- B. Piping
 1. Piping in boiler and mechanical rooms less than 1 1/4" (32mm) inside diameter.
 2. All other piping less than 2 1/2" (64mm) inside diameter.
 3. All piping suspended by individual hangers 12" (300mm) or less as measured from the top of the pipe to the bottom of the support where the hanger is attached. However, if the 12" (300mm) limit is exceeded by any hanger in the run, seismic bracing is required for the run.

4. The 12" (300mm) exemption applies for trapeze supported systems if the top of each item supported by the trapeze qualifies.

3.7 INSPECTION

- A. Examine systems under provisions of Division 1.
- B. On completion of installation of all vibration isolation devices herein specified, the local representative shall inspect the completed system and report in writing any installation error, improperly elected isolation devices, or other faults in the system that could affect the performance of the system. Contractor shall submit a report to the Owner, including the manufacturers representatives' final report, indicating all isolation reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.

END OF SECTION

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Nameplates.
 - 2. Tags.
 - 3. Pipe markers.
 - 4. Ceiling tacks.
 - 5. Labels.
 - 6. Lockout devices.

- B. Related Sections:
 - 1. Section 09 90 00 - Painting and Coating: Execution requirements for painting specified by this section.
 - 2. Section 22 04 00 – General Conditions for Plumbing Trades
 - 3. Section 22 05 00 – Common work results for Plumbing
 - 4. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment
 - 5. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping
 - 6. Section 22 05 23 - General-Duty Valves for Plumbing Piping
 - 7. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
 - 8. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment
 - 9. Section 22 07 00 - Plumbing Insulation
 - 10. Section 22 21 23 – Plumbing Pumps
 - 11. Section 22 30 00 – Plumbing Specialties
 - 12. Section 22 34 00 – Fuel Fired Domestic Water Heaters
 - 13. Section 22 40 00 – Plumbing Fixtures

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. American Society of Mechanical Engineers:
 - 1. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit manufacturers catalog literature for each product required.
- C. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- F. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.

4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

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

1.7 QUALITY ASSURANCE

- A. Conform to NFPA 99 requirements for labeling and identification of medical gas piping systems and accessories.
- B. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.
- C. Maintain one copy of each document on site.
- D. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.9 PRE-INSTALLATION MEETINGS

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

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.11 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two containers of spray-on adhesive

PART 2 PRODUCTS

2.1 NAMEPLATES

- A. Manufacturers:
 - 1. Craftmark Identification Systems
 - 2. Safety Sign Co.
 - 3. Seton Identification Products
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS

- A. Metal Tags:
 - 1. Manufacturers:
 - a. Craftmark Identification Systems
 - b. Safety Sign Co.
 - c. Seton Identification Products
 - d. Substitutions: Section 01 60 00 - Product Requirements.
 - 2. Stainless Steel with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.
- B. Information Tags:
 - 1. Manufacturers:
 - a. Craftmark Identification Systems
 - b. Safety Sign Co.
 - c. Seton Identification Products

- d. Substitutions: Section 01 60 00 - Product Requirements.
- 2. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.
- C. Tag Chart: Typewritten letter size list of applied tags and location plastic laminated.

2.3 PIPE MARKERS

- A. Color and Lettering: Conform to ASME A13.1.
- B. Plastic Pipe Markers:
 - 1. Manufacturers:
 - a. Craftmark Identification Systems
 - b. Safety Sign Co.
 - c. Seton Identification Products
 - d. Substitutions: Section 01 60 00 - Product Requirements.
 - 2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.
- C. Plastic Tape Pipe Markers:
 - 1. Manufacturers:
 - a. Craftmark Identification Systems
 - b. Safety Sign Co.
 - c. Seton Identification Products
 - d. Substitutions: Section 01 60 00 - Product Requirements.
 - 2. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- D. Plastic Underground Pipe Markers:
 - 1. Manufacturers:
 - a. Seton
 - b. Northtown
 - c. Kolbi
 - d. Substitutions: Section 01 60 00 - Product Requirements.
 - 2. Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.4 CEILING TACKS

- A. Manufacturers:
 - 1. Seton
 - 2. Northtown
 - 3. Kolbi
 - 4. Substitutions: Section 01 60 00 - Product Requirements.

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

2.5 LABELS

- A. Manufacturers:
 - 1. Seton
 - 2. Northtown
 - 3. Kolbi
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Description: Aluminum, size 1.9 x 0.75 inches, adhesive backed with printed identification and bar code.

2.6 LOCKOUT DEVICES

- A. Lockout Hasps:
 - 1. Manufacturers:
 - a. Seton
 - b. Brady
 - c. Omark
 - d. Substitutions: Section 01 60 00 - Product Requirements
 - 2. Reinforced nylon hasp with erasable label surface; size minimum 7-1/4 x 3 inches.
- B. Valve Lockout Devices:
 - 1. Manufacturers:
 - a. Seton
 - b. Brady
 - c. Omark
 - d. Substitutions: Section 01 60 00 - Product Requirements.
 - 2. Nylon device preventing access to valve operator, accepting lock shackle.

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Section 09 90 00 for stencil painting.

3.2 INSTALLATION

- A. Install identifying devices after completion of coverings and painting.
- B. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.
- C. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.
- D. Install tags using corrosion resistant chain. Number tags consecutively by location.
- E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- F. Identify water heaters, pumps, tanks, and water treatment devices with plastic nameplates stencil painting. Identify in-line pumps and other small devices with tags.
- G. Identify control panels and major control components outside panels with plastic nameplates.
- H. Identify valves in main and branch piping with tags.
- I. Identify piping, concealed or exposed, with plastic pipe markers plastic tape pipe markers stenciled painting. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
- J. Provide ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 220700 - PLUMBING INSULATION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Plumbing piping insulation, jackets and accessories.
 - 2. Plumbing equipment insulation, jackets and accessories.

- B. Related Sections:
 - 1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
 - 2. Section 09 90 00 - Painting and Coating: Execution requirements for painting insulation jackets and covering specified by this section.
 - 3. Section 22 04 00 – General Conditions for Plumbing Trades
 - 4. Section 22 05 00 – Common work results for Plumbing
 - 5. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment
 - 6. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping
 - 7. Section 22 05 23 - General-Duty Valves for Plumbing Piping
 - 8. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
 - 9. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment
 - 10. Section 22 05 53 – Identification for Plumbing Piping and Equipment
 - 11. Section 22 15 00 – Specialty Plumbing Systems and Equipment
 - 12. Section 22 30 00 – Plumbing Specialties
 - 13. Section 22 34 00 – Fuel Fired Domestic Water Heaters
 - 14. Section 22 40 00 – Plumbing Fixtures
 - 15. Section 23 04 00 – General Conditions for Mechanical Trades

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of

School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. ASTM International:
1. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 2. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 3. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 4. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
 5. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
 6. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
 7. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
 8. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 9. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
 10. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 11. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
 12. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
 13. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
 14. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 15. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 16. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
 17. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
 18. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

19. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
20. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
21. IECC 2012 – Insulation Thickness.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.
- C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- E. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 QUALITY ASSURANCE

- A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 450 50 in accordance with ASTM E84.
- B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.

- C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.
- D. Maintain one copy copies of each document on site.
- E. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.

1.8 PRE-INSTALLATION MEETINGS

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

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.

- C. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.12 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for man made fiber.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:
 - 1. CertainTeed.
 - 2. Knauf.
 - 3. Johns Manville.
 - 4. Owens-Corning.
 - 5. Substitutions: Section 01 60 00 - Product Requirements Not Permitted.
- B. Manufacturers for Closed Cell Elastomeric Insulation Products:
 - 1. Aeroflex. Aerocell.
 - 2. Armacell, LLC. Armaflex.
 - 3. Nomaco. K-flex.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.

2.2 PIPE INSULATION

- A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation. Conform to ASTM C795 for application on Austenitic stainless steel.
 - 1. Thermal Conductivity: 0.23 at 75 degrees F.
 - 2. Operating Temperature Range: 0 to 850 degrees F.
 - 3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
 - 4. Jacket Temperature Limit: minus 20 to 150 degrees F.
- B. TYPE P-5: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
 - 1. Thermal Conductivity: 0.27 at 75 degrees F.
 - 2. Operating Temperature Range: Range: Minus 70 to 180 degrees F.

2.3 PIPE INSULATION JACKETS

- A. Vapor Retarder Jacket:
 - 1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
 - 2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
- B. PVC Plastic Pipe Jacket:
 - 1. Product Description: ASTM D1785, One piece molded type fitting covers and sheet material, off-white color.
 - 2. Thickness: 15 mil.
 - 3. Connections: Brush on welding adhesive Tacks Pressure sensitive color matching vinyl tape.

2.4 PIPE INSULATION ACCESSORIES

- A. Vapor Retarder Lap Adhesive: Compatible with insulation.
- B. Covering Adhesive Mastic: Compatible with insulation.
- C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.
- D. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.
- E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum stainless steel jacket single piece construction with self adhesive closure. Thickness to match pipe insulation.
- F. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- G. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.
- H. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.
- I. Adhesives: Compatible with insulation.

2.5 EQUIPMENT INSULATION

- A. TYPE E-1: ASTM C553; glass fiber, flexible or semi-rigid, noncombustible.
 - 1. Thermal Conductivity: 0.24 at 75 degrees F.
 - 2. Operating Temperature Range: 0 to 450 degrees F.
 - 3. Density: 1.65 pound per cubic foot.
- B. TYPE E-2: ASTM C612; glass fiber, rigid board, noncombustible with factory applied kraft reinforced aluminum foil jacket.
 - 1. Thermal Conductivity: 0.24 at 75 degrees F.

2. Operating Temperature Range: 0 to 450 degrees F.
 3. Density: 3.0 pound per cubic foot.
 4. Jacket Temperature Limit: minus 20 to 150 degrees F.
- C. TYPE E-8: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.
1. Thermal Conductivity: 0.27 at 75 degrees F.
 2. Operating Temperature Range: Range: Minus 70 to 220 degrees F.
 3. .

2.6 EQUIPMENT INSULATION JACKETS

- A. PVC Plastic Equipment Jacket:
1. Product Description: ASTM D1785, sheet material, off-white color.
 2. Minimum Service Temperature: -40 degrees F.
 3. Maximum Service Temperature: 150 degrees F.
 4. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
 5. Thickness: 20 mil.
 6. Connections: Brush on welding adhesive Tacks Pressure sensitive color matching vinyl tape.
- B. Canvas Equipment Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.
- C. Vapor Retarder Jacket:
1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
 2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
- D. Field Applied Glass Fiber Fabric Jacket System:
1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
 2. Glass Fiber Fabric:
 - a. Cloth: Untreated; 9 oz/sq yd weight.
 - b. Blanket: 1.0 lb/cu ft density.
 - c. Weave: 10 x 10.
 3. Indoor Vapor Retarder Finish:
 - a. Cloth: Untreated; 9 oz/sq yd weight.
 - b. Vinyl emulsion type acrylic, compatible with insulation, black white color.

2.7 EQUIPMENT INSULATION ACCESSORIES

- A. Vapor Retarder Lap Adhesive: Compatible with insulation.
- B. Covering Adhesive Mastic: Compatible with insulation.
- C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

- D. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.
- E. Adhesives: Compatible with insulation.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify piping and equipment has been tested before applying insulation materials.
- C. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - PIPING SYSTEMS

- A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.
- B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 07 84 00 for penetrations of assemblies with fire resistance rating greater than one hour.
- C. Piping Systems Conveying Fluids Below Ambient Temperature:
 - 1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
 - 2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 - 3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.
- D. Glass Fiber Board Insulation:
 - 1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
 - 2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
 - 3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

- E. Polyisocyanurate Foam Insulation Extruded Polystyrene Insulation:
 - 1. Wrap elbows and fitting with vapor retarder tape.
 - 2. Seal butt joints with vapor retarder tape.

- F. Hot Piping Systems less than 140 degrees F:
 - 1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
 - 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.
 - 3. Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.

- G. Hot Piping Systems greater than 140 degrees F:
 - 1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
 - 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.
 - 3. Insulate flanges and unions at equipment.

- H. Inserts and Shields:
 - 1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
 - 2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
 - a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
 - b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
 - 3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.

- I. Insulation Terminating Points:
 - 1. Coil Branch Piping 1 inch and Smaller: Terminate hot water piping at union upstream of the coil control valve.
 - 2. Chilled Water Coil Branch Piping: Insulate chilled water piping and associated components up to coil connection.
 - 3. Condensate Piping: Insulate entire piping system and components to prevent condensation.

- J. Closed Cell Elastomeric Insulation:
 - 1. Push insulation on to piping.
 - 2. Miter joints at elbows.
 - 3. Seal seams and butt joints with manufacturer's recommended adhesive.
 - 4. When application requires multiple layers, apply with joints staggered.
 - 5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

- K. High Temperature Pipe Insulation:
 - 1. Install in multiple layers to meet thickness scheduled.
 - 2. Attach each layer with bands. Secure first layer with bands before installing next layer.
 - 3. Stagger joints between layers.
 - 4. Finish with canvas jacket sized for finish painting.
 - 5. Cover with aluminum jacket stainless steel jacket with seams located on bottom side of horizontal piping.

- L. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with canvas jacket sized for finish painting PVC jacket and fitting covers ABS jacket and fitting covers aluminum jacket stainless steel jacket.

- M. Piping Exterior to Building: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum stainless steel jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.

- N. Buried Piping: Insulate only where insulation manufacturer recommends insulation product may be installed in trench, tunnel or direct buried. Install factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.

- O. Heat Traced Piping Interior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer.

- P. Heat Traced Piping Exterior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size insulation large enough to enclose pipe and heat tracer. Cover with aluminum stainless steel jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water.

- Q. Prepare pipe insulation for finish painting. Refer to Section 09 90 00.

3.3 INSTALLATION - EQUIPMENT

- A. Factory Insulated Equipment: Do not insulate.

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

- C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

- D. Equipment Containing Fluids Below Ambient Temperature:
 - 1. Insulate entire equipment surfaces.

2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
 3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 4. Finish insulation at supports, protrusions, and interruptions.
- E. Equipment Containing Fluids 140 degrees F Or Less:
1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
 2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
 3. Finish insulation at supports, protrusions, and interruptions.
- F. Equipment Containing Fluids Over 140 degrees F:
1. Insulate flanges and unions with removable sections and jackets.
 2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
 3. Finish insulation at supports, protrusions, and interruptions.
- G. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting PVC jacket and fitting covers aluminum jacket stainless steel jacket.
- H. Equipment Located Exterior to Building: Install vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum stainless steel jacket with seams located on bottom side of horizontal equipment.
- I. Cover glass fiber cellular glass hydrous calcium silicate cellular foam insulation with metal mesh and finish with heavy coat of insulating cement aluminum jacket stainless steel jacket.
- J. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.
- K. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.
- L. Prepare equipment insulation for finish painting. Refer to Section 09 90 00.

3.4 SCHEDULES

A. Water Supply Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Domestic Hot Water Supply and Recirculation	P-1	1-1/4 inches and smaller	0.5
		1-1/2 inches and larger	1.0
Domestic Hot Water Supply and Recirculation systems with domestic water temperature maintenance cable	P-1	1 inch and smaller	1.0
		1-1/4 inches to 2 inches	1.5
		2-1/2 inches and larger	2.0
Domestic Cold Water	P-1 or P-5	1-1/4 inches and smaller	0.5
		1-1/2 inches and larger	1.0

B. Drainage Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Storm Piping (above ground within building)	P-1 or P-5	All sizes	1.0
Storm Piping (horizontal and vertical above ground within building when PVC pipe is used)	P-1 or P-5	All sizes	1.0
Sanitary Sewer Piping (horizontal and vertical above ground within building when PVC or plastic piping is used)	P-1 or P-5	All sizes	1.0

C. Equipment Insulation Schedule:

EQUIPMENT	INSULATION TYPE	INSULATION THICKNESS inches
Roof Drain Bodies	E-2 E-8	0.5
Domestic Hot Water Storage Tanks	E-1 E-2	1.5
Domestic Water Booster Pump Bodies	E-8	0.5

END OF SECTION

SECTION 220800 - COMMISSIONING OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. OPR and BoD documentation are included by reference for information only.

1.2 SUMMARY

- A. This Section includes general requirements that apply to implementation of the commissioning process without regard to specific systems, assemblies, and components.
- B. Related Sections include the following:
 - 1. Division 01 Section 019113 General Commissioning Requirements for general commissioning process activities.
 - 2. Division 22 – Plumbing

1.3 DEFINITIONS

- A. Commissioning Plan: A document, prepared by CxA, that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process. This Plan is included in Volume 4 of these specifications.
- B. CxA: Commissioning Authority.
- C. Quality Assurance: A program for the systematic monitoring and evaluation of the various aspects of a system, assembly, or component to ensure that standards of quality are being met. This is the responsibility of the CxA.
- D. Quality Control: A system for ensuring the maintenance of proper standards in systems, assemblies, and components. This is the responsibility of the Contractor.
- E. Official: State or Local official having jurisdiction over the conveying systems.
- F. Systems, Assemblies, Equipment, and Components: Where these terms are used together or separately, they shall mean “as-built” systems, assemblies, equipment, and components.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION CHECKLISTS

- A. The CxA shall provide Construction Checklists to the Contractors for execution that will indicate expected Quality Control features required for a highest-quality installation. The contractor shall complete the checklists as construction progresses and return them to the CxA as indicated in Section 019113 General Commissioning Requirements.
- B. Checklists for this section will include:
 - 1. Domestic Hot Water System
 - 2. Water Using Systems
- C. A sample installation checklist is included to show the typical scope and rigor of the process.

3.2 PREREQUISITES TO TESTING

- A. Prior to the testing of these systems or assemblies, the Contractor shall certify that:
 - 1. The system or assembly is completely installed, functional, and documented.
 - 2. Work performed by other trades, but essential for this system or assembly's operation, is complete (e.g., electrical components are wired and power is provided)
 - 3. All contractor-performed start-up procedures and Pre-Functional Tests are complete and documented.
 - 4. The system or assembly is ready for the Owner to take beneficial use.

3.3 SYSTEM OR ASSEMBLY TEST REQUIREMENTS

- A. The CxA will provide Functional Performance Test procedures to the Contractor for execution for the following specific systems, assemblies, and components:
 - 1. Domestic Hot Water System
 - 2. Water Using Systems
- B. Acceptance criteria and test details will be in accordance with the related sections including the following:
 - 1. Division 01 Section 019113 General Commissioning Requirements for general commissioning process activities.
 - 2. Division 22 – Plumbing
- C. A sample functional performance test is included to show the typical scope and rigor of the process.

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11/17/2017

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BRANFORD, CONNECTICUT
State Project No.s: 014-0034 EA / 014-0035 BE-EA

3.4 TEST REPORTS

- A. Provide copies of all reports required in the listed reference sections (see Section 1.2 SUMMARY above for the sections) for review.

3.5 SAMPLE FORMS

**Sample Installation Checklist
General Plumbing Pipe Installation**

Schedule ID# from drawings: Piping System: _____

Location _____

Reference Specification:

Reference Drawing:

Model Verification

	Specified	Submitted	Installed
Construction Standards	Miscellaneous		

Installation Checks

ID	Description	Pass/fail	Comments
1	Water piping: 1. Below ground water service piping 4" and larger shall be cement lined ductile iron pipe and fittings. 2. Above ground potable and non-potable water systems: 1/2"-4" Type L copper tubing with soldered joints.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	
2	Gas Piping: 1. Aboveground exterior and interior gas and vents shall be schedule 40 steel pipe 2. Fittings 2-1/2" and less shall be screwed type for 3" and larger shall be welded.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	
3	Verify sleeves are installed for pipes passing through concrete walls or floors, 1/2" air space around pipe to sleeve and sealed to make smoke/fire proof.	<input type="checkbox"/> <input type="checkbox"/>	
4	Verify that proper provisions for expansion and contraction of the hot water piping systems piping are provided by means of pipe bends, pipe offsets, swing connections or changes in direction of piping.	<input type="checkbox"/> <input type="checkbox"/>	
5	Verify that hose and drain valves are provided for complete draining of the system.	<input type="checkbox"/> <input type="checkbox"/>	
6	Verify that all high points in closed water piping systems have either equipment venting or manual vents installed.	<input type="checkbox"/> <input type="checkbox"/>	
7	Natural Gas piping: 1. Verify piping pitches to drains at drip legs at least 6" long. 2. Verify shut off valve is installed at each equipment connection on the downstream side of any regulators and installed in accessible location. 3. Piping is securely fastened, separately hung and not strapped or supporting other devices.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	
8	Identification: 1. Verify color coded piping identification markers on piping systems are installed including flow direction markings: Identify equipment such as pumps, compressors, water heaters, and tanks with names and equipment numbers.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	
9	Verify Plumbing piping, fittings, and valves Insulation: All interior water piping.	<input type="checkbox"/> <input type="checkbox"/>	

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State Project No.s: 014-0034 EA / 014-0035 BE-EA

Approvals (only one required)

	Name (printed neatly)	Signature	Date
Contractor/Manuf. Rep.			
Engineer			
Construction Administrator			
Commissioning Agent			

**Sample Functional Performance Test
Plumbing Fixtures**

1. Participants

<u>Name/Representing</u>	<u>Participation (Testing, Witness, etc)</u>
	Owners Representative

Party filling out this form _____ Date of test _____

2. Prerequisite Checklist

- a. An as-built version of the plumbing drawing has been provided.
- b. The plumbing contractor has certified that their internal commissioning is complete and the project is ready for third-party verification. PC initials: _____. Date: _____.
- c. The general contractor has certified that the construction is substantially complete and ready for third-party verification. GC initials: _____. Date: _____.

3. Functional Testing Procedures

Test Sequence	Fixture Type	Test Procedure	Expected Results	Pass/Fail	Comments
1	Fixtures	Operate each faucet and water closet to verify water connections and pressure.	Fixtures will operate and drain. Automatic flush valves will not cause splashing. For sinks and lavs, hot water will be on the left, cold on the right.		
2	Fixtures	Measure hot water temperature at each sink and lavatory.	Water temp shall not exceed 115 degrees.		
3	Fixtures	Operate all Electronic Sensors	All sensor operated fixtures shall respond as designed		

END OF TEST

END OF SECTION 220800

SECTION 221123 - FACILITY NATURAL-GAS PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Each Contractor, Subcontractor and/or supplier providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 SUMMARY

- A. Section Includes:
 - 1. Natural gas piping buried within 5 feet of building.
 - 2. Natural gas piping above grade.
 - 3. Unions and flanges.
 - 4. Valves.
 - 5. Pipe hangers and supports.
 - 6. Strainers.
 - 7. Natural gas pressure regulators.
 - 8. Natural gas pressure relief valves.
 - 9. Underground pipe markers.

10. Bedding and cover materials.

B. Related Sections:

1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
2. Section 08 31 13 - Access Doors and Frames
3. Section 09 90 00 - Painting and Coating
4. Section 22 04 00 – General Conditions for Plumbing Trades
5. Section 22 05 00 – Common work results for Plumbing
6. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping
7. Section 22 05 23 - General-Duty Valves for Plumbing Piping
8. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
9. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment
10. Section 22 05 53 – Identification for Plumbing Piping and Equipment
11. Section 22 07 00 - Plumbing Insulation
12. Section 22 15 00 – Specialty Plumbing Systems and Equipment
13. Section 22 30 00 – Plumbing Specialties
14. Section 22 34 00 – Fuel Fired Domestic Water Heaters
15. Section 22 40 00 – Plumbing Fixtures

1.5 REFERENCES

A. American National Standards Institute:

1. ANSI Z21.15 - Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.

B. American Society of Mechanical Engineers:

1. ASME B16.3 - Malleable Iron Threaded Fittings.
2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
3. ASME B16.33 - Manually Operated Metallic Gas Valves for Use in Gas Piping Systems Up to 125 psig (sizes 1/2 - 2).
4. ASME B31.9 - Building Services Piping.
5. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

C. ASTM International:

1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
4. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
5. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
6. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

- D. American Welding Society:
 - 1. AWS D1.1 - Structural Welding Code - Steel.
- E. American Water Works Association:
 - 1. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
- F. Manufacturers Standardization Society of the Valve and Fittings Industry:
 - 1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 - 2. MSS SP 67 - Butterfly Valves.
 - 3. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
 - 4. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
 - 5. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
 - 6. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
- G. National Fire Protection Association:
 - 1. NFPA 54 - National Fuel Gas Code.
- H. Underwriters Laboratories Inc.:
 - 1. UL 842 - Valves for Flammable Fluids.
- I. ICC Codes
 - 1. International Fuel Gas Code 2012.

1.6 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.
- B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves, equipment.
- C. Provide pipe hangers and supports in accordance with ASME B31.9, ASTM F708, MSS SP 58, MSS SP 69, and MSS SP 89.
- D. Use plug, valves for shut-off and to isolate equipment, part of systems, or vertical risers.

1.7 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data:
 - 1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
 - 2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.

3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
4. Piping Specialties: Submit manufacturers catalog information including capacity, rough-in requirements, and service sizes for the following:
 - a. Strainers.
 - b. Natural gas pressure regulators.
 - c. Natural gas pressure relief valves.

- C. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

- D. Test Reports: Indicate results of piping system pressure test.

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

- F. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

- G. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.8 CLOSEOUT SUBMITTALS

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

- B. Project Record Documents: Record actual locations of valves piping system, and system components.

- C. Operation and Maintenance Data: Submit for valves and gas pressure regulators installation instructions, spare parts lists, and exploded assembly views.

1.9 QUALITY ASSURANCE

- A. Perform natural gas Work in accordance with NFPA 54.
- B. Perform work in accordance with NFPA 54, Fuel Gas Code and local gas company requirements.
- C. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- D. Perform Work in accordance with applicable code authority having jurisdiction AWS D1.1 for welding hanger and support attachments to building structure.
- E. Furnish shutoff valves complying with ASME B16.33 or ANSI Z21.15.
- F. Maintain one copy of each document on site.
- G. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.10 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.
- C. Design piping system hangers and supports under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location

1.11 PRE-INSTALLATION MEETINGS

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

1.12 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Protect piping and fittings from soil and debris with temporary end caps and closures. Maintain in place until installation. Furnish temporary protective coating on cast iron and steel valves.

1.13 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.
- B. Do not install underground piping when bedding is wet or frozen.

1.14 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.15 COORDINATION

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

1.16 WARRANTY

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

1.17 EXTRA MATERIALS

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

PART 2 PRODUCTS

2.1 NATURAL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASTM A234/A234M forged steel welding type.
 - 2. Joints: ASME B31.9, welded.
 - 3. Jacket: AWWA C105 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.

2.2 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 forged steel welding type.
 - 2. Joints: Threaded for pipe 2 inch and smaller; welded for pipe 2-1/2 inches and larger.

2.3 NATURAL GAS EQUIPMENT PIPING CONNECTION, ABOVE GRADE

- A. Corrugated Stainless Steel Tubing: ANSI LC 1.

2.4 REGULATOR VENT PIPING, ABOVE GRADE

- A. Indoors: Same as natural gas piping, above grade.

2.5 UNIONS AND FLANGES

- A. Unions for Pipe 2 inches and Smaller:
 - 1. Ferrous Piping: Class 150, malleable iron, threaded.
 - 2. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
- B. Flanges for Pipe 2-1/2 inches and Larger:
 - 1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
 - 2. Gaskets: 1/16 inch thick preformed neoprene gaskets.

2.6 PLUG VALVES

- A. Manufacturers:
 - 1. DeZURIK, Unit of SPX Corp.
 - 2. Flow Control Equipment, Inc.
 - 3. Homestead Valve
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. 2 inches and Smaller: MSS SP 78, Class 300, semi-steel construction, round port, full pipe area, and pressure lubricated, teflon packing, threaded ends. Furnish one plug valve wrench for every ten plug-valves with minimum of one wrench.
- C. 2-1/2 inches and Larger: MSS SP 78, Class 300, semi-steel construction, round port, full pipe area, and pressure lubricated, teflon packing, flanged ends. Furnish wrench-operated.

2.7 EMERGENCY GAS SOLENOID VALVE

- A. Manufacturers:
 - 1. Asco.
 - 2. DeZURIK, Unit of SPX Corp.
 - 3. Tuflin.

- B. Die-cast aluminum body, Buna “N” seals and discs, 430F stainless steel core and plugnut, 305 stainless steel core tube, 320 stainless steel springs, copper shading coil, zinc plated steel plugs and threaded ends.
- C. Operator: Solenoid enclosure, red hat metal type 1 general purpose junction box.
- D. Zero differential, internal pilot-operated diaphragm valve incorporating a double disc arrangement.
- E. Electrical: Standard coil 120 volts, 60 Hz.
- F. Gas valve shall be provided as a normally closed, power open type valve.

2.8 STRAINERS

- A. Manufacturers:
 - 1. Mueller Steam Specialty
 - 2. Armstrong
 - 3. Spirax Sarco, Inc.
 - 4. Yarway
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. 2 inch and Smaller: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
- C. 2-1/2 inch to 4 inch: Flanged iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

2.9 NATURAL GAS PRESSURE REGULATORS

- A. Manufacturers:
 - 1. Invensys
 - 2. Maxitrol
 - 3. Dormont
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Spring loaded, general purpose, self-operating service regulator including internal relief type diaphragm assembly and vent valve. Diaphragm case can be rotated 360 degrees in relation to body.
 - 1. Comply with ANSI Z21.80.
 - 2. Temperatures: minus 20 degrees F to 150 degrees F.
 - 3. Body: Steel.
 - 4. Spring case, lower diaphragm casing, union ring, seat ring and disk holder: Aluminum.
 - 5. Disk, diaphragm, and O-ring: Nitrile
 - 6. Maximum inlet pressure: 150 psig.
 - 7. Furnish sizes 2 inches and smaller with threaded ends. Furnish sizes 2-1/2 inches and larger with flanged ends.

2.10 NATURAL GAS PRESSURE RELIEF VALVES

- A. Manufacturers:
 - 1. Dresser
 - 2. Fisher
 - 3. Maxitrol
 - 4. Substitutions: Section 01 60 00 - Product Requirements.

- B. Product Description: Spring loaded type relief valve.
 - 1. Body: Aluminum.
 - 2. Diaphragm: Nitrile
 - 3. Orifice: Stainless steel.
 - 4. Maximum operating temperature: 150 degrees F.
 - 5. Inlet Connections: Threaded.
 - 6. Outlet or Vent Connection: Same size as inlet connection.

PART 3 EXECUTION

3.1 EXAMINATION

- A. 01300 - Administrative Requirements: Coordination and project conditions.
- B. Verify excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

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

3.3 INSTALLATION - INSERTS

- A. Provide inserts for placement in concrete forms.
- B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install hangers and supports in accordance with ASME B31.9 ASTM F708 and MSS SP 89.
- B. Support horizontal piping hangers as scheduled.
- C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Install hangers to allow 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
- F. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
- G. Where installing several pipes in parallel and at same elevation, provide multiple pipe hangers or trapeze hangers.
- H. Provide sheet lead packing between hanger or support and piping.
- I. Prime coat exposed steel hangers and supports in accordance with Section 09 90 00. Finish paint exposed steel hangers and supports in accordance with Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

3.5 INSTALLATION - BURIED PIPING SYSTEMS

- A. Install natural gas piping in accordance with IFGC 2012.
- B. Remove scale and dirt on inside of piping before assembly.
- C. Excavate pipe trench in accordance with requirements in Division 31 specifications.
- D. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches compacted depth; compact to 95 percent maximum density.
- E. Install pipe on prepared bedding.
- F. Route pipe in straight line.
- G. Install pipe to allow for expansion and contraction without stressing pipe or joints.

- H. Install plastic ribbon tape continuous. Buried 6 inches below finish grade, above pipe line; coordinate with Division 31.
- I. Pipe Cover and Backfilling:
 - 1. Backfill trench in accordance with Division 31
 - 2. Maintain optimum moisture content of fill material to attain required compaction density.
 - 3. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in 6 inches compacted layers to 12 inches minimum cover over top of jacket. Compact to 95 percent maximum density.
 - 4. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
 - 5. Do not use wheeled or tracked vehicles for tamping.

3.6 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

- A. Install natural gas piping in accordance with NFPA 54.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient.
- D. Where required, bend pipe with pipe bending tools in accordance with procedures intended for that purpose.
- E. Install piping to conserve building space and not interfere with use of space.
- F. Size and install gas piping to provide sufficient gas to supply maximum appliance demand at pressure higher than appliance minimum inlet pressure.
- G. Group piping whenever practical at common elevations.
- H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- I. Sleeve pipe passing through partitions, walls and floors. Refer to Section 23 05 29.
- J. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping. Refer to Section 07 84 00 23 05 29
- K. Provide clearance for installation of insulation and access to valves and fittings.
- L. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 13.
- M. Where pipe support members are welded to structural building framing, scrape, brush clean, weld, and apply one coat of zinc rich primer. Refer to Section 05 12 00, 05 21 00.
- N. Provide support for utility meters in accordance with requirements of utility company.

- O. Install vent piping from gas pressure reducing valves to outdoors and terminate in weatherproof hood. Protect vent against entry of insects and foreign material.
 - 1. Minimum Vent Size: Connection size at regulator vent connection.
 - 2. Run individual vent line from each relief device, independent of breather vents.
 - 3. Maintain minimum of 25' (feet) from outdoor air intakes.
- P. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting. Refer to Section 09 90 00.
- Q. Piping installed at the building exterior shall be primed and painted, or otherwise protected as required by NFPA 54 and IFGC.
- R. Install identification on piping systems including underground piping. Refer to Section 22 05 53.
- S. Install valves with stems upright or horizontal, not inverted.
- T. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.
- U. Install medium pressure gas pressure regulator with tee fitting between regulator and upstream shutoff valve. Cap or plug one opening of tee fitting.
- V. Install medium pressure gas pressure regulator with tee fitting not less than 10 pipe diameters down stream of regulator. Cap or plug one opening of tee fitting.
- W. Install gas pressure regulator with independent vent full size opening on regulator and terminate outdoors as indicated on Drawings.
- X. Provide new gas service complete with gas meter and regulators. Gas service distribution piping to have initial minimum pressure of 2 psi. Provide regulators on each line serving gravity type appliances, sized in accordance with equipment. Provide source valve to shut down entire service at meter assembly.
- Y. The plumbing contractor shall furnish and install an adequate natural gas supply to all gas fired appliances and devices throughout the project. In addition to the specifications and drawings included in Division 22, the plumbing contractor shall also review the contract documents prepared by the site/civil, food service and architectural /structural disciplines for coordination and additional work by the plumbing contractor required to complete the project.
- Z. Terminate pressure regulator relief vent lines as required by the utility provider.
- AA. Gas solenoid valves shall be installed within 12"x12"x6" deep lockable steel enclosure.

3.7 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

- B. Where gas appliance will be damaged by test pressure, disconnect appliance and cap piping during pressure test. Reconnect appliance after pressure test and leak test connection.
- C. Where gas appliance is designed for operating pressures equal to or greater than piping test pressure, provide gas valve to isolate appliance or equipment from gas test pressure.
- D. Pressure test natural gas piping in accordance with NFPA 54.
- E. Inspect, test and purge gas piping in accordance with applicable code and local gas company requirements. Where new branch piping is extended from existing system, pressure test new branch piping only. Leak test joint between new and existing piping with noncorrosive leak detection fluid or other approved method.
- F. When pressure tests do not meet specified requirements, remove defective work, replace and retest.
- G. Immediately after gas is applied to a new system, or a system has been restored after gas service interruption, check pipe for leakage.
 - 1. Where leakage is detected, shut off gas supply until necessary repairs are complete.
- H. Do not place appliances in service until leak testing and repairs are complete.

END OF SECTION

SECTION 222123 - PLUMBING PUMPS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. In-line circulators.
 - 2. Sump pumps.
 - 3. Booster pumps.

- B. Related Sections:
 - 1. Section 07 90 00 - Joint Protection: Product requirements for calking between fixtures and building components for placement by this section.
 - 2. Section 22 04 00 – General Conditions for Plumbing Trades
 - 3. Section 22 05 00 – Common work results for Plumbing
 - 4. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment
 - 5. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping
 - 6. Section 22 05 23 - General-Duty Valves for Plumbing Piping
 - 7. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
 - 8. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment
 - 9. Section 22 05 53 – Identification for Plumbing Piping and Equipment
 - 10. Section 22 07 00 - Plumbing Insulation
 - 11. Section 22 15 00 – Specialty Plumbing Systems and Equipment
 - 12. Section 22 34 00 – Fuel Fired Domestic Water Heaters
 - 13. Section 22 40 00 – Plumbing Fixtures

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- B. Underwriters Laboratories Inc.:
 - 1. UL 778 - Motor Operated Water Pumps.

1.5 PERFORMANCE REQUIREMENTS

- A. Provide pumps to operate at system fluid temperatures indicated on Drawings 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.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements. Submit also, manufacturer model number, dimensions, service sizes, and finishes.
- C. Manufacturer's Installation Instructions: Submit application, selection, and hookup configuration with pipe and accessory elevations. Submit hanging and support requirements and recommendations.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.7 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit installation instructions, servicing requirements, assembly views, lubrication instructions, and replacement parts list.
- C. Maintain one copy of each document on site.

1.8 QUALIFICATIONS

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

- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.9 PRE-INSTALLATION MEETINGS

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

1.10 DELIVERY, STORAGE, AND HANDLING

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

1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.12 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Warranty period: one (2) year parts and labor with warranty registration. Mechanical seals are not covered during the warranty period.

1.13 EXTRA MATERIALS

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

PART 2 PRODUCTS

2.1 IN-LINE CIRCULATORS

- A. Manufacturers:
 - 1. B+G
 - 2. Taco
 - 3. Armstrong
 - 4. Grundfos
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 125 psig 175 psig maximum working pressure.

- C. Casing: Cast iron, with flanged pump connections.
- D. Impeller: Cadmium plated steel, Stamped brass or cast bronze, keyed to shaft.
- E. Bearings: Two, oil lubricated bronze sleeves.
- F. Shaft: Alloy or stainless steel with copper or bronze sleeve, integral thrust collar.
- G. Seal: Carbon rotating against stationary ceramic seat, 225 212 degrees F maximum continuous operating temperature.
- H. Drive: Flexible coupling.
- I. Performance:
 - 1. Flow Capacity: gal/min.
 - 2. Head: feet.
- J. Electrical Characteristics and Components:
 - 1. Electrical Characteristics: In accordance with Section 26 05 03 and the following:
 - 2. Motors: 1750 rpm unless indicated otherwise.
 - 3. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

2.2 SUMP PUMPS

- A. Manufacturers:
 - 1. Hydromatic
 - 2. Zoeller
 - 3. Little Giant
 - 4. Weil
 - 5. Goulds
 - 6. Substitutions: Section 01 60 00 - Product Requirements.
- B. Impeller: Cast iron, semi-open, non-clog.
- C. Casing: Cast iron.
- D. Mechanical Seal: Silicon carbide.
- E. Shaft: Stainless steel.
- F. Designed for continuous operation.
- G. Bearings: Upper and lower heavy duty ball bearings.

2.3 PUMP MOTORS

- A. Fully submerged in high-grade turbine oil for lubrication and efficient heat transfer.
- B. Power Cable: Severe duty rated, oil and water resistant, epoxy seal on motor end.
- C. Built-in overload with automatic reset.
- D. Class B insulation.

2.4 BOOSTER PUMPS

- A. Manufacturers:
 - 1. Armstrong Fluid TechnologyPeerless
 - 2. Grundfos Pump
 - 3. Bell & Gossett
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Provide an Armstrong Design Envelope Series 6800 Packaged Booster System model N230202. The design envelope shall encompass an initial design point of 100.0 gpm at 35.0 psi head. The design envelope shall also be capable of supplying 140 gpm at 27.5 psi boost
- C. Each Vertical Multi Stage (VMS) pump, with pump characteristics which provide rising heads to shut off, shall be supplied with a 2 hp, TEFC, 460/3/60 Volt, NEMA Premium® efficiency motor and an Armstrong UL Type-12 enclosure variable speed drive, which shall be integrated with the motor. Drives shall not be enclosed within the control panel.
- D. Material of construction of Pump casing shall be:
 - 1. 304 stainless steel with ANSI-150 flanges for working pressures to 232 psig (16 bar) at 250°F (120°C)
- E. Material of construction of Impeller shall be 304 stainless steel, fully enclosed type.
- F. Material of construction of Shaft shall be stainless steel pump shaft.
- G. Material of Coupling should be rigid spacer type of brass or steel. Coupling to be designed to allow removal of all mechanical seal components for servicing without removal of the pump.
- H. Mechanical shaft seals should have FPM® secondary seal, carbon rotating face and silicon carbide stationary seat.
- I. Integrated controls (Variable speed drives):
 - 1. Integrated controls shall have the following features:
 - 2. VVC-PWM type providing near unity displacement power factor ($\cos \theta$) without the need for external power factor correction capacitors at all loads and speeds,
 - 3. DC link chokes for the reduction of mains borne harmonic currents to reduce the DC link ripple current thereby increasing the DC link capacitors lifetime,

4. UL and C-UL Listed and CE Marked showing compliance with both the EMC directive 89/336/EEC and the Low Voltage directive 72/23/EEC,
 5. RFI filters incorporated within the drive to ensure it meets the emission and immunity requirements of EN61800-3 to the 1st Environment Class C1 (EN55011 unrestricted sales class B)
- J. Integrated controls and motor protection shall include:
1. Motor phase to phase fault,
 2. Motor phase to earth fault,
 3. Loss of supply phase,
 4. Over voltage, under voltage,
 5. Motor over temperature
 6. Inverter overload, over current.
- K. Headers, Base and Panel support:
1. A. Material of construction of Headers, Base and Panel support should be stainless steel 304. Headers shall be a minimum of 3”.
- L. Control Panel:
1. The control panel shall be of the programmable logic controller (PLC) type.
 2. The complete control panel assembly and all internal devices shall be UL508 labelled.
 3. The panel shall be complete with NEMA 12 Painted steel enclosure and include door interlocked main disconnect, water tight LCD interface, fused drive connections, adjustable time delays, Hand-Off-Auto selector for each pump and minimum run timers.
 4. The control circuit shall include fault relay circuit to turn on the next pump should the lead pump fail.
 5. The controller must be capable of controlling up to 5 pumps, with a 4-20 mA analogue signal using pressure as the control variable.
 6. Controller design shall include provisions for:
 - a. Low flow energy savings,
 - b. Soft fill mode for gradual filling of pipes at system start up or after maintenance
 - c. Pressure setback as a built in software logic as per ASHRAE 90.1,2010 section 10.4.2 (a)
 - d. Emergency power mode for limiting pumps during power cut off
 - e. Alternate set points, for easy setup of multiple duty points
 - f. End of pump curve protection
 - g. 24hr operation automatic alternation of pumps,
 - h. Built-in pump on-delay and minimum run timers,
 - i. Re-settable pump elapsed run time meters, smooth pump starting and sequencing,
 - j. On-screen field modifiable control and alarm parameters
 - k. High suction pressure shutdown and
 - l. No-flow shutdown as per ASHRAE 90.1, 2010 section 10.4.2(c) with drawdown tank/system optimization (the system would build additional pressure, typically 5 psi, in the draw down tank before it shuts down to limit the short cycling of pumps). System shall come loose with a 132

Gallon ASME bladder storage tank, ASME, 240F max temp and 150# max operating pressure. Tank shall be field piped into the high side of the booster system.

- m. On-screen alarm display with alarm identification shall be incorporated with the following alarms included:
 - 1) Low and high system pressure shutdown,
 - 2) Low suction pressure or level shutdown,
 - 3) Pump failure,
 - 4) Drive fault, and
 - 5) Suction and discharge pressure sensor failures.
 - 6) On-screen display shall be incorporated with the following data included:
 - a) Energy consumption display and profiling:
 - b) Instantaneous kW
 - c) Monthly/Yearly kW consumption
 - d) Capacity for reset of data
 - 7) Flow Estimation and profiling:
 - a) Max. drawn flow based on history of logged data
Current flow
 - b) Data profiling to show consumption versus time
 - c)
- n. The controller shall include on-screen fault description and possible cause information with alarm horn for alarms.
- o. The control panel shall be equipped with a user friendly screen mounted on the panel front door.
- p. The interface screen shall include:
 - 1) Touch Screen
 - 2) Can type in easily any setting number
 - 3) Have Multilanguage capability in any of the following languages as a minimum (English, French, Spanish, Portuguese) Can display history of alarms
- q. Non-volatile factory set parameters must be capable of being restored at any time in the field without requiring any programming device or connection to an external source.
- r. The controller must hold software in FLASH memory storage which prevents accidental loss of data due to voltage surge or spike.
- s. All controls to be factory pre-wired and tested in accordance with provisions of the national electrical code. All control wires shall be individually numbered and each component shall be labelled accordingly. All internal wiring shall be Copper stranded, A.W.G. with a minimum 90°F rating. The controller shall bear the UL508 label for industrial controls

2.5 Pump Sequencing:

- A. The pump designated as the lead pump shall start following a 5 second On-Delay time after sensing a drop in the system pressure 5 PSI below the desired set point value

- B. The pump controller shall compare a signal from the discharge pressure transducer to the set point value and the lead pump speed shall ramp up in order to satisfy the set point pressure.
- C. The lag pump shall start following a 60 second On-Delay time, when the lead pump exceeds its best operating point (BOP), and a minimum run timer shall ensure that the lag pump runs for a minimum of 60 seconds.
- D. The lag pump shall ramp down in speed and turn off when the pumps that are running are operating at a point below the BOP and the lag pump minimum run timer has expired.
- E. The lead pump shall continue to operate and meet system requirements based on the set point value.
- F. The lead pump shall alternate every 24 hrs of operation where the second pump shall start and run for a period of 5 seconds, both pumps shall operate, the first pump on shall ramp down and the new lead pump shall continue to operate as above to meet system requirements

2.6 Lead pump shutdown controls:

- A. All systems are equipped with a 'No-Flow' shutdown that will stop the pumps when the pump controller determines there has been a 'No-Flow' condition for a continuous 5 minute period.
- B. The lead pump will start again once a drop in pressure of at least 5 psi is measured on the discharge of the system.
- C. The system can be manually operated by means of the virtual Hand-off-Auto (HOA) selector buttons provided on the operator interface

2.7 NAMEPLATES

- A. A. Each Domestic Booster system shall have a nameplate permanently attached to the control panel or any other visible location.
- B. B. The nameplate shall include as a minimum, the following data stamped on the face of the nameplate:
 - 1. Booster System Serial number,
 - 2. Booster Model,
 - 3. Maximum pressure,
 - 4. Booster Capacity,
 - 5. Flow,
 - 6. Total Motor HP,
 - 7. Electrical source.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Provide pumps to operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B. Install long radius reducing elbows or reducers between pump and piping. Support piping adjacent to pump so no weight is carried on pump casings. For close coupled or base mounted pumps, install supports under elbows on pump suction and discharge line sizes 4 inches and over.
- C. Install pumps on vibration isolators. Refer to Section 22 05 48.
- D. Install flexible connectors at or near pumps where piping configuration does not absorb vibration. On Victaulic grooved installations, install three (3) Flexible couplings in lieu of each flexible connector and place in close proximity to the vibrating source. Refer to Section 23 05 48.
- E. Provide line sized shut-off valve and strainer pump suction fitting on pump suction, and line sized soft seat check valve, balancing valve, and shut-off valve combination pump discharge valve on pump discharge. On Victaulic grooved installations, provide line sized combination Tri-Service Assembly or AGS Tri-Service Assembly with grooved ends. Refer to Section Section 22 05 23
- F. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump so no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches and larger.
- G. Provide air cock and drain connection on horizontal pump casings.
- H. Provide drains for bases and seals.
- I. Check, align, and certify alignment of base mounted pumps prior to start-up.
- J. Install close coupled and base mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Refer to Section 03 30 00.
- K. Lubricate pumps before start-up.

3.2 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect for alignment of base mounted pumps.

END OF SECTION

SECTION 223000 - PLUMBING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Hose bibs.
 - 2. Wall hydrants.
 - 3. Water hammer arrestors.
 - 4. Trap primers.
 - 5. Thermostatic mixing valves.
 - 6. Expansion tanks.
 - 7. Floor drains.
 - 8. Floor sinks.
 - 9. Recessed valve boxes.
 - 10. Roof drains.
 - 11. Parapet drains.
 - 12. Canopy and cornice drains.
 - 13. Special purpose downspout covers.
 - 14. Downspout nozzles.
 - 15. Area drains.
 - 16. Trench Drains

- B. Related Sections:
 - 1. Section 07 90 00 - Joint Protection: Product requirements for calking between fixtures and building components for placement by this section.
 - 2. Section 22 04 00 – General Conditions for Plumbing Trades
 - 3. Section 22 05 00 – Common work results for Plumbing
 - 4. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment
 - 5. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping
 - 6. Section 22 05 23 - General-Duty Valves for Plumbing Piping
 - 7. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
 - 8. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment
 - 9. Section 22 05 53 – Identification for Plumbing Piping and Equipment
 - 10. Section 22 07 00 - Plumbing Insulation
 - 11. Section 22 15 00 – Specialty Plumbing Systems and Equipment
 - 12. Section 22 34 00 – Fuel Fired Domestic Water Heaters
 - 13. Section 22 40 00 – Plumbing Fixtures

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-

manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI/ASSE 1011 - Hose Connection Vacuum Breakers.
 - 2. ANSI/ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.
 - 3. ANSI A112.26.1 - Water Hammer Arrestors.
 - 4. ASME A112.21.1 - Floor Drains.
 - 5. ASME A112.21.2M - Roof Drains.
- B. Plumbing Drainage institute:
 - 1. PDI WH-201 – Water Hammer Arresters.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
- C. Product Data: Provide component sizes, rough-in requirements, service sizes, capacities and finishes.
- D. Manufacturer's Installation Instructions: Submit installation methods and procedures. Indicate assembly and support requirements.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- F. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.

- G. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
- H. Hangers and Supports: Submit manufacturers catalog information including load capacity.
- I. Storm Drainage Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.
- J. Sanitary Drainage Specialties: Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes, and finishes.
- K. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit fixture, trim, exploded view and replacement parts lists.
- C. Project Record Documents: Record actual locations of equipment and clean-outs.

1.7 QUALITY ASSURANCE

- A. Record actual locations of equipment, cleanouts, etc.
- B. Provide products requiring electrical connections listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and indicated.
- C. Provide plumbing fixture fittings in accordance with ASME A112.18.1 that prevent backflow from fixture into water distribution system.
- D. Maintain one copy of each document on site.
- E. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum three years documented experience.

1.9 PRE-INSTALLATION MEETINGS

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

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Accept specialties on site in factory packaging. Inspect for damage.
- C. Protect installed specialties from damage by securing areas.

1.11 WARRANTY

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

1.12 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Provide two loose keys for hose bibs and wall hydrants

PART 2 PRODUCTS

2.1 HOSE BIBS

- A. Manufacturers:
 - 1. Woodford.
 - 2. JR Smith.
 - 3. Watts.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. ANSI/ASSE 1011 Bronze or brass with integral mounting flange, vacuum breaker.

2.2 WALL HYDRANTS

- A. Manufacturers:
 - 1. Woodford.
 - 2. JR Smith.
 - 3. Watts.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Wall Hydrant: ANSI/ASSE 1019; self-draining type, freeze proof with removable key and integral vacuum breaker.

2.3 WATER HAMMER ARRESTORS

- A. Manufacturers:
 - 1. Precision Plumbing Products.
 - 2. JR Smith
 - 3. Zurn.
 - 4. Watts.
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. ANSI A112.26.1; sized in accordance with PDI, precharged, suitable for operation in temperature range -100 to 300 degrees F (-73 to 149 degrees C) and maximum 250 psig (1700 kPa) working pressure.

2.4 TRAP PRIMERS

- A. Manufacturers:
 - 1. JR Smith.
 - 2. Zurn.
 - 3. Watts.
 - 4. PPP.
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. ASSE 1018: Corrosion resistant brass, temperature range -40 to 450 degrees, 1/2" male inlet and 1/2" female outlet, pressure operating range 35 to 75 psig.

2.5 THERMOSTATIC MIXING VALVES

- A. Manufacturers: Powers model as scheduled on the drawings.
- B. Other acceptable manufacturers offer equivalent products:
 - 1. Lawler
 - 2. Acorn
 - 3. Bradley
 - 4. Watts
- C. Accessories:
 - 1. Check valves on inlets.
 - 2. Volume control shut-off valve on outlet.
 - 3. Stem thermometer on outlet.
 - 4. Strainer stop checks on inlets.
- D. Cabinet: 16 gage (1.5 mm) prime coated steel, for recessed mounting with keyed lock.
 - 1. Mixing Valves installed in mechanical rooms may be exposed. Valves installed in finished space shall be installed in box.

2.6 EXPANSION TANKS

- A. Manufacturers:
 - 1. Amtrol.
 - 2. Taco.
 - 3. Bell and Gossett.
 - 4. Watts.
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Construction: Welded steel, ASME labeled, tested and stamped in accordance with Section 8D of ASME Code; supplied with National Board Form U-1, rated for working pressure of 125 psig (860 kPa), with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.

2.7 RECESSED VALVE BOXES

- A. Manufacturers: Symmons model as scheduled on the drawings.

- B. Other acceptable manufacturers offer equivalent products:
 - 1. Acorn
 - 2. Watts
 - 3. Zurn
- C. Washing Machine: Plastic preformed rough-in box with brass water control valve, socket for 2 inch waste, and cover.
- D. Refrigerator: Plastic preformed rough-in box with brass valves with wheel handle, slip in finishing cover.

2.8 FLOOR DRAINS

- A. Manufacturers:
 - 1. Watts
 - 2. JR Smith
 - 3. Zurn
 - 4. Mifab
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Floor Drain: ASME A112.21.1; cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, trap primer connection, and round, adjustable nickel-bronze strainer with maximum ½" grate spacing.
- C. Floor Drain: ASME A112.21.1; cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, trap primer connection and round, adjustable round nickel-bronze strainer with maximum ½" grate spacing, removable perforated sediment bucket.

2.9 FLOOR SINKS

- A. Manufacturers:
 - 1. Watts
 - 2. JR Smith
 - 3. Zurn
 - 4. Mifab
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Floor Sink: Square lacquered cast iron body with integral seepage pan, epoxy coated interior, dome strainer, clamp collar, sediment bucket, epoxy coated, nickel bronze frame and half grate, trap primer connection.

2.10 CLEANOUTS

- A. Manufacturers:
 - 1. Watts
 - 2. JR Smith
 - 3. Zurn
 - 4. Mifab
 - 5. Substitutions: Section 01 60 00 - Product Requirements.

- B. Exterior Surfaced Areas: Round Square cast nickel bronze access frame and non-skid cover.
- C. Exterior Unsurfaced Areas: Line type with lacquered cast iron body and round epoxy coated cover with gasket.
- D. Interior Finished Floor Areas: Lacquered Galvanized cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round scored cover with gasket in service areas and round square depressed cover with gasket to accept floor finish in finished floor areas.
- E. Interior Finished Wall Areas: Line type with lacquered cast iron body and round epoxy coated cover with gasket, and round stainless steel access cover secured with machine screw.
- F. Interior Unfinished Accessible Areas: Calked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

2.11 BACK WATER VALVES

- A. Manufacturers:
 - 1. Watts
 - 2. JR Smith
 - 3. Zurn
 - 4. Mifab
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Cast Iron: ASME A112.14.1; lacquered galvanized cast iron body and cover, brass valve, 6 inch extension sleeve, and access cover.

2.12 SEDIMENT INTERCEPTORS

- A. Manufacturers:
 - 1. Watts
 - 2. JR Smith
 - 3. Zurn
 - 4. Mifab
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Epoxy coated cast iron body and secured cover with removable stainless steel sediment bucket.

2.13 DILUTION NEUTRALIZATION TANKS

- A. Manufacturers:
 - 1. Zurn
 - 2. Orion
 - 3. Wade
 - 4. T&C Plastics

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

B. Polypropylene tank, bolted cover, inlet & outlet for piping connections, vent connection.

2.14 ROOF DRAINS

A. Manufacturers:

1. Watts
2. JR Smith
3. Zurn
4. Mifab
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Roof Drain:

1. Assembly: ASME A112.21.2M.
2. Body: cast iron with sump.
3. Strainer: Removable polyethylene dome.
4. Accessories: Coordinate with roofing type, refer to architectural drawings and specifications.
 - a. Membrane flange and membrane clamp with integral gravel stop.
 - b. Adjustable under deck clamp.
 - c. Roof sump receiver.
 - d. Waterproofing flange.
 - e. Controlled flow weir.
 - f. Leveling frame.
 - g. Adjustable extension sleeve for roof insulation.
 - h. Perforated or slotted ballast guard extension for inverted roof.
 - i. Perforated stainless steel ballast guard extension.

C. Roof Drain (Overflow):

1. Assembly: ASME A112.21.2M.
2. Body: cast iron with sump.
3. Strainer: Removable polyethylene dome.
4. Pipe extended to 4" inches above flood elevation.
5. Accessories: Coordinate with roofing type refer to architectural drawings and specifications.
 - a. Membrane flange and membrane clamp with integral gravel stop.
 - b. Adjustable under deck clamp.
 - c. Roof sump receiver.
 - d. Waterproofing flange.
 - e. Controlled flow weir.
 - f. Leveling frame.
 - g. Adjustable extension sleeve for roof insulation.
 - h. Perforated or slotted ballast guard extension for inverted roof.
 - i. Perforated stainless steel ballast guard extension.

2.15 PARAPET DRAINS

- A. Manufacturers:
 - 1. Watts
 - 2. JR Smith
 - 3. Zurn
 - 4. Mifab
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Galvanized cast iron body with aluminum flashing clamp collar and nickel bronze sloping flush grate.

2.16 CANOPY AND CORNICE DRAINS

- A. Manufacturers:
 - 1. Watts
 - 2. JR Smith
 - 3. Zurn
 - 4. Mifab
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Galvanized cast iron body with aluminum flashing clamp collar and nickel bronze flat strainer.

2.17 SPECIAL PURPOSE DOWNSPOUT COVER

- A. Manufacturers:
 - 1. Watts
 - 2. JR Smith
 - 3. Zurn
 - 4. Mifab
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Brass with stainless steel mesh liner, vandal proof lock nut, and pipe clamp securing holes.

2.18 DOWNSPOUT NOZZLES

- A. Manufacturers:
 - 1. Watts
 - 2. JR Smith
 - 3. Zurn
 - 4. Mifab
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Polished finish body and wall flange round with straight offset bottom section. Furnish with bird screen.

2.19 TRENCH DRAINS

- A. Manufacturers:
 - 1. Watts
 - 2. JR Smith
 - 3. Zurn
 - 4. Substitutions: Section 01 60 00 - Product Requirements.

- B. Trench Drain: Pre-Sloped Trench Drain System with 6”(152) wide x 48”(1219) long (standard) ductile iron frame, UV stabilized glass-filled polypropylene channels with integral 4”(102) no hub bottom or end outlet(s). System shall be frame-anchored, with (specify) grating to suit DIN Class (specify) load rating. System to include frame connectors, grate lockdowns, and construction covers. Installation to be performed in accordance with manufacturer’s recommendations.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify walls and floor finishes are prepared and ready for installation of fixtures.
- C. Verify electric power is available and of correct characteristics.

3.2 PREPARATION

- A. Coordinate cutting and forming of roof and floor construction to receive drains to required invert elevations.

3.3 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. Cleanouts shall be same size as the pipes served, up to 4 inches; 5 and 6 inch pipes shall have 4 inch cleanouts; 8 inch pipes shall have 6 inch cleanouts; 10 inch pipes and larger shall have 8 inch cleanouts.
- D. Encase exterior cleanouts in concrete flush with grade.
- E. Install components level and plumb.
- F. Install piping penetrating roofed areas to maintain integrity of roof assembly.

- G. Install water hammer arrestors with isolation valve in accessible locations, provide with access doors, size, color and exact location to be coordinated by plumbing contractor with architect and architectural drawings.
- H. Trap primers shall be provided and installed to serve all floor drains floor sinks and indirect drains, provide distribution units as required for all drains.
- I. Trap primer connections shall be installed on cold water piping 1 ½ inch diameter or less.
- J. When floor finish includes tile, floor drain strainers and cleanout covers shall be provided to match tile shape to best extend possible. Square shall be used when square tiles are provided. When tile is a different shape, the contractor shall confirm with architect what shape shall be provided.

3.4 INTERCEPTORS

- A. Provide sediment interceptors for all art room sinks, maintain clearances as required by the manufacturer.

3.5 INTERFACE WITH OTHER PRODUCTS

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

3.6 ADJUSTING

- A. Section 01 77 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

3.7 CLEANING

- A. Section 01 77 00 - Execution and Closeout Requirements: Final cleaning.

3.8 PROTECTION OF INSTALLED CONSTRUCTION

- A. Section 01 77 00 - Execution and Closeout Requirements: Protecting installed construction.

3.9 COMMISSIONING OF EQUIPMENT

- A. Engage a factory-authorized service representative, who is familiar with this project, to participate and assist, if necessary, in the functional performance testing of this equipment with the Commissioning Agent.

END OF SECTION

SECTION 223400 - FUEL-FIRED DOMESTIC WATER HEATERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Commercial gas-fired water heaters.
- B. Related Sections:
 - 1. Section 22 04 00 – General Conditions for Plumbing Trades
 - 2. Section 22 05 00 – Common work results for Plumbing
 - 3. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment
 - 4. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping
 - 5. Section 22 05 23 - General-Duty Valves for Plumbing Piping
 - 6. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
 - 7. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment
 - 8. Section 22 05 53 – Identification for Plumbing Piping and Equipment
 - 9. Section 22 07 00 - Plumbing Insulation
 - 10. Section 22 30 00 – Plumbing Specialties
 - 11. Section 22 40 00 – Plumbing Fixtures

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI Z21.10.1 - Gas Water Heaters Vol. I Storage Water Heaters with Input Ratings of 75,000 Btu per Hour or Less.
 - 2. ANSI Z21.10.3 - Gas Water Heaters - Vol. III Storage, with Input Ratings Above 75,000 Btu per Hour, Circulating and Instantaneous Water Heaters.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. American Society of Mechanical Engineers:
 - 1. ASME PTC 25 - Pressure Relief Devices.
 - 2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
- D. National Fire Protection Association:
 - 1. NFPA 54 - National Fuel Gas Code.
- E. United States Department of Energy:
 - 1. DOE 10 CFR - Uniform Test Method for Measuring the Energy Consumption of Furnaces.
- F. ICC
 - 1. IECC- 2012.
 - 2. IFGC- 2012

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate heat exchanger dimensions, size of taps, and performance data. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, taps, and drains.
- C. Product Data:
 - 1. Water Heaters: Submit dimensioned drawings of water heaters indicating components and connections to other equipment and piping. Indicate pump type, capacity and power requirements. Submit electrical characteristics and connection locations.

2. Pumps: Submit certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
- D. Manufacturer's Installation Instructions: Submit mounting and support requirements.
 - E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
 - F. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).
- 1.6 CLOSEOUT SUBMITTALS
- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
 - B. Operation and Maintenance Data: Submit replacement part numbers and availability.
- 1.7 QUALITY ASSURANCE
- A. ASME Compliance: Water Heater shall bear ASME HLW stamp and be National Board listed.
 - B. Listing: The water heater shall be listed ETL listed to UL 795 or ANSI Z21.10.3/CSA 4.3 "Gas Water Heaters"
 - C. The water heater will comply shall current ASHRAE 90.1 requirements.

- D. Water heaters with full rated input of 800,000 BTU shall operate at a minimum 94% thermal efficiency at full firing rate when tested to the ANSI Z21.10.3 thermal efficiency test protocol (DOE 10 CFR 431).
- E. Maintain one copy of each document on site.
- F. Water heater manufacturer certified to the ISO 9001 International Quality System.
- G. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

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

1.9 PRE-INSTALLATION MEETINGS

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

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Products storage and handling requirements.
- B. Accept water heaters on site in original labeled cartons. Inspect for damage.
- C. Protect tanks with temporary inlet and outlet caps. Maintain caps in place until installation.

1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.12 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for domestic water heaters packaged water heating systems.

1.13 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Storage tank, heating surfaces, and combustion chamber will have a manufacturer's **15-year** warranty (8 years non-prorated, 7 years prorated) covering manufacturing or material defects, waterside or fire side corrosion, leaks, and/or the production of rusty water. Warranties must be directly provided from the water heater manufacturer. Warranties provided by distributors, contractors, sales representatives or third party insurers will not be accepted.
- C. Burner and all heater parts: 1 year

PART 2 PRODUCTS

2.1 COMMERCIAL GAS FIRED STORAGE TYPE CONDENSING WATER HEATERS

- A. Acceptable Manufacturers:
 - 1. PVI Conquest 80L130A-GCL
 - 2. Pre-Approved equal storage type condensing water heater
 - 3. Skid mounted, packaged, pre-piped boiler and tank system in adherence to section 2.1
 - a. Available Manufacturers: Manufacturer shall be a company specializing in manufacturing the products specified in this section with minimum twenty years' experience. The water heaters shall be manufactured by a company that has achieved certification to the ISO 9001 Quality Management System.
 - b. The water heaters shall be ETL listed as a complete unit. The heater shall satisfy current Federal Energy Policy Act standards for both thermal efficiency and stand-by heat losses as established for gas fired water heaters.
 - c. Manufacturers: PVI is the basis of design. Acceptable manufacturers shall be subject to compliance with the requirements of section 2.1 A through L.

2.2 COMMERCIAL GAS FIRED STORAGE TYPE CONDENSING WATER HEATERS

- A. Construction: Tank, combustion chamber and fire tubes will be constructed from phase-balanced austenitic and ferritic duplex steel with a chemical structure containing a minimum of 21% chromium to prevent corrosion and mill certified per ASTM A 923 Methods A to ensure that the product is free of detrimental chemical precipitation that

affects corrosion resistance. The material selected shall be tested and certified to pass stress chloride cracking test protocols as defined in ISO 3651-2 and ASTM G123 - 00(2005) "Standard Test Method for Evaluating Stress-Corrosion Cracking of Stainless Alloys with Different Nickel Content in Boiling Acidified Sodium Chloride Solution."

- B. Materials shall meet ASME Section II material requirements and be accepted by NSF 61 for municipal potable water systems. Storage tank materials shall contain more than 80% post-consumer recycled materials and be 100% recyclable.
- C. Substitution Compliance requirements: The water heating system shall be storage type condensing or pre-piped boiler/tank condensing design with appropriate storage tanks and capable of delivering return water back to the boiler below 90 degrees to insure continual condensing operation. The system manufacturer's design must be ETL listed as a complete unit and shall have an efficiency of 96% as tested to Thermal Efficiency based on ANSI Z21.10.3. Submittals must include ETL or equal test results showing conformance to efficiency requirements. This system must include a double wall plate & frame heat exchanger manufactured by Aerco (Smart Plate) or Alpha Laval along with detailed engineering calculations. A complete CAD design must be presented for approval with the submittals showing piping layout, pipe sizes, bypass piping, isolation valves, balance valves, pipe insulation type and thickness, pump size and type (must be all bronze), boiler manufacturer and efficiency, electrical requirements, double wall heat exchanger selection, skid dimensions and tank specifications. Approved boiler manufacturers are Aerco Benchmark and Viessmann VitoCrossal 300. Approved storage tank manufacturers are 90/10 copper nickel tanks from Hubbell or equal unlined storage tanks. Each tank will be piped to an external double wall heat exchanger with a bronze pump capable of delivering the required 932 gph recovery while providing a return water temperature to the boiler below 90 degrees. A boiler efficiency curve will be submitted showing efficiency related to return water temperature. Any additional cost for motor starters, insulation, venting, gas pipe and/or other subcontractor labor shall be included in the submittal for equal substitutions and are the contractor's responsibility.
- D. All tank connections/fittings will be non-ferrous or stainless steel.
- E. To preserve thermal efficiency, the water heater will not use or require a circulator piped from the hot water outlet to the cold water inlet of the heater for the purpose of temperature control during normal operation. Connection for a building return circulation line will be made to a dedicated hot return fitting at the center of the storage vessel and not the cold inlet piping.
- F. Finished vessel will not require sacrificial or impressed current anodes and none will be used. Water heaters or sidearm storage tanks that employ anode rods of any type will not be acceptable.
- G. Combustion will be provided by a premix, fan-assisted surface burner with a gas train meeting UL, ANSI and FM standards for the input specified. Gas train components will be capable of self-proportionating gas and air to maintain optimum combustion in response to varying vent pressures. The burner will employ non-linkage modulation utilizing only a VFD drive to vary gas and air.

- H. Burner NOx emissions will be less than 20 ppm when corrected to 3% oxygen.
- I. Water heater will be a category IV, condensing appliance and vent through PVC or Polypropylene. Water heater will satisfy requirements for sealed combustion. Vents for inlet air and exhaust can terminate in different pressure zones.
- J. Capacity:
 - 1. Storage capacity: 130 gallon each heater
 - 2. Input: 800,000 BTU
 - 3. Min recovery rate: 932 gph with 100 deg temperature rise
- K. Options shall include condensate neutralization system and other options as listed on the schedule.
- L. The water heater shall employ an electronic operating control with digital temperature readout. Operator shall be capable of connecting to a building automation system through serial connection using Modbus RTU protocol. An optional protocol gateway for BacNet MSTP/IP or Lonworks will be provided in accordance with the water heated schedule listed on the drawings.
- M. Water heater will be certified by the DOE/EPA Energy Star program for commercial water heaters, whereby standby loss and thermal efficiency are independently tested and certified.
- N. Water heaters will operate at a minimum 96% thermal efficiency at full firing rate when tested to the ANSI Z21.10.3 thermal efficiency test protocol (DOE 10 CFR 431).
- O. Controls: As a minimum, the heater will be equipped with the following:
 - 1. Electronic flame monitoring
 - 2. Electronic low water cutoff
 - 3. An immersion operating control
 - 4. an immersion UL listed temperature limiting device
 - 5. an ASME rated temperature and pressure relief valve
- P. Start Up: Start up on the unit will be performed by factory trained and authorized personnel. A copy of the start-up report will be provided to the owner. Water heater manufacture will provide a one year service policy from the date of approved start-up.
- Q. Substitution shall follow the requirements of section 01 60 00 – Product Requirements

2.3 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Electrical Characteristics: In accordance with Section 26 05 03 and the following:
 - 1. 120 volts, single phase, 60 Hz.
- B. Motors: In accordance with Section 22 05 13.
- C. Disconnect Switch: Factory mount disconnect switch on equipment.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Maintain manufacturer's recommended clearances around and over water heaters.
- B. Install water heater on concrete housekeeping pad, minimum 3-1/2 inches high and 6 inches larger than water heater base on each side. Refer to Section 03 30 00.
- C. Connect natural gas piping in accordance with NFPA 54.
- D. Connect natural gas piping to water heater, full size of water heater gas train inlet. Arrange piping with clearances for burner removal and service. Provide pressure regulator's as required.
- E. Connect domestic hot water domestic cold water piping to supply and return water heater connections.
- F. Install the following piping accessories. Refer to Section 22 11 00.
 - 1. On supply:
 - a. Thermometer well and thermometer.
 - b. Strainer.
 - c. Pressure gage.
 - d. Shutoff valve.
 - 2. On return:
 - a. Thermometer well and thermometer.
 - b. Pressure gage.
 - c. Shutoff valve.
- G. Install the following piping accessories on natural gas piping connections.
 - 1. Strainer.
 - 2. Pressure gage.
 - 3. Shutoff valve.
 - 4. Pressure reducing valve.
- H. Install discharge piping from relief valves and drain valves to nearest floor drain.
- I. Install circulator and diaphragm expansion tank on water heater.
- J. Install water heater trim and accessories furnished loose for field mounting.
- K. Install electrical devices furnished loose for field mounting.
- L. Install control wiring between water heater control panel and field mounted control devices.
- M. Connect flue to water heater outlet, full size of outlet. Refer to Section 23 51 00.

END OF SECTION

SECTION 224000 - PLUMBING FIXTURES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Water closets.
 2. Urinals.
 3. Sinks.
 4. Service sinks.
 5. Electric water coolers.
 6. Drinking fountains.
 7. Showers.
 8. Wash fountains.
 9. Emergency Eye and Face Wash.
 10. Emergency Combination Shower with Eye and Face Wash.
- B. Related Sections:
1. Section 07 90 00 - Joint Protection: Product requirements for calking between fixtures and building components for placement by this section.
 2. Section 22 04 00 – General Conditions for Plumbing Trades
 3. Section 22 05 00 – Common work results for Plumbing
 4. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment
 5. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping
 6. Section 22 05 23 - General-Duty Valves for Plumbing Piping
 7. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment
 8. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment
 9. Section 22 05 53 – Identification for Plumbing Piping and Equipment
 10. Section 22 07 00 - Plumbing Insulation
 11. Section 22 30 00 – Plumbing Specialties
 12. Section 22 34 00 – Fuel Fired Domestic Water Heaters
 13. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest

extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 - 2. ANSI Z124.2 - Plastic Shower Units.
 - 3. ANSI Z358.1 - Emergency Eyewash and Shower Equipment.
- B. Air-Conditioning and Refrigeration Institute:
 - 1. ARI 1010 - Self-Contained, Mechanically Refrigerated Drinking-Water Coolers.
- C. American Society of Mechanical Engineers:
 - 1. ASME A112.6.1 - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use.
 - 2. ASME A112.18.1 - Plumbing Fixture Fittings.
 - 3. ASME A112.19.1M - Enameled Cast Iron Plumbing Fixtures.
 - 4. ASME A112.19.2M - Vitreous China Plumbing Fixtures.
 - 5. ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
 - 6. ASME A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures.
 - 7. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks and Urinals.
- D. ICC:
 - 1. IECC - 2012

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
- C. Manufacturer's Installation Instructions: Submit installation methods and procedures.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

- E. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit fixture, trim, exploded view and replacement parts lists.

1.7 QUALITY ASSURANCE

- A. Provide products requiring electrical connections listed and classified by Underwriters Laboratories Inc., testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.
- B. Provide plumbing fixture fittings in accordance with ASME A112.18.1 that prevent backflow from fixture into water distribution system.
- C. Maintain one copy of each document on site.
- D. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.

2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

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

1.9 PRE-INSTALLATION MEETINGS

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

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Accept fixtures on site in factory packaging. Inspect for damage.
- C. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.11 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for plumbing fixtures.

1.12 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two sets of faucet washers flush valve service kits sink/lavatory supply fittings shower heads toilet seats

PART 2 PRODUCTS

2.1 FLUSH VALVE WATER CLOSETS

- A. Manufacturers:
 - 1. American Standard Plumbing
 - 2. Zurn
 - 3. Sloan
 - 4. Kohler Co.
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Bowl: ASME A112.19.2M; wall hung, siphon jet vitreous china closet bowl, with elongated rim, 1-1/2 inch top or back spud, china bolt caps.
- C. Sensor Operated Flush Valve: ASME A112.18.1; concealed rough brass, diaphragm type with low voltage operated solenoid operator, infrared sensor and over-ride button in chrome plated plate, wheel handle stop and vacuum breaker; maximum 1.28 gallon flush volume.
- D. Seat: Solid white plastic, open front, extended back, self-sustaining hinge, brass bolts, without cover.
- E. Wall Mounted Carrier: ASME A112.6.1; adjustable cast iron frame, integral drain hub and vent, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers.

2.2 WALL HUNG URINALS

- A. Manufacturers:
 - 1. American Standard Plumbing
 - 2. Sloan
 - 3. Kohler Co.
 - 4. Zurn
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Urinal: ASME A112.19.2M or ANSI Z124.9, vitreous; vitreous china, wall hung washout siphon jet urinal with shields, integral trap, removable stainless steel strainer, 3/4 inch top or back spud, steel supporting hanger.
- C. Sensor Operated Flush Valve: ASME A112.18.1; concealed rough brass, diaphragm type with battery operated solenoid operator, infrared sensor and over-ride button in chrome plated plate, wheel handle stop and vacuum breaker; maximum 1/8 gallon flush volume.
- D. Wall Mounted Carrier: ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs.
- E. Provide elastomeric gasket complying with ASME A112.4.3, or approved setting compound, for fixture to flange connection.

2.3 SINKS

- A. Manufacturers:
 - 1. American Standard Plumbing
 - 2. Eljer Plumbingware
 - 3. Kohler Co.
 - 4. Elkay
 - 5. Just. Mfg.
 - 6. Substitutions: Section 01 60 00 - Product Requirements.
- B. Single Compartment Bowl: ASME A112.19.3; 18 gage thick, Type 302 stainless steel. Undermount and undercoated, with 1-1/2 inch chromed brass stainless steel rear offset drain 3-1/2 inch crumb cup and tailpiece, ledge back drilled for trim.
- C. Double Compartment Bowl: ASME A112.19.3; 18 gage thick, Type 302 stainless steel. Self-rimming and undercoated, with 1-1/2 inch chromed brass stainless steel drains 3-1/2 inch crumb cups and tailpieces, ledge back drilled for trim.
- D. Epoxy Science Sink: Bowl shall be furnished by others. Plumbing contractor shall furnish and install trim and accessories as indicated on plumbing fixture schedule and architectural drawings.
- E. Trim: ASME A112.18.1; chrome plated brass supply with high rise swing spout, vandal proof water economy aerator with maximum 1.0 gpm flow, sensor operated thermostatic mixing valve, furnish with retractable spray when installed in lounge or lunch areas.
- F. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, wheel handle screwdriver stop, rigid flexible supplies.

2.4 SHOWERS

- A. Manufacturers:
 - 1. Bradley Corp.
 - 2. Aquarius
 - 3. Lasco
 - 4. Aquaglass
 - 5. Kohler Co.
 - 6. Fiat
 - 7. Substitutions: Section 01 60 00 - Product Requirements.
- B. Cabinet: Built up shower enclosure, refer to architectural drawings.
- C. Floor Receptor: (By others) Furnished with stainless steel entry cap, 1/2" barrier free entry threshold, 1" cast tiling flange, Shoulder shall be not less than 4" high inside, integral stainless steel drain with 2" drain outlet.
- D. Trim: ASME A112.18.1; concealed shower supply with indexed handles, bent shower arm with flow control and adjustable spray ball joint showerhead with maximum 1.5 gpm flow, and escutcheon.

- E. Trim: ASME A112.18.1; concealed shower supply with pressure balanced thermostatic mixing valves, integral service stops, ball joint showerhead with maximum 1.5 gpm flow and escutcheon, hand held shower with 60 inch metal hose and slide bar, female inlet.
1. Provide backflow protection in accordance with ASME A112.18.1 or by device complying with ASME 112.18.3.

2.5 ELECTRIC WATER COOLERS

- A. Manufacturers:
1. Elkay
 2. Hasley Taylor
 3. Haws
 4. Oasis
 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Fountain:
1. recessed handicapped mounted electric water cooler with stainless steel top, #18 gauge, type 304 stainless steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, mounting bracket, refrigerated with integral air cooled condenser and stainless steel grille. Bottle filler feature.
 2. Capacity: minimum 7.5 gpm of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F.
 3. Electrical: 115V, single phase, cord and plug for connection to electric wiring system including grounding connector.

2.6 DRINKING FOUNTAINS

- A. Manufacturers:
1. Elkay
 2. Hasley Taylor
 3. Haws
 4. Oasis
 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Fountain:
1. recessed handicapped mounted fountain with stainless steel top, #18 gauge, type 304 stainless steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, mounting bracket, Bottle filler feature.

2.7 WASH FOUNTAINS

- A. Manufacturers:
1. Bradley Corp.
 2. Acorn
 3. Sloan
 4. Willoughby
 5. Substitutions: Section 01 60 00 - Product Requirements.

- B. Bowl: (One, Two or Three station units), continuous blow constructed from solid surface material, sensor operated, 0.5 gpm flow rate, wall mounted with heavy gauge stainless steel support frame, shroud below fixture to conceal piping.
- C. Accessories: self-closing valve, spray head, thermostatic mixing valve, supporting tube, spud and strainer, combination stop, strainer and check valves.

2.8 SERVICE SINKS

- A. Manufacturers:
 - 1. American Standard Plumbing
 - 2. Acorn
 - 3. Fiat
 - 4. Just
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Bowl: 36 x 24 x 10 inch 24 x 24 x 10 inch high molded stone, floor mounted, with one inch wide shoulders, stainless steel bumper guard, and stainless steel strainer.
- C. Trim: ASME A112.18.1 exposed wall type supply with cross lever handles, spout wall brace, vacuum breaker, hose end spout, strainers, eccentric adjustable inlets, integral screwdriver stops with covering caps and adjustable threaded wall flanges.
- D. Accessories:
 - 1. 5 feet of 1/2 inch diameter plain end reinforced plastic rubber hose.
 - 2. Hose clamp hanger.
 - 3. Mop hanger.

2.9 EMERGENCY EYE AND FACE WASH

- A. Manufacturers:
 - 1. Bradley Corp.
 - 2. Encon Safety Products
 - 3. Guardian
 - 4. Speakman
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. ANSI Z358.1; pedestal mounted, stainless steel bowl with elbow, 1-1/4 inch stainless steel pipe pedestal with floor flange, instant action stay open valve actuated by push flag or foot pedal, twin spray heads with face spray ring, dust cover assembly, wall mount bracket, and tailpiece and chrome plated brass P-trap. Furnish universal emergency sign.
- C. Furnish emergency type mixing valve with cold water bypass, stainless steel valve box and temperature gauge.

2.10 EMERGENCY COMBINATION SHOWER WITH EYE AND FACE WASH

- A. Manufacturers:
 - 1. Bradley Corp.
 - 2. Encon Safety Products
 - 3. Guardian
 - 4. Speakman
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Shower: ANSI Z358.1; free standing, self- cleaning, non-clogging stainless steel drench shower head, instant action stay open valve actuated by rigid stainless steel pull rod.
- C. Eyewash: ANSI Z358.1; stainless steel bowl with elbow, 1-1/4 inch stainless steel pipe pedestal with floor flange, instant action stay open valve actuated by push flag , twin spray heads with face spray ring, dust cover assembly, wall mount bracket, and tailpiece and chrome plated brass P-trap.
- D. Supply and Waste Piping: 1 inch 1-1/4 inch galvanized steel stainless steel pipe pedestal with floor flange.
- E. Furnish universal emergency sign.
- F. Furnish emergency type mixing valve with cold water bypass, secure, stainless steel valve box and temperature gauge.

2.11 LAVATORY INSULATION KIT

- A. Manufacturers:
 - 1. McGuire
 - 2. Truebro
 - 3. Plumerex
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Where Lavatories are noted to be insulated for ADA compliance, furnish the following: Safety Covers conforming to ANSI A177.1 and consisting of insulation kit of molded closed cell vinyl construction, 3/16 inch thick, white gray color, for insulating tailpiece, P-trap, valves, and supply piping. Furnish with weep hole and angle valve access covers.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify walls and floor finishes are prepared and ready for installation of fixtures.

- C. Verify electric power is available and of correct characteristics.
- D. Confirm millwork is constructed with adequate provision for installation of counter top lavatories and sinks.

3.2 PREPARATION

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

3.3 INSTALLATION

- A. Install each fixture with trap, easily removable for servicing and cleaning.
- B. Provide chrome plated rigid or flexible supplies to fixtures with loose key screwdriver stops, reducers, and escutcheons.
- C. Install components level and plumb.
- D. Install and secure fixtures in place with wall supports wall carriers and bolts.
- E. Seal fixtures to wall and floor surfaces with sealant as specified in Section 07 90 00, color to match fixture.
- F. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.
- G. For ADA accessible water closets, install flush valve with handle to wide side of stall.
- H. For faucets rated for less than 2.2 gpm, hot water recirculation shall connect to within eight feet of faucet and shall be provided with a balancing valve.
- I. Contractor shall furnish and install faucet aerators as required to comply with CT high performance building water conservation requirements.

3.4 INTERFACE WITH OTHER PRODUCTS

- A. Review millwork shop-drawings. Confirm location and size of fixtures and openings before rough in and installation.
- B. Review kitchen, finish, and equipment plans and specifications for additional work and materials to be furnished or installed by the plumbing contractor.

3.5 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Clean plumbing fixtures and equipment.

3.7 PROTECTION OF INSTALLED CONSTRUCTION

- A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.
- B. Do not permit use of fixtures before final acceptance.

3.8 SCHEDULES

- A. Fixture Rough-In:

Fixture	Hot inches	Cold inches	Waste inches	Vent inches
Water Closet (Flush Valve):		1	4	2
Urinal (Flush Valve):		3/4	2	1-1/2
Lavatory:	1/2	1/2	1-1/2	1-1/2
Sink:	1/2	1/2	1-1/2	1-1/2
Service Sink:	1/2	1/2	3	1-1/2
Drinking Fountain:		1/2	1-1/2	1-1/2
Shower:	1/2	1/2	1-1/2	1-1/2

END OF SECTION

SECTION 230400 - GENERAL CONDITIONS FOR MECHANICAL TRADES

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections:
 - 1. Section 01 91 13 – General Commissioning Requirements
 - 2. Section 23 08 00 – Commissioning of HVAC Systems

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 DESCRIPTION

- A. The General Conditions and Supplementary General Conditions are a part of this Division and are to be considered a part of this Contract.
- B. Where items of the General Conditions and Supplementary General Conditions are repeated in other Sections of the Specifications, it is merely intended to qualify or to call particular attention to them. It is not intended that any other parts of the General Conditions and Supplementary General Conditions shall be assumed to be omitted if not

repeated therein. This Section applies equally and specifically to all Contractors supplying labor and/or equipment and/or materials as required under each Section of this Division. Where conflicts exist between the drawings and the specifications or between this section of the specifications and other sections, the more stringent or higher cost option shall apply.

- C. Demolition and renovation work shall be performed in accordance with SMACNA IAQ Guidelines for Occupied Buildings Under Construction.

1.5 INTENT

- A. It is the intent of the Specifications and Drawings to call for finished work, tested and ready for operation.
- B. Any apparatus, appliance, material or work not shown on drawings but mentioned in the specifications, or vice versa, or any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation as determined by good trade practice even if not particularly specified, shall be furnished, delivered and installed under their respective Divisions without any additional expense to the Owner.
- C. Minor details not usually shown or specified but necessary for proper installation and operation shall be included in the work as though they were hereinafter shown or specified.
- D. Work under each Section shall include giving written notice to the Owner and Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, it is mutually agreed that work under each Section includes the cost of all required items for the accepted, satisfactory functioning of the entire system without extra compensation.

1.6 DEFINITIONS

- A. Approve: The term "approved," where used in conjunction with the Engineer's action on the Contractor's submittals, applications, and requests, is limited to the Engineer's duties and responsibilities as stated in General and Supplementary Conditions.
- B. "Approved equal" mean any product which in the opinion of the Engineer is equal in quality, arrangement, appearance, and performance to the product specified.
- C. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Engineer," "requested by the Engineer," and similar phrases.
- D. "Finished" refers to all rooms and areas to be specified to receive architectural treatment as indicated on the drawings. All rooms and areas not covered, including underground tunnels and areas above ceilings shall be considered not finished, unless otherwise noted.

- E. “Furnish” or “supply” shall mean purchase, deliver to, and off-load at the job site, ready to be installed including where appropriate all necessary interim storage and protection.
- F. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, other paragraphs or schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.
- G. “Install” shall mean set in place complete with all mounting facilities and connections as necessary ready for normal use or service.
- H. “Product” shall mean any item of equipment, material, fixture, apparatus, appliance or accessory installed under this Division.
- I. “Provide” shall mean furnish (or supply) and install as necessary.
- J. Regulation: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.
- K. Remove: The term “remove” means “ to disconnect from its present position, remove from the premises and to dispose of in a legal manner.”
- L. Special Warranties: The term “Special Warranties” are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.
- M. Standard Product Warranties: The term “Standard Product Warranties” are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.
- N. “Subcontractor” means specifically the subcontractor working under this Division. Other Contractors are specifically designated “Plumbing Subcontractor”, “General Contractor” and so on. Note: Take care to ascertain limits of responsibility for connecting equipment which requires connections by two or more trades.
- O. Substitutions: Requests for changes in products, materials, equipment, and methods of construction proposed by the Contractor are considered requests for "substitutions."
- P. “Wiring” shall mean cable assembly, raceway, conductors, fittings and any other necessary accessories to make a complete wiring system.

1.7 DRAWINGS

- A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. Consult the Architectural Drawings and Details for exact location of fixtures and equipment; where same are not definitely located, obtain this information from the Architect. (Do not scale the drawings)

- B. Work under each Section shall closely follow Drawings in layout of work; check Drawings of other Divisions to verify spaces in which work will be installed. Maintain maximum headroom; where space conditions appear inadequate, Owner and Engineer shall be notified before proceeding with installations.
- C. The Owner may, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades and/or for proper execution of the work.
- D. Where variances occur between the Drawings and Specifications or within either of the Documents, the item or arrangement of better quality, shall be included in the Contract price. The Owner and Engineer shall decide on the item and the manner in which the work shall be installed.

1.8 SURVEYS AND MEASUREMENTS

- A. Before submitting his Bid, the Contractors shall visit the site and become thoroughly familiar with all existing conditions under which work will be installed. This Contract includes all modifications of existing systems required for the installation of new equipment. This Contract includes all necessary offsets, transitions and modifications required to install all new equipment in existing spaces. All new and existing equipment and systems shall be fully operational under this Contract before the job is considered complete. The Contractors shall be held responsible for any assumptions he makes, any omissions or errors he makes as a result of his failure to become fully familiar with the existing conditions at the site and the Contract Documents.
- B. The Contractor shall base all measurements, both horizontal and vertical, from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.
- C. Should the Contractor discover any discrepancies between actual measurements and those indicated which prevent following good practice or which interfere with the intent of the Drawings and Specifications, the Engineer will be notified and work will not proceed until instructions from the Engineer are received.

1.9 DEMOLITION

- A. Demolition work shall be performed in a neat and orderly fashion. After piping, ductwork, equipment, etc., has been removed, neatly cap remaining ductwork and piping, and insulate caps in accordance to Section 230700 – HVAC Insulation. In finished areas, all ductwork and piping shall be cut back to a concealed location, i.e., within walls, above ceilings, etc., before capping.
- B. Before submitting his Bid, the Contractor shall visit the site with Architectural and Mechanical Plans in hand, and shall inspect all existing systems to determine the extent of demolition work involved. Particular attention is drawn to the removal of existing walls or portions of existing walls. In those areas, all exposed and concealed piping, ductwork, equipment, etc., running across or through affected areas shall be removed as required. Piping and ductwork shall then be either capped, or, if required for the proper

continuing operation of an existing system to remain, piping and ductwork shall be rerouted around the affected areas and reconnected as required.

In general, it shall be the responsibility of the Contractor to remove demolished equipment, piping, ductwork, etc., from the site and properly dispose of it. If the Owner shall so request, however, the Contractor shall turn over demolished equipment, etc., to the Owner for the Owner's use.

- C. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, heating units, and other mechanical items made obsolete by the new Work.
- D. Location of existing systems and equipment shown on the drawings is based on the best available information. The Contractor shall verify dimensions and locations of existing systems and equipment in the field and adjust as necessary.
- E. Certain items of existing equipment and piping or ductwork may be indicated for removal or relocation. Items noted for removal shall be disconnected and disposed of by the Contractor or turned over to the Owner if the Owner so requested. If instructed to dispose of items, the Contractor shall remove the items from the premises and dispose of them in a safe, legal and responsible manner and location. Items noted for relocation are intended for reuse in another location as designated on the Drawings. It shall be the responsibility of the Contractor to remove the material from its present location, store the material in a safe place and reinstall the material in its new location. Questions regarding the suitability of the material or equipment shall be brought to the attention of the Owner and Engineer in writing.
- F. Demolition work shall be performed in accordance with SMACNA IAQ Guidelines for Occupied Buildings Under Construction.

1.10 REFRIGERANT RECLAMATION

- A. The Contractor shall provide all required equipment and labor to reclaim all chlorofluorocarbon refrigerant liquids and vapors from all refrigeration equipment being demolished under this Contract, including all existing equipment, freon storage tanks and piping. When work on an existing system would otherwise release refrigerant to the environment, the Contractor shall reclaim all refrigerant before commencing with such work.

1.11 CODES AND STANDARDS

- A. Reference Standard Compliance
 - 1. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), and Underwriters Laboratories Inc. (UL), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.

2. Independent Testing Organization Certificate: In lieu of the label or listing indicated above, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Engineer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.
- B. The Following Codes and Standards listed below apply to all mechanical work. Wherever Codes and/or Standards are mentioned in these Specifications, the latest applicable edition or revision shall be followed:
- 2016 Connecticut State Building Code - Connecticut Supplement
 - 2012 International Building Code
 - 2012 International Mechanical Code
 - 2012 International Plumbing Code
 - 2012 International Energy Conservation Code
 - 2012 International Fuel Gas Code
 - 2014 National Electrical Code
 - 2013 ASHRAE 90.1
- C. The following Standards shall be used where referenced by the following abbreviations:
- | | |
|--------|---|
| AABC | Associated Air Balance Council |
| ACGIH | American Conference of Governmental Industrial Hygienists |
| ADC | Air Diffusion Council |
| AGA | American Gas Association |
| AIA | American Institute of Architects |
| AMCA | Air Moving and Conditioning Association |
| ANSI | American National Standards Institute |
| API | American Petroleum Institute |
| ARI | Air Conditioning and Refrigeration Institute |
| ASHRAE | American Society of Heating, Refrigerating and Air Conditioning Engineers |
| ASME | American Society of Mechanical Engineers |
| ASPE | American Society of Plumbing Engineers |
| ASSE | American Society of Sanitary Engineers |
| ASTM | American Society of Testing and Materials |
| AWS | American Welding Society |
| AWWA | American Water Works Association |
| CGA | Compressed Gas Association |
| CSA | Canadian Standards Association |
| CISPI | Cast Iron Soil Pipe Institute |
| EJMA | Expansion Joint Manufacturing Association |
| EPA | Environmental Protection Agency |
| FM | Factory Mutual |
| FSSC | Federal Specification |
| HIS | Hydraulic Institute Standards |
| IEEE | Institute of Electrical and Electronics Engineers |
| IRI | Industrial Risk Insurers |
| ISO | Insurance Services Office |
| MCAA | Mechanical Contractors Association of America |

NBS	National Bureau of Standards
NEBB	National Environmental Balancing Bureau
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NOFI	National Oil Fuel Institute
NSC	National Safety Council
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Administration
PDI	Plumbing and Drainage Institute
SBI	Steel Boiler Industry (Division of Hydronics Institute)
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
STI	Steel Tank Institute
UL	Underwriters' Laboratories

- D. All materials furnished and all work installed shall comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction and the requirements of all Governmental departments having jurisdiction.
- E. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and Drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether shown on Drawings and/or specified or not.

1.12 PERMITS AND FEES

- A. The Contractor shall give all necessary notices, obtain all permits; and pay all Government and State sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the work, file all necessary Drawings, prepare all documents and obtain all necessary approvals of all Governmental and State departments having jurisdiction, obtain all required certificates of inspection for his work, and deliver a copy to the Owner and Engineer before request for acceptance and final payment for the work.

1.13 EQUIPMENT SUBSTITUTIONS

- A. In these Contract Documents, one or more makes of materials, apparatus or appliances may have been specified for use in this installation. These describe the basis of design and approved equivalents. This has been done for convenience in fixing the standard of workmanship, finish and design required for installation without consideration of any or all costs associated but not limited to (structural, mechanical, or electrical feeder, breaker, or transformer requirements). The Contractor acknowledges that not all requirements are shown for either alternate acceptable manufacturers listed or those alternates requiring a request for substitution and it is their responsibility to coordinate all requirements necessary to accommodate any change from the basis of design listed or scheduled. The contractor is required to submit any and all costs (including costs associated or required by all trades) along with performance differences as part of their request for substitution. The details of workmanship, finish and design, and the guaranteed performance of any material, apparatus or appliance which the Contractor desires to deviate for those mentioned herein shall also conform to these standards.

- B. Where no specific make of material, apparatus or appliance is mentioned, any first-class product made by a reputable manufacturer may be submitted for the Engineers review.
- C. Where two or more names are given as approved manufacturers of equivalents, the Contractor must use the specified item or one of the named equivalents which still must meet all of the performance characteristics of the basis of design make and model. Where one name only is used and is followed by the words “or approved equal”, the Contractor must use the item named or he is required to apply for a substitution. Where one name only is used, the Contractor must use that item named.
- D. Where the Contractor proposes to deviate (provide an equivalent or request for substitution) from the equipment or materials as hereinafter specified, they are required to submit a requested for substitution in writing. The Contractor shall state in their request whether it is a substitution or a non approved equivalent to that specified and the amount of credit or extra cost involved. A copy of said request shall be included in the Base Bid with manufacturer’s equipment cuts. The Base Bid shall be based on using the materials and equipment as specified with no exceptions.
- E. Where the Contractor proposes to use an item of equipment other than specified or detailed on the Drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout, all such redesign and all new drawings and detailing required therefore shall be prepared by the Engineers/Architects of Record at the expense of the Contractor and at no additional cost to the Owner.
- F. Where such accepted deviation resulting from using an approved equivalent or substitution requires a different quantity and arrangement of piping, ductwork, valves, pumps, insulation, wiring, conduit and equipment from that specified or indicated on the Drawings, the Contractor shall, after acceptance by the Engineer, furnish and install any such additional equipment required by the system at no additional cost to the Owner, including any costs added to other trades due to the deviation.
- G. Equipment, material or devices submitted for review as an “equivalent” shall meet the following requirements:
1. The equivalent shall have the same construction features such as, but not limited to:
 - a. Material thickness, gauge, weight, density, etc.
 - b. Welded, riveted, bolted, etc., construction
 - c. Finish, undercoating, corrosion protection
 2. The equivalent shall perform with the same or better operating efficiency.
 3. The equivalent shall be locally represented by the manufacturer for service, parts and technical information.
 4. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as UL or NEMA labels.
- H. Equipment, material or devices submitted for review as a “substitution” shall meet the following requirements:
1. Substitution Request Submittal: Requests for substitution will be considered if received in writing 14 days before the bid date. Requests received later than 14

days before the bid date may be considered or rejected at the discretion of the Engineer/Owner. Once the Contractor submits a complete request for substitution as determined by the engineer, the engineer reserves the right to request the time necessary to evaluate the request for substitution and review it with the Owner.

2. Submit three (3) copies of each request for substitution for consideration.
3. Identify the product, or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
 - a. Product Data, including Drawings and descriptions of products, fabrication and installation procedures.
 - b. Samples, where applicable or requested.
 - c. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect.
 - d. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate Contractors, that will become necessary to accommodate the proposed substitution.
 - e. A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
 - f. Cost information, including a proposal of the net change, if any in the Contract Sum.
 - g. Certification by the Contractor that the substitution proposed is equal-to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the Contractor's waiver of rights to additional payment or time, that may subsequently become necessary because of the failure of the substitution to perform adequately.
 - h. Engineer's Action: Within one week of receipt of the request for substitution, the Engineer will notify the Contractor of acceptance or rejection of the proposed substitution. If a decision on use of a proposed substitute cannot be made or obtained within the time allocated, use the product specified by name. Acceptance of a product substitution will be in the form of an Addendum.
 - i. Other Conditions: The Contractor's substitution request will be received and considered by the Engineer when one or more of the following conditions are satisfied, as determined by the Engineer; otherwise requests will be returned without action except to record noncompliance with these requirements.
 - 1) The request is directly related to an "or equal" clause or similar language in the Contract Documents.
 - 2) The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a

result of failure to pursue the Work promptly or coordinate activities properly.

- 3) A substantial advantage is offered the Owner, in terms of cost, time, energy conservation or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear. Additional responsibilities for the Owner may include additional compensation to the Engineer for redesign and evaluation services, increased cost of other construction by the Owner or separate Contractors, and similar considerations.

1.14 SUBMITTAL PROCEDURES

- A. Provide Submittals in accordance with the requirements of Division 1 and as indicated in the following.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.
 2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for resubmittals.
 1. Allow two weeks for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The Engineer will promptly advise the Contractor when a submittal being processed must be delayed for coordination.
 2. If an intermediate submittal is necessary, process the same as the initial submittal.
 3. Allow two weeks for reprocessing each submittal.
 4. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing.
- D. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block. Submittals shall be arranged in order of specification sections.
 1. Include the following information on the label for processing and recording action taken.
 - a. Project name.
 - b. Date.
 - c. Name and address of Engineer.
 - d. Name and address of Contractor.
 - e. Name and address of subcontractor.

- f. Name and address of supplier.
 - g. Name of manufacturer.
 - h. Number, title and paragraph of appropriate Specification Section.
 - i. Drawing number and detail references, as appropriate.
- E. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to Engineer using a transmittal form. Submittals received from sources other than the Contractor will be returned without action. On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.
- F. Except for submittals for record, information or similar purposes, the Engineer will review each submittal, mark to indicate action taken, and return promptly. Compliance with specified characteristics is the Contractor's responsibility.
- G. Action Stamp: The Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, to indicate the action taken.

1.15 SHOP DRAWINGS

- A. Submit neatly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.
- B. The Contractor shall submit for review detailed shop drawings of all equipment and material specified in each section and coordinated ductwork layouts. No material or equipment may be delivered to the job site or installed until the Contractor has received shop drawings for the particular material or equipment which have been properly reviewed. Shop drawings shall be submitted within 60 days after award of Contract before any material or equipment is purchased. The Contractor shall submit for review copies of all shop drawings to be incorporated in the Mechanical Contract. Refer to Division 1 for the quantity of copies required for submission. Where quantities are not specified, provide seven (7) copies for review.
- C. Provide shop drawings for all devices specified under equipment specifications for all systems. Shop drawings shall include manufacturers' names, catalog numbers, cuts, diagrams, dimensions, identification of products and materials included, compliance with specified standards, notation of coordination requirements, notation of dimensions established by field measurement and other such descriptive data as may be required to identify and accept the equipment. A complete list in each category (example: all fixtures), of all shop drawings, catalog cuts, material lists, etc., shall be submitted to the Engineer at one time. No consideration will be given to a partial shop drawing submittal.

- D. When a submittal could involve more than one trade, e.g., valves, piping, etc., the submitted shall be separated by traded involved, ie. HVAC, plumbing, fire protection, etc.
- E. Where multiple quantities or types of equipment are being submitted, provide a cover sheet (with a list of contents) on the submittal identifying the equipment or material being submitted.
- F. The Contractor shall furnish all necessary templates, patterns, etc., for installation work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.
- G. “No Exception Taken” rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, review does not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the Contract Drawings and Specifications. Verify available space prior to submitting shop drawings. Review of shop drawings shall not apply to quantity of material.
- H. After shop drawings have been reviewed, with no exceptions taken, no further changes will be allowed without the written consent of the Engineer.
- I. Shop drawing submittal sheets which may show items that are not being furnished shall have those items crossed off to clearly indicate which items will be furnished.
- J. Bidders shall not rely on any verbal clarification of the Drawings and/or Specifications. Any questions shall be referred to the Engineer in writing at least five (5) working days prior to Bidding to allow for issuance of an Addendum.
- K. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.
- L. Prepare sheetmetal and sprinkler shop drawings drawn in the latest AutoCAD version to a minimum scale of $1/4" = 1' - 0"$. Final approved drawings shall be turned over to the Owner on floppy disk or CD Rom.
- M. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor’s or subcontractor’s work. Material cost does not include costs associated with labor and equipment.

2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.16 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.17 COORDINATION DRAWINGS

- A. Prepare coordination drawings drawn in the latest AutoCAD version in accordance with Division 1 to a minimum scale of 1/4"=1'-0" detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
 1. The Contractor shall indicate the proposed locations of piping, conduit, ductwork, equipment, and materials. Include the following:
 - a. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
 - b. Equipment connections and support details.
 - c. Exterior wall and foundation penetrations.
 - d. Fire-rated wall and floor penetrations.
 - e. Sizes and locations of required concrete pads and bases.
- B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

- C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
- D. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.
- E. The Contractor and each subcontractor shall sign and date each coordination drawing prior to submission.
- F. Work shall not be performed until coordination drawings have been approved by the architect and engineer.
- G. Electronic copies of the MEP floor plans are available to use as a basis for preparing coordination drawings and can be provided by the Engineer. If the Contractor elects to obtain the Engineers electronic files an Electronic Drawing File Release Form must be submitted. This form must be signed by the Contractor, Owner, and Architect. Upon receipt of a signed copy of the Electronic Drawing File Release Form, the Engineer will provide copies of the electronic files for the Contractor's use. A copy of the Electronic Drawing File Release Form is appended to the end of this specification section.

1.18 COORDINATION WITH OTHER DIVISIONS

- A. All work shall be carried out in conjunction with other trades and full cooperation shall be given in order that all work may proceed with a minimum of delay and interference. Particular emphasis is placed on timely installation of major apparatus and furnishing other Contractors, especially the Contractor or Construction Manager, with information as to openings, chases, sleeves, bases, inserts, equipment locations, panels, etc., required by other trades.
- B. The Contractors are required to examine all of the Project Drawings and mutually arrange work so as to avoid interference with the work of other trades. In general, ductwork, HVAC piping, sprinkler piping and drainage lines take precedence over water, gas and electrical conduits. The Engineer shall make final decisions regarding the arrangement of work which cannot be agreed upon by the Contractors.
- C. Where the work of the Contractor will be installed in close proximity to or will interfere with work of other trades, the Contractors will cooperate in working out space conditions to make a satisfactory adjustment.
- D. If the work under a Section is installed before coordinating with other Divisions or Sections or so as to cause interference with work of other Sections, the necessary changes to correct the condition shall be made by the Contractor causing the interference without extra charge to the Owner.

1.19 WORKMANSHIP

- A. Service Support: The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.
- B. Modification of References: In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.
- C. The Contractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work together with all skilled workmen, fitters, metal workers, welders, helpers and laborers required to unload, transfer, erect, connect, adjust, start, operate and test each system.
- D. Unless otherwise specifically indicated on the Drawings or Specifications, all equipment and materials shall be installed with the acceptance of the Engineer and in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.
- E. All labor for installation of mechanical systems shall be performed by experienced, skilled tradesmen under the supervision of a licensed journeyman foreman. All work shall be of a quality consistent with good trade practice and shall be installed in a neat, workmanlike manner. The Engineer reserves the right to reject any work which, in his opinion, has been installed in a substandard, dangerous or unserviceable manner. The Contractor shall replace said work in a satisfactory manner at no extra cost to the Owner.

1.20 SHUTDOWNS

- A. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such time as designated by the Owner.
- B. The Engineer and the Owner shall be notified in writing of the estimated duration of the shutdown period at least ten (10) days in advance of the date the work is to be performed.
- C. Work shall be arranged for continuous performance whenever possible. The Contractor shall provide all necessary labor, including overtime if required, to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.21 TEMPORARY UTILITIES

- A. General: Provide new materials and equipment; if acceptable to the Engineer, undamaged previously used materials in serviceable condition may be used. Provide materials suitable for the use intended.

- B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload facilities, or permit them to interfere with progress. Do not allow hazardous dangerous or unsanitary conditions, or public nuisances to develop or persist on the site.
- C. First Aid Supplies: Comply with governing regulations.
- D. Fire Extinguishers: Provide hand-carried, portable UL-rated, class "A" fire extinguishers for temporary offices and similar spaces. In other locations provide hand-carried, portable, UL-rated, class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposures.
- E. Utilities: Engage the appropriate local utility company to install temporary service or connect to existing service. Where the company provides only part of the service, provide the remainder with matching, compatible materials and equipment; comply with the company's recommendations.
 - 1. Use Charges: Cost or use charges for temporary facilities are not chargeable to the Owner or Engineer, and will not be accepted as a basis of claims for a Change Order.
- F. Water Service: Install water service and distribution piping of sizes and pressures adequate for construction until permanent water service is in use.
- G. Temporary Heat-Cool-Dehumidification: Provide temporary services required by construction activities, for curing or drying of completed installations or protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate temporary services to produce the ambient condition required and minimize consumption of energy. The building's permanent HVAC systems shall not be used for these purposes. When propane is used for temporary heat, contractor shall be trained per state's department of public safety or equivalent requirements in storing, use and emergency planning of propane systems for temporary heat at construction sites. Documentation of trained personnel shall be kept on site.
- H. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons or firms near the site.
- I. Termination and Removal: Unless the Engineer requires that it be maintained longer, remove each temporary facility when the need has ended, or when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces and replace construction that cannot be satisfactorily repaired. Materials and facilities that constitute temporary facilities are property of the Contractor. The Owner reserves the right to take possession of Project identification signs.

1.22 PROJECT PHASING

- A. Work under each Section shall include all necessary temporary connections, equipment, piping, heating, temperature control work, fire stopping, water heaters, labor, and material as necessary to accommodate the phasing of Construction as developed by the General Contractor or Construction Manager and approved by the Owner. All existing systems that pass-thru an area of the building shall remain operational during all phases of construction. No extra compensation shall be granted the Contractor for work required to maintain existing systems operational or to accommodate the construction phasing of the project.

1.23 PROTECTION OF MATERIALS AND EQUIPMENT

- A. Work under each Section shall include protecting the work and material of all other Sections from damage by work or workmen and shall include corrective actions to damage thus caused.
- B. The Contractor shall be responsible for work and equipment until the facility has been accepted by the Owner. Protect work against theft, injury or damage and carefully store material and equipment received on site which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of foreign material.
- C. Work under each Section includes receiving, unloading, uncrating, storing, protecting, setting in place and completely connecting equipment supplied under each Section. Work under each Section shall also include exercising special care in handling and protecting equipment and fixtures, and shall include the cost of replacing any of the equipment and fixtures which are missing or damaged.
- D. Equipment and material stored on the job site shall be protected from the weather, vehicles, dirt and/or damage by workmen or machinery. Insure that all electrical or absorbent equipment or material is protected from moisture during storage.

1.24 ADJUSTING AND TESTING

- A. After all the equipment and accessories to be furnished are in place, they shall be put in final adjustment and subjected to such operating tests so as to assure the Engineer that they are in proper adjustment and in satisfactory, permanent operating condition.
- B. Where requested by the Engineer, a factory-trained service representative shall inspect the installation and assist in the initial startup and adjustment to the equipment. The period of these services shall be for such time as necessary to secure proper installation and adjustments. After the equipment is placed in permanent operation, the service representative shall supervise the initial operation of the equipment and instruct personnel responsible for operation and maintenance of the equipment. The service representative shall notify the Contractor in writing that the equipment was installed according to manufacturer's recommendations and is operating as intended by the manufacturer.

1.25 CLEANING

- A. The Contractor shall thoroughly clean and flush all piping, ducts and equipment of all foreign substances, oils, burrs, solder, flux, etc., inside and out before being placed in operation.
- B. If any part of a system should be stopped or damaged by any foreign matter after being placed in operation, the system shall be disconnected, cleaned and reconnected wherever necessary to locate and/or remove obstructions. Any work damaged in the course of removing obstructions shall be repaired or replaced when the system is reconnected at no additional cost to the Owner.
- C. During the course of construction, all ducts and pipes shall be capped in an acceptable manner to insure adequate protection against the entrance of foreign matter.
- D. Upon completion of all work under the Contract, the Contractor shall remove from the premises all rubbish, debris and excess materials left over from his work. Any oil or grease stains on floor areas caused by the Contractor shall be removed and floor areas left clean.
- E. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.
 - 1. Remove labels that are not permanent labels.
 - 2. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compound and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
 - 3. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean. Vacuum carpeted surfaces.
 - 4. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition. Clean light fixtures and lamps.
- F. Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful or dangerous materials into drainage systems. Remove and dispose of ALL waste materials, packaging material, skids etc. from the site and dispose of in a lawful manner in accordance with municipal, state and federal regulations.
- G. Where extra materials of value remaining after completion of associated Work have become the Owner's property, arrange for disposition of these materials as directed.

1.26 OPERATING AND MAINTENANCE

- A. Upon completion of all work and tests, the Contractor shall furnish the necessary skilled labor and helpers for operating his system and equipment for a period specified under

each applicable Section of this Division. During this period, he shall fully instruct the Owner or the Owner's representative in the operation, adjustment and maintenance of all equipment furnished. The Contractor shall give at least seven (7) days notice to the Owner and the Engineer in advance of this period.

- B. The Contractor shall include the maintenance schedule for the principal items of equipment furnished under this Division.
- C. The Contractor shall physically demonstrate procedures for all routine maintenance of all equipment furnished under each respective Section to assure accessibility to all devices.
- D. An authorized manufacturer's representative shall attest in writing that the equipment has been properly installed prior to startup of any major equipment. The following equipment will require this inspection: pumps; air conditioning equipment, controls, air handling equipment, compressors, boilers etc. These letters shall be bound into the operating and maintenance books.
- E. Refer to individual trade Sections for any other particular requirements related to operating instructions.
- F. Demonstration shall be recorded on DVD with two (2) DVD's turned over to the Owner.

1.27 OPERATING AND MAINTENANCE MANUALS

- A. Prepare operating and maintenance manuals in accordance with the requirements of Division 1 and requirements listed below. The Contractor shall prepare six (6) copies of a complete maintenance and operating instructions manual, bound in booklet form. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty 3-ring vinyl-covered binders, with pocket folders for folded sheet information and designation partitions with identification tabs. Mark appropriate identification on front and spine of each binder.
- B. Manual shall include the following:
 - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 - 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 - 4. Servicing and operating instructions including lubrication charts and schedules.
 - 5. Emergency and safety instructions.
 - 6. Spare parts list.
 - 7. Copies of warranties.
 - 8. Wiring diagrams.
 - 9. Recommended "turn around" cycles.

10. Inspection procedures.
 11. Approved Shop Drawings and Product Data.
 12. Equipment Start-up Reports.
 13. Temperature control diagrams and written sequences of operations.
 14. Balance reports.
- C. Include in the manual, a tabulated equipment schedule for all equipment. Schedule shall include pertinent data such as: make, model number, serial number, voltage, normal operating current, belt size, filter quantities and sizes, bearing number, etc. Schedule shall include maintenance to be done and frequency.
- D. Maintenance and instruction manuals shall be submitted to the Owner at the same time as the seven (7) day notice is given prior to the instruction period.

1.28 ACCEPTANCES

- A. The equipment, materials, workmanship, design and arrangement of all work installed under the Mechanical Sections shall be subject to the review of the Engineer.
- B. Within 30 days after the awarding of a Contract, the Mechanical Contractor shall submit to the Engineer, for review, a list of manufacturers of equipment proposed for the work under the Mechanical Sections. The intent to use the exact manufacturers and models specified does not relieve the Contractor of the responsibility of submitting such a list.
- C. If extensive or unacceptable delivery time is expected on a particular item of equipment specified, the Contractor shall notify the Owner and Engineer, in writing, within 30 days of award of the Contract. In such instances, equipment substitutions may be made pending acceptance by the Engineer or the Owner's representative.
- D. Where any specific material, process or method of construction or manufactured article is specified by reference to the catalog number of a manufacturer, the Specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings. In all cases, the Mechanical Contractor shall verify the duty specified with the specific characteristics of the equipment offered for review. Equipment characteristics are to be used as mandatory requirements where the Contractor proposes to use an acceptable equivalent.
- E. If material or equipment is installed before it is reviewed and/or approved, the Contractor shall be liable for its removal and replacement at no extra charge to the Owner if, in the opinion of the Engineer, the material or equipment does not meet the intent of, or standard of quality implied by, the Drawings and Specifications.
- F. Failure on the part of the Engineer to reject shop drawings or to reject work in progress shall not be interpreted as acceptance of work not in conformance with the Drawings and/or Specifications. Work not in conformance with the Drawings and/or Specifications shall be corrected whenever it is discovered.

1.29 RECORD DRAWINGS

- A. General: Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Engineer's reference during normal working hours.
- B. Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately. Give particular attention to concealed elements that would be difficult to measure and record at a later date. Items to be indicated include but are not limited to:
 - 1. Dimensional change
 - 2. Revision to drawing detail
 - 3. Location and depth of underground utility
 - 4. Revision to pipe routing
 - 5. Revision to electrical circuitry
 - 6. Actual equipment location
 - 7. Duct size and routing
 - 8. Location of concealed internal utility
 - 9. Changes made by Change Order
 - 10. Details not on original Contract Drawing
 - 11. Information on concealed elements which would be difficult to identify or measure later
- C. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.
- D. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.
- E. Note related Change Order numbers where applicable.
- F. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.
- G. Final record documents shall be prepared in the latest AutoCAD version. A CD Rom of all drawings and a clean set of reproducible mylar sepias shall be turned over to the Owner at the completion of the work.

1.30 WARRANTIES AND BONDS

- A. The following general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturers standard warranties on products and special warranties are to be included:
 - 1. General close-out requirements included in Division 1.
 - 2. Specific requirements for warranties for the Work and products and installation that are specified to be warranted are included in the individual Sections of Divisions-2 through -16.

3. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.
- B. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.
- C. Separate Prime Contracts: Each prime Contractor is responsible for warranties related to its own Contract.

1.31 WARRANTY REQUIREMENTS

- A. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.
- D. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, right and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.
- E. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- F. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.
- G. Submit written warranties to the Engineer prior to the date certified for Substantial Completion. If the Engineer's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Engineer.

- H. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Engineer within fifteen days of completion of that designated portion of the Work.
- I. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner through the Engineer for approval prior to final execution.
 - 1. Refer to individual Sections of Divisions-2 through -16 for specific content requirements, and particular requirements for submittal of special warranties.
- J. Form of Submittal: At Final Completion compile two copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- K. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2" by 11" paper.
 - 1. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the installer.
 - 2. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS," the Project title or name, and the name of the Contractor.
 - 3. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

1.32 GUARANTEES

- A. The Contractor shall guarantee all material and workmanship under these Specifications and the Contract for a period of one (1) year from the date of final acceptance by Owner. During this guarantee period, all defects developing through faulty equipment, materials or workmanship shall be corrected or replaced immediately by this Contractor without expense to the Owner. Such repairs or replacements shall be made to the Engineer's satisfaction.
- B. Contractor shall provide name, address, and phone number of all contractors and subcontractors and associated equipment they provided.

1.33 PROJECT CLOSE-OUT

- A. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications and similar documents in accordance with Division 1.
- B. Deliver tools, spare parts, extra stock, and similar items.

- C. Complete start-up testing of systems, and instruction of the Owner's operating and maintenance personnel. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.
- D. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.
- E. Field Observation Procedures: On receipt of a request for an Engineers Field Observation, the Engineer will advise the Contractor of unfulfilled requirements. The Engineer will advise the Contractor of construction that must be completed or corrected before the certificate will be issued.
 - 1. The Engineer will repeat the Field Observation when requested and assured that the Work has been substantially completed.
 - 2. Results of the completed list of unfulfilled items will form the basis of requirements for final acceptance.

END OF SECTION

16030
11/17/2017

FRANCIS WALSH INTERMEDIATE SCHOOL /
BOARD OF EDUCATION CENTRAL OFFICES
BRANFORD, CONNECTICUT
State Project No.s: 014-0034 EA / 014-0035 BE-EA

Electronic Drawing File Release Form

DELIVERY OF FILES FOR: _____

Project Name

In accepting and utilizing any drawings or other data on any form of electronic media generated and provided by the Design Professional, the Client covenants and agrees that all such drawings and data are instruments of service of the Design Professional, who shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

The Client further agrees not to use these drawings and data, in whole or in part, for any purpose or project other than the project which is the subject of this Agreement. The Client agrees to waive all claims against the Design Professional resulting in any way from any unauthorized changes or reuse of the drawings and data for any other project by anyone other than the Design Professional.

In addition, the Client agrees, to the fullest extent permitted by law, to indemnify and hold the Design Professional harmless from any damage, liability or cost, including reasonable attorneys' fees and costs of defense, arising from any changes made by anyone other than the Design Professional or from any reuse of the drawings and data without the prior written consent of the Design Professional.

Under no circumstances shall transfer of the drawings and other instruments of service on electronic media for use by the Client be deemed a sale by the Design Professional, and the Design Professional makes no warranties, either express or implied, of merchantability and fitness for any particular purpose.

Client's Signature

Date

Company - Title

Architects' Signature

Date

Firm - Title

Owner's Signature

Date

Company - Title

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Adhesives and sealants with low emitting VOC's.
 - 2. Identification.
 - 3. Sleeves.
 - 4. Mechanical sleeve seals.
 - 5. Firestopping.
 - 6. Formed steel channels.
 - 7. Flashing.

- B. Related Sections:
 - 1. Division 3- Concrete Forming and Accessories: Execution requirements for placement of sleeves in concrete forms specified by this section.
 - 2. Division 7 - Firestopping: Product requirements for firestopping for placement by this section.
 - 3. Division 7- Joint Protection: Product requirements for sealant materials for placement by this section.
 - 4. Section 23 04 00 – General Conditions for Mechanical Trades
 - 5. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product and execution requirements for vibration isolators.
 - 6. Section 23 21 13 - Hydronic Piping: Execution requirements for placement of hangers and supports specified by this section.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. American Society of Mechanical Engineers:
 - 1. ASME B31.1 - Power Piping.
 - 2. ASME B31.9 - Building Services Piping.
- B. ASTM International:
 - 1. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 2. ASTM E814 - Standard Test Method for Fire Tests of Through Penetration Fire Stops.
 - 3. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
 - 4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
- C. American Welding Society:
 - 1. AWS D1.1 - Structural Welding Code - Steel.
- D. FM Global:
 - 1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.
- E. Underwriters Laboratories Inc.:
 - 1. UL 263 - Fire Tests of Building Construction and Materials.
 - 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
 - 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
 - 4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
 - 5. UL - Fire Resistance Directory.

1.5 SUBMITTALS

- A. Shop Drawings: Submit for identification list of wording, symbols, letter size, and color coding for pipe and ductwork identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- B. Product Data for Identification: Submit for mechanical identification and mechanical sleeve seals manufacturers catalog literature for each product required.
- C. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:

- a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.7 SYSTEM DESCRIPTION

- A. Firestopping Materials: ASTM E119 or UL 263 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating. Firestopping Materials: ASTM E119, UL 263, to achieve fire ratings of adjacent construction
- B. Firestop interruptions to fire rated assemblies, materials, and components.

1.8 PERFORMANCE REQUIREMENTS

- A. Firestopping: Conform to applicable code for fire resistance ratings and surface burning characteristics.
- B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.9 QUALITY ASSURANCE

- A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.

2. Floor and Roof Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
 - a. Floor Penetrations Within Wall Cavities: T-Rating is not required.
- B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
 1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
 2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.
- C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.
- D. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.
- E. Surface Burning Characteristics: Maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
- F. Maintain one copy of each document on site.
- G. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

PART 2 PRODUCTS

2.1 ADHESIVES/SEALANTS

- A. All adhesives and sealants shall be products which emit low volatile organic compounds (VOC's). Adhesives shall comply with South Coast Air Quality Management District Rule #1168.
- B. Aerosol adhesives shall comply with Green Seal Standard for Commercial Adhesives GS-36.
- C. Specifically, PVC welding products shall emit maximum VOC of 510 g/L.

2.2 IDENTIFICATION

- A. Manufacturers:
 - 1. Seton Identification Products
 - 2. Craftmark Identification Systems
 - 3. Safety Sign Co.
 - 4. Substitutions: Permitted.
- B. Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light background color.
- C. Plastic Tags and Plastic Valve Tags: Laminated three-layer plastic with engraved black letters on light background color, minimum 1-1/2 inches diameter.
- D. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener. Color and Lettering: Conform to ASME A13.1.
- E. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings. Color and Lettering: Conform to ASME A13.1.
- F. Underground Pipe Markers: Provide manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe. Provide multi-ply tape consisting of solid aluminum foil core between 2-layers of plastic tape
- G. Ductwork Markers: Identify ductwork with duct markers; or provide stenciled signs and arrows, showing ductwork service and direction of flow, in black or white (whichever provides most contrast with ductwork color).

2.3 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Schedule 40 steel pipe or 18 gage thick galvanized steel.
- C. Sleeves for Round Ductwork: Galvanized steel.
- D. Sleeves for Rectangular Ductwork: Galvanized steel.
- E. Sealant: Acrylic for non-fire rated penetrations.
- F. Escutcheons: The Contractor shall provide chrome plated escutcheons on pipes, conduit and ductwork wherever they pass through floors, ceilings, walls or partitions in finished locations.

2.4 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
 - 1. Thunderline Link-Seal, Inc.
 - 2. Fernco
 - 3. BWM
 - 4. Substitutions: Permitted.

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

2.5 FORMED STEEL CHANNEL

- A. Manufacturers:
 - 1. Allied Tube & Conduit Corp.
 - 2. B-Line Systems
 - 3. Unistrut Corp.
 - 4. Substitutions: Permitted.

- B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.6 FLASHING

- A. Metal Flashing: 26 gage thick galvanized steel.
- B. Metal Counterflashing: 22 gage thick galvanized steel.
- C. Lead Flashing:
 - 1. Waterproofing: 5 lb./sq. ft sheet lead.
 - 2. Soundproofing: 1 lb./sq. ft sheet lead.
- D. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.
- E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify openings are ready to receive sleeves.

3.2 INSTALLATION – IDENTIFICATION FOR HVAC WORK

- A. Install plastic nameplates with adhesive for equipment and devices located inside the building.

- B. Install plastic nameplates with rivets for equipment and devices located outside the building.
- C. Install plastic tags with corrosion resistant metal chain.
- D. Pipe markers shall be color coded and shall identify the pipe size, type of piping system and direction of flow. Markers shall be located as listed below wherever piping is exposed to view in occupied spaces, mechanical rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations:
 - 1. Near each valve, control device, major equipment items and points of origination and termination
 - 2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
 - 3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
 - 4. At access doors, manholes and similar access points which permit view of concealed piping.
 - 5. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.
 - 6. On piping above removable acoustical ceilings, except omit intermediately spaced markers.
- E. Ductwork markers shall be provided:
 - 1. Ductwork markers shall be color coded and shall identify the type of system and direction of flow.
 - 2. In each space where ductwork is exposed, or concealed only by removable ceiling system, locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment), and at 50' spacing along exposed runs. Locate identification at air handling equipment.
 - 3. Provide duct markers or stenciled signs on each access door in ductwork and housings, indicating purpose of access (fire damper, temperature sensor, etc.) and other maintenance and operating instructions, and appropriate safety and procedural information.
 - 4. Access doors for fire and smoke dampers shall be permanently identified on the exterior by a label having letter not less the 0.5 inches in height reading "SMOKE DAMPER", FIRE DAMPER, etc.
- F. Underground Pipe Markers: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.
- G. Plastic Tags and Plastic Valve Tags:
 - 1. Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system. For each page

of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls.

2. Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.

- H. Mechanical identification work shall comply with ANSI A13.1. Names, abbreviations and other designations used in mechanical identification work, shall correspond with designations shown on drawings, specified or scheduled.
- I. Piping, valves and controls in all rooms housing equipment with refrigerants shall be labeled per ASHRAE 15 – Safety Standard for Refrigeration Systems.

3.3 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with mechanical sleeve seals.
- B. Set sleeves in position in forms. Provide reinforcing around sleeves.
- C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- E. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- F. Mechanical Sleeve Seal: When piping or conduit penetrate a wall below grade, the floor of a mechanical room located above an occupied space, or other locations where water may cause damage, such penetrations shall be made completely watertight with mechanical sleeve seal, such that a liquid leak shall not pass through the penetration.
- G. Install chrome plated steel escutcheons at finished surfaces.

3.4 INSTALLATION – FLASHING

- A. Provide flexible flashing and metal counter-flashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. Where multiple pipes penetrate the roof at one location, provide a minimum 30" high roof curb. Piping shall penetrate side wall of the roof curb. Seal and flash each pipe as it penetrates the wall of the curb. In addition, provide aluminum rain shield over side wall piping where it penetrates the curb.

- C. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms for sound control.
- D. Provide curbs for roof installations 12 inches minimum high above roofing surface. Flash and counter-flash with sheet metal; seal watertight. Attach counter-flashing to equipment and lap base flashing on roof curbs. Flatten and solder joints.
- E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.5 INSTALLATION - FIRESTOPPING

- A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items, requiring firestopping.
- B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.
- C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating, to uniform density and texture.
- D. Place foamed material in layers to ensure homogenous density, filling cavities and spaces. Place sealant to completely seal junctions with adjacent dissimilar materials.
- E. Remove dam material after firestopping material has cured.
- F. Fire Rated Surface:
 - 1. Seal opening at floor, wall, partition, ceiling, and roof as follows:
 - a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
 - b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
 - c. Pack void with backing material.
 - d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
 - 2. Where bus, conduit, wireway, penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.
- G. Non-Rated Surfaces:
 - 1. Seal opening through non-fire rated wall, partition floor, ceiling, and roof opening as follows:
 - a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
 - b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
 - c. Install type of firestopping material recommended by manufacturer.
 - 2. Install escutcheons or ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.

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3. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.
4. Interior partitions: Seal pipe penetrations at data rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

END OF SECTION

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes single- and three-phase motors for application on equipment provided under other sections and for motors furnished loose to Project.
- B. Related Sections:
 - 1. Section 23 04 00 – General Conditions for Mechanical Trades
 - 2. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 3. Section 26 05 53 - Identification for Electrical Systems.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. American Bearing Manufacturers Association:
 - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. National Electrical Manufacturers Association:
 - 1. NEMA MG 1 - Motors and Generators.

- C. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.
- C. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.
- D. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles

shall be documented in accordance with the High Performance Building Requirements of this Section.

3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Testing Agency: Company member of International Electrical Testing Association and specializing in testing products specified in this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.
- C. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.
- D. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 PRODUCTS

2.1 MOTORS

- A. Manufacturers:
 1. Baldor Electric.
 2. General Electric.
 3. Marathon Electric.
 4. Reliance Electric
 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Motors 3/4 hp and Larger: Three-phase motor except where specifically noted otherwise.
- C. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- D. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

- E. Three-Phase Motors: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds as indicated on Drawings.
1. 60 Hertz except where specifically noted otherwise.
 2. Enclosure: Meet conditions of installation.
 3. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 4. Insulation System: NEMA Class B or better.
 5. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
 6. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
 7. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
 8. Sound Power Levels: Conform to NEMA MG 1.
- F. Single Phase Motors:
1. Permanent split-capacitor type where available, otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
 2. 60 Hertz except where specifically noted otherwise
 3. Starting Torque: Exceeding one fourth of full load torque.
 4. Starting Current: Up to six times full load current.
 5. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, pre-lubricated sleeve or ball bearings, automatic reset overload protector.

2.2 MISCELLANEOUS SPECIALTIES

- A. Explosion-Proof Motors: UL approved and labeled for hazard classification, with over temperature protection.
- B. 10 HP and larger: All motors shall be provided with AEGIS SGR bearing protection ring or approved equal; factory installed in the motor housing; and where called for at individual specifications.
- C. Inverter Duty Rated Motors: Totally enclosed blower cooled (TEBC) with Class H insulation, two normally closed thermal protectors, 1800 rpm for belt drive application. Blower motor shall be 230/460 volt, three phase.
- D. Multiple Speed Motors: Through tapped windings.

2.3 SOURCE QUALITY CONTROL

- A. Test motors in accordance with NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

2.4 EFFICIENCY

- A. All motors shall be "Premium Efficiency" with minimum efficiencies as required by the local utility company's current rebate program. The nominal efficiency shall be stamped on the nameplate in accordance with NEMA Standard MG. 1.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- B. Install engraved plastic nameplates in accordance with Section 26 05 53.
- C. Ground and bond motors in accordance with Section 26 05 26.

3.2 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements and Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.15.

END OF SECTION

SECTION 230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Design of expansion system and anchors.
 - 2. Flexible pipe connectors.
 - 3. Expansion joints.
 - 4. Expansion compensators.
 - 5. Pipe alignment guides.
 - 6. Pipe anchors.

- B. Related Sections:
 - 1. Section 23 04 00 – General Conditions for Mechanical Trades
 - 2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product and installation requirements for piping hangers and supports.
 - 3. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product and installation requirements for vibration isolators used in piping systems.
 - 4. Section 23 21 13 - Hydronic Piping: Product and installation requirements for piping used in hydronic heating and cooling systems.
 - 5. Section 23 23 00 - Refrigerant Piping: Product and installation requirements for piping used in refrigerant piping systems.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. American Society of Mechanical Engineers:
 - 1. ASME B31.1 - Power Piping.
 - 2. ASME B31.9 - Building Services Piping.
 - 3. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.
- B. American Welding Society:
 - 1. AWS D1.1 - Structural Welding Code - Steel.

1.5 DESIGN REQUIREMENTS

- A. Provide design, details, work and equipment required for expansion and contraction of hot water and steam piping systems. Verify anchors, guides, and expansion joints provide and adequately protect system.
- B. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.
- C. Expansion Compensation Design Criteria:
 - 1. Installation Temperature: 50 degrees F.
 - 2. Hot Water Heating System Temperature: 210 degrees F.
 - 3. Safety Factor: 30 percent.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Pipe Expansion Analysis, Design and Certification:
 - 1. Provide pipe expansion and anchoring calculations for all refrigerant and hydronic water piping systems including connections to equipment, building expansion joints and to the structure. Piping layouts and associated calculations must be stamped by a registered professional engineer with at least five years of pipe expansion experience, licensed in the state of the job location.
 - 2. Analysis must indicate calculated dead loads, active expansion loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All expansion and anchoring devices shall be designed to accept the forces as calculated.

- C. Shop Drawings: Indicate layout of piping systems, including flexible connectors, expansion joints, expansion compensators, loops, offsets and swing joints.
- D. Product Data:
 - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
 - 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
- E. Design Data: Indicate criteria and show calculations. Submit calculations sealed by a registered professional engineer.
- F. Manufacturer's Installation Instructions: Submit special procedures.
- G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- H. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.7 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.

- C. Operation and Maintenance Data: Submit adjustment instructions.

1.8 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.1 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- B. Maintain one copy of each document on site.
- C. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years experience.
- C. Design expansion compensating system under direct supervision of Professional Engineer experienced in design of this Work and licensed in state which the Work will occur.

1.10 DELIVERY, STORAGE, AND HANDLING

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

1.11 WARRANTY

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

PART 2 PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS

- A. Manufacturers:
 - 1. Mason Type BSS
 - 2. Metraflex
 - 3. Vibration Elimination
- B. Copper and Steel Piping:
 - 1. Inner Hose: Stainless Steel.
 - 2. Exterior Sleeve: Double braided stainless steel.
 - 3. Pressure Rating: 200 psig WOG and 250 degrees F.
 - 4. Joint: As specified for pipe joints.
 - 5. Size: Use pipe-sized units.
 - 6. Maximum offset: 1 inch on each side of installed center line.

2.2 EXPANSION JOINTS

- A. Manufacturers:
 - 1. Mason
 - 2. Metraflex
 - 3. Vibration Elimination
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Carbon Steel Expansion Compensator:
 - 1. Mason EFL or approved equal.
 - 2. Externally pressurized expansion compensator with 2 ply 304 stainless steel bellows in carbon steel casing,
 - 3. Maximum Temperature: 300 degrees F at 170 psig.
 - 4. Joint: Flanged or threaded carbon steel.
- C. Copper Expansion Compensator:
 - 1. Mason EW or approved equal.
 - 2. Externally pressurized expansion compensator with 2 ply, 304 stainless steel bellows in stainless steel casing
 - 3. Maximum Temperature: 300 degrees F at 170 psig.
 - 4. Joint: copper sweat ends.

2.3 ACCESSORIES

- A. Manufacturers:
 - 1. Mason
 - 2. Metraflex
 - 3. Vibration Elimination
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Pipe Alignment Guides: Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inch travel.
- C. Pipe Anchors: All-directional acoustical pipe anchor, consisting of two sizes of steel tubing separated by a minimum 1/2" (12mm) thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 psi (.35 kg/mm²) and the design shall be balanced for equal resistance in any direction.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install Work in accordance with ASME B31.1.
- B. Install flexible pipe connectors on:
 - 1. Pipes connected to pumps: Refer to Section 230548.
 - 2. Refrigerant piping connections to equipment (pipe expansion loops).
 - 3. Pipes connected to equipment supported by vibration isolation. Refer to Section 23 05 48. Provide line size flexible connectors.
- C. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
- D. Rigidly anchor pipe to building structure. Provide pipe guides to direct movement only along axis of pipe. Erect piping so strain and weight is not on cast connections or apparatus.
- E. Provide support and anchors for controlling expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required. Refer to Section 23 05 29 for pipe hanger installation requirements.
- F. For systems using grooved piping systems, provide with minimum one joint per inch pipe diameter instead of flexible connector supported by vibration isolation.

- G. Provide piping expansion joints or expansion loops as indicated on Drawings, as scheduled below and as required per layouts and calculations as noted above:
1. Provide and install pipe expansion joints or expansion loops at all conditions listed below and as required to minimize stress on the piping systems.
 2. Provide pipe guides at inlet and outlet of each expansion joint and expansion loop.
 3. Where expansion joints or loops are required, provide pipe anchors at ends of each straight length of run.
 4. Provide and install expansion joints, expansion loops, pipe guides and anchors per ASHRAE Guidelines and manufacturer's recommendations.

PIPING SYSTEM	PIPING MATERIAL	PIPE SIZE	Condition Requiring expansion joint or expansion loop (all conditions assume "offset leg" at end of runs are minimum 12'0" long)
Refrigerant Piping	Copper Pipe and Copper Tubing		Per pipe and tubing manufacturers recommendation's for operating pressure and temperature.
Hot water supply and return (all temperatures)	Copper	Up to 3 inches	All straight sections of piping over 90' long.
Hot water supply and return (all temperatures)	Steel	Up to 2 inches	All straight sections of piping over 140' long.
Hot water supply and return (all temperatures)	Steel	2" to 4"	All straight sections of piping over 90' long
Hot water supply and return (all temperatures)	Steel	5" to 8"	All straight sections of piping over 45' long

3.2 MANUFACTURER'S FIELD SERVICES

- A. Section 01 40 00 - Quality Requirements: Manufacturers' field services.
- B. Furnish inspection services by flexible pipe manufacturer's representative for final installation and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION

SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Gate valves.
 - 2. Globe valves.
 - 3. Ball valves.
 - 4. Butterfly valves.
 - 5. Check valves.

- B. Related Sections:
 - 1. Section 23 04 00 – General Conditions for Mechanical Trades
 - 2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product and installation requirements for pipe hangers and supports.
 - 3. Section 23 07 00 - HVAC Insulation: Product and installation requirements for insulation for valves.
 - 4. Section 23 21 13 - Hydronic Piping: Product and installation requirements for piping used in hydronic piping systems.
 - 5. Section 23 21 16 - Hydronic Piping Specialties: Product and installation requirements for piping specialties used in hydronic piping systems.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. ASTM International:
1. ASTM A216/A216M - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
 2. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
 3. ASTM D4101 - Standard Specification for Propylene Injection and Extrusion Materials.
- B. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 67 - Butterfly Valves.
 2. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
 3. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
 4. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
 5. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
 6. MSS SP 85 - Cast Iron Globe & Angle Valves, Flanged and Threaded.
 7. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit manufacturers catalog information with valve data and ratings for each service. Valve pressure and temperature ratings shall be in accordance with pressure and temperature ratings of systems they serve.
- C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- E. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).

- c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of valves.
- C. Operation and Maintenance Data: Submit installation instructions, spare parts lists, exploded assembly views.

1.7 QUALITY ASSURANCE

- A. Maintain one copy of each document on site.
- B. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

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

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not install valves underground when bedding is wet or frozen.

1.11 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
- B. Furnish one year manufacturer warranty for valves excluding packing.

1.12 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for extra materials.
- B. Furnish two packing kits for each size valve.

PART 2 PRODUCTS

2.1 GATE VALVES

- A. Manufacturers:
 - 1. Crane Valve, North America.
 - 2. Milwaukee Valve Company.
 - 3. NIBCO, Inc.
 - 4. Stockham Valves & Fittings Model.
 - 5. Watts
- B. 2 inches and Smaller: MSS SP 80, Class 125 / 250, bronze body, bronze trim, threaded union bonnet, non-rising stem, hand-wheel, solid wedge disc, solder o threaded ends.
- C. 2-1/2 inches and Larger: MSS SP 70, Class 125 / 250, iron body, bronze trim, bolted bonnet, non-rising stem, hand-wheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.2 GLOBE VALVES

- A. Manufacturers:
 - 1. Crane Valve, North America
 - 2. Milwaukee Valve Company
 - 3. NIBCO, Inc.

4. Stockham Valves & Fittings
 5. Watts
- B. 2 inches and Smaller: MSS SP 80, Class 125, bronze body, bronze trim, threaded bonnet, hand wheel, Buna-N composition disc, threaded ends.
- C. 2-1/2 inches and Larger: MSS SP 85, Class 125, cast iron body, bronze trim, hand wheel, outside screw and yoke, flanged ends. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.3 BALL VALVES

- A. Manufacturers:
1. Crane Valve, North America
 2. Jamesbury
 3. NIBCO, Inc.
 4. Stockham Valves & Fittings
 5. Watts
- B. 2 inches and Smaller: MSS SP 110, Class 150, bronze, two piece body, type 316 stainless steel ball, full port, teflon seats, blow-out proof stem, solder or threaded ends with union, lever handle.
- C. 2-1/2 inches and Larger: MSS SP 110, Class 150, bronze, three piece body, type 316 stainless steel ball, full port, teflon seats, blow-out proof stem, solder or threaded ends, lever handle.

2.4 BALL VALVES (Press Style)

- A. Manufacturers:
1. Viega
 2. Milwaukee Valve Company
 3. Watts
 4. Substitutions: Not Permitted.
- B. 2 inches and Smaller: MSS SP 110, Class 150, bronze, two piece body, chrome plated bronze ball, regular port, teflon seats, blow-out proof stem and lever handle.
- C. Press Fitting: Copper press fitting shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22. Sealing elements for copper or copper alloy press fittings shall be EPDM.

2.5 BUTTERFLY VALVES

- A. Manufacturers:
1. Crane Valve, North America
 2. Keystone
 3. NIBCO, Inc.
 4. Stockham Valves & Fittings

5. Centerline.
 6. Norriseal.
- B. 2-1/2 inches and Larger: MSS SP 67, Class 150.
1. Body: Cast or ductile iron, wafer or lug ends, stainless steel stem, extended neck.
 2. Disc: Aluminum bronze.
 3. Seat: Resilient replaceable EPDM.
 4. Handle and Operator: 10 position lever handle. Furnish gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.

2.6 PLUG VALVES

- A. Manufacturers:
1. DeZURIK, Unit of SPX Corp.
 2. Flow Control Equipment, Inc.
 3. Homestead Valve
- B. Furnish materials in accordance with Owner's guidelines.
- C. MSS SP 78, Class 150, semi-steel construction, square or rectangular port, full pipe area, pressure lubricated, teflon packing, threaded ends. Furnish one plug valve wrench for every ten plug-valves with minimum of one wrench. Provide with threaded ends for 2" and smaller and flanged ends for sizes over 2".

2.7 SWING CHECK VALVES

- A. Horizontal Swing Check Valves:
1. Manufacturers:
 - a. Crane Valve, North America
 - b. Milwaukee Valve Company
 - c. NIBCO, Inc.
 - d. Stockham Valves & Fittings
 - e. Watts
 2. 2 inches and Smaller: MSS SP 80, Class 150 body and cap, bronze seat, Buna-N disc, solder or threaded ends.
 3. 2-1/2 inches and Larger: MSS SP 71, Class 125 cast iron body, bolted cap, bronze or cast iron disc, renewable disc seal and seat, flanged ends.
- B. Spring Loaded Check Valves:
1. Manufacturers:
 - a. Crane Valve, North America
 - b. Milwaukee Valve Company
 - c. NIBCO, Inc.
 - d. Stockham Valves & Fittings
 - e. Watts
 2. Class 125, aluminum bronze disc, Buna-N seat, split plate, hinged with stainless steel spring, resilient seal bonded to body. Pressure drop shall not exceed 1 psig at design flow.

2.8 CHECK VALVES (Press Style Fittings)

- A. Spring Loaded Check Valves :
 - 1. Manufacturers:
 - a. Viega
 - b. Milwaukee Valve Company
 - c. Watts
 - d. Substitutions: Not Permitted.
 - 2. 2 inches and Smaller: MSS SP 80, Class 250, bronze body, in-line spring lift check, silent closing, Buna-N disc, integral seat.
 - 3. Press Fitting: Copper press fitting shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22. Sealing elements for copper or copper alloy press fittings shall be EPDM.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify piping system is ready for valve installation.

3.2 INSTALLATION

- A. Install valves with stems upright or horizontal, not inverted.
- B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- C. Install 3/4 inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.
- D. Install valves with clearance for installation of insulation and allowing access.
- E. Use gate, ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- F. Use globe valves for throttling, bypass, or manual flow control services.
- G. Use 3/4 inch gate or ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. In mechanical rooms, pipe to nearest floor drain.
- H. Use horizontal swing check valves on discharge of pumps.
- I. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Section 08 31 13.

- J. Refer to Section 23 05 29 for pipe hangers.
- K. Refer to Section 23 07 00 for insulation requirements for valves.

3.3 INSTALLATION – PRESS STYLE FITTINGS

- A. Press connections: Copper and copper alloy press connections shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool(s) recommended by the manufacturer. Contractor shall be trained on the use and installation of the system by manufacturer's representative.

3.4 VALVE APPLICATIONS / GENERAL INFO

- A. Provide valve charts posted in frames behind plexi-glass and electronic pdf files. Charts shall be installed in Mech Rooms and shall include piping diagrams keyed to listing of valves.
- B. Install shutoff and drain valves at locations indicated on Drawings and at all low points in each piping system.
- C. Install ball, butterfly or gate valves for shut-off and to isolate equipment, part of systems, or vertical risers and as shown on the drawings. Also, provide valves to allow phasing.
- D. Install spring loaded check valves on discharge of all water pumps.

END OF SECTION

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe hangers and supports.
 - 2. Hanger rods.
 - 3. Inserts.
 - 4. Roof curbs for duct penetrations through roof.
- B. Related Sections:
 - 1. Section 03 10 00 - Concrete Forming and Accessories: Execution requirements for placement of sleeves in concrete forms specified by this section.
 - 2. Section 23 04 00 – General Conditions for Mechanical Trades
 - 3. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
 - 4. Section 23 23 00 - Refrigerant Piping: Execution requirements for placement of hangers and supports specified by this section.
 - 5. Section 23 21 13 - Hydronic Piping: Execution requirements for placement of hangers and supports specified by this section.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 PHASE 2 SUPPORT REQUIREMENTS

- A. All mechanical systems including equipment, ductwork, piping and accessories being hung from above shall not be supported from the existing "space truss" roof structure unless noted otherwise. Systems shall be supported from new framing only. Refer to structural drawings for locations of new framing. Provide supplemental framing as required.

1.5 REFERENCES

- A. American Society of Mechanical Engineers:
 - 1. ASME B31.1 - Power Piping.
 - 2. ASME B31.9 - Building Services Piping.
- B. ASTM International:
- C. American Welding Society:
 - 1. AWS D1.1 - Structural Welding Code - Steel.
- D. Manufacturers Standardization Society of the Valve and Fittings Industry:
 - 1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 - 2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
 - 3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.
- C. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
- D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- E. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- G. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:

- a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with applicable authority for welding hanger and support attachments to building structure.
- B. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section approved by manufacturer.

1.9 PRE-INSTALLATION MEETINGS

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

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.
- C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.
- D. Provide ventilation in areas to receive solvent cured materials.

1.12 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

- A. Manufacturers:
 - 1. Flex-Weld, Inc.
 - 2. Globe Pipe Hanger Products Inc.
 - 3. Superior Valve Co.
 - 4. Grinnell Corp.
 - 5. Creative Systems Inc.
 - 6. Superior Valve Co.
- B. Hydronic Piping:
 - 1. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69, or MSS SP89.
 - 2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
 - 3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
 - 4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
 - 5. Hangers for Hot Pipe Sizes 5 inches and Larger: Adjustable steel yoke, cast iron roll, double hanger.

6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 7. Multiple or Trapeze Hangers for Hot Pipe Sizes 5 inches and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
 8. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hooks.
 9. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
 10. Wall Support for Hot Pipe Sizes 5 inches and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
 11. Vertical Support: Steel riser clamp.
 12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 13. Floor Support for Hot Pipe Sizes 4 Inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 14. Floor Support for Hot Pipe Sizes 5 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
 15. Copper Pipe Support: Copper-plated, carbon steel ring.
- C. Refrigerant Piping:
1. Conform to ASME B31.5, ASTM F708, MSS SP58, MSS SP69, or MSS SP89.
 2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
 3. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 5. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
 6. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
 7. Vertical Support: Steel riser clamp.
 8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 9. Copper Pipe Support: Copper-plated carbon-steel ring.

2.2 ACCESSORIES

- A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.3 INSERTS

- A. Manufacturers:
1. Thunderline Link Seal
 2. Fernco
 3. BWM
 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 ROOF CURBS FOR DUCT PENETRATIONS THROUGH ROOF

- A. Manufacturers:
 - 1. Trimco
 - 2. Cambridgeport
 - 3. Pate
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Fabrication: Welded 18 gage galvanized steel shell and base, mitered 3 inch cant, variable step to match root insulation, 1-1/2 inch thick insulation, factory installed wood nailer. Seal duct penetration through roof curb weather tight

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify openings are ready to receive sleeves.

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
- B. Remove incompatible materials affecting bond.
- C. Install backing damming materials to arrest liquid material leakage.
- D. Obtain permission from Architect/Engineer before using powder-actuated anchors.
- E. Do not drill or cut structural members.
- F. Obtain permission from Architect/Engineer before drilling or cutting structural members.

3.3 INSTALLATION – FLASHING AND CURBS

- A. Provide flexible flashing and metal counter-flashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms for sound control.
- C. Provide curbs for roof installations 12 inches minimum high above roofing surface. Flash and counter-flash with sheet metal; seal watertight. Attach counter-flashing to equipment and lap base flashing on roof curbs. Flatten and solder joints.

- D. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.4 INSTALLATION - INSERTS

- A. Install inserts for placement in concrete forms.
- B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above flush with top of recessed into and grouted flush with slab.

3.5 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.1, ASME B31.9, ASTM F708, MSS SP 58, MSS SP 69, and MSS SP 89.
- B. Support horizontal piping as scheduled.
- C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Use hangers with 1-1/2 inch minimum vertical adjustment.
- F. Support vertical piping at every other floor.
- G. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Provide sheet lead packing between hanger or support and piping.
- J. Design hangers for pipe movement without disengagement of supported pipe.
- K. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- L. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings Refer to Section 23 07 00.

- M. Provide supplemental angles, channels and formed steel supports to support piping, ductwork, equipment, etc. from building's structure. Piping, ductwork, equipment, etc. shall not be supported from the roof deck.

3.6 SCHEDULES

A. Copper and Steel Pipe Hanger Spacing:

PIPE SIZE Inches	COPPER TUBING MAXIMUM HANGER SPACING Feet	STEEL PIPE MAXIMUM HANGER SPACING Feet	COPPER TUBING HANGER ROD DIAMETER Inches	STEEL PIPE HANGER ROD DIAMETER Inches
1/2	5	7	3/8	3/8
3/4	5	7	3/8	3/8
1	6	7	3/8	3/8
1-1/4	7	7	3/8	3/8
1-1/2	8	9	3/8	3/8
2	8	10	3/8	3/8
2-1/2 (Note 2)	9	11	1/2	1/2
3	10	12	1/2	1/2
4	12	14	1/2	5/8
5	13	16	1/2	5/8
6	14	17	5/8	3/4
8	16	19	3/4	3/4

B. Plastic and Ductile Iron Pipe Hanger Spacing:

PIPE MATERIAL	MAXIMUM HANGER SPACING Feet	HANGER ROD DIAMETER Inches
ABS (All sizes)	4	3/8
FRP (All Sizes)	4	3/8
Ductile Iron (Note 2)		
PVC (All Sizes)	4	3/8

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BRANFORD, CONNECTICUT
State Project No.s: 014-0034 EA / 014-0035 BE-EA

- C. Note 1: Refer to manufacturer's recommendations for grooved end piping systems.
- D. Note 2: 20 feet maximum spacing, minimum of one hanger for each pipe section close to joint behind bell. Provide hanger at each change of direction and each branch connection. For pipe sizes 6 inches and smaller, subjected to loadings other than weight of pipe and contents, limit span to maximum spacing for water service steel pipe.

END OF SECTION

SECTION 230548 - VIBRATION AND SEISMIC CONTROLS
FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Intent
1. All mechanical equipment, piping and ductwork as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
 2. All isolators and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.
 3. This specification is considered to be minimum requirements for seismic consideration as required for life safety.
 4. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.
- B. The work of this section includes but is not limited to the following:
1. Vibration isolation elements.
 2. Equipment isolation bases.
 3. Piping flexible connections.
 4. Seismic restraints for any mechanical components with Component Importance Factor of $I_p = 1.5$ as defined by ASCE Chapter 7 and 2012 International Building Code.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- C. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.2 PHASE 2 SUPPORT REQUIREMENTS

- A. All mechanical systems including equipment, ductwork, piping and accessories being hung from above shall not be supported from the existing "space truss" roof structure unless noted otherwise. Systems shall be supported from new framing only. Refer to structural drawings for locations of new framing. Provide supplemental framing as required.

1.4 QUALIFICATIONS

- A. Qualifications: Only firms having five years experience designing and manufacturing seismic devices shall be capable of work in this specification.

1.5 SUBMITTALS

- A. Submit under provisions of Division 1 and Section 23 04 00.
- B. The submittal material shall include copies of descriptive data for all products and materials including but not limited to the following:
 - 1. Descriptive Data: Catalog cuts or data sheets.
 - 2. Shop Drawings:
 - a. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
 - b. Provide Drawings showing methods of suspension and support guides for conduit, piping, ductwork and ceiling hung equipment.
 - c. Drawings showing methods for isolation of conduits, pipes and ductwork penetrating walls and floor slabs.

1.6 CONTRACTOR'S RESPONSIBILITIES

- A. Contractor shall have the following responsibilities:
 - 1. Provide and install isolation systems and seismic restraints as scheduled or specified.
 - 2. Guarantee specified isolation system deflection.
 - 3. Provide installation instructions, drawings and field supervision to assure proper installation and performance.
 - 4. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.

1.7 RELATED WORK

- A. Housekeeping Pads
 - 1. Housekeeping pad reinforcement and monolithic pad attachment to the structure details and design shall be prepared by the restraint vendor if not already indicated on the drawings.
 - 2. Housekeeping pads shall be coordinated with restraint vendor and sized to provide a minimum edge distance of ten (10) bolt diameters all around the outermost anchor bolt to allow development of full drill-in wedge anchor ratings. If cast-in anchors are to be used, the housekeeping pads shall be sized to accommodate the ACI requirements for bolt coverage and embedment.
- B. Supplementary Support Steel
 - 1. Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc. including roof mounted equipment, as required or specified.
- C. Attachments
 - 1. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the vibration vendor's calculations.

1.8 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 1 and Section 23 04 00.
- B. Record actual locations and installation of vibration isolators and restraints including attachment points.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Mason Industries Inc. models listed below.
- B. Other approved manufacturers providing equivalent products include:
 - 1. Novia Associates. (Seismic Control Products)
 - 2. Pate.
 - 3. Vibro-Acoustics Ltd

2.2 PRODUCT DESCRIPTIONS

- A. Vibration Isolators and Seismic Restraint Specifications
 - 1. Specification 1 - Neoprene Pad
 - a. Two layers of 3/4" thick neoprene pad consisting of 2" square waffle modules separated horizontally by a 16 gauge galvanized shim. Load distribution plates shall be used as required.
 - b. Pads shall be Type Super "W" as manufactured by Mason Industries, Inc.

2. Specification 2 - Bridge - Bearing Neoprene Mountings
 - a. Bridge bearing neoprene mountings shall have a minimum static deflection of 0.2" and all directional seismic capability. The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge bearing specifications. Mountings shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings.
 - b. Mountings shall be Type BR as manufactured by Mason Industries, Inc.
3. Specification 3 – Bushing Assemblies
 - a. Sheet metal panels shall be bolted to the walls or supporting structure by assemblies consisting of a neoprene bushing cushioned between 2 steel sleeves. The outer sleeve prevents the sheet metal from cutting into the neoprene. Enlarge panel holes as required. Neoprene elements pass over the bushing to cushion the back panel horizontally. A steel disc covers the inside neoprene element and the inner steel sleeve is elongated to act as a stop so tightening the anchor bolts does not interfere with panel isolation in 3 planes. Bushing assemblies can be applied to the ends of steel cross members where applicable. All neoprene shall be bridge bearing quality.
 - b. Bushing assemblies shall be type PB as manufactured by Mason Industries, Inc.
4. Specification 4 - Neoprene Bushing
 - a. A one piece molded bridge bearing neoprene washer/bushing. The bushing shall surround the anchor bolt and have a flat washer face to avoid metal to metal contact.
 - b. Neoprene bushings shall be type HG as manufactured by Mason Industries, Inc.
5. Specification 5 – Spring Isolators
 - a. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height.
 - b. Mountings shall be Type SLF as manufactured by Mason Industries, Inc.
6. Specification 6 – Restrained Spring Mountings
 - a. Restrained spring mountings shall have an SLF mounting as described in Specification 5, within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation. Since

- housings will be bolted or welded in position there must be an internal isolation pad. Housing shall be designed to resist all seismic forces. Mountings shall have Anchorage Preapproval "R" Number from OSHPD in the state of California certifying the maximum certified horizontal and vertical load ratings.
- b. Mountings shall be SLR as manufactured by Mason Industries, Inc.
7. Specification 7 – Spring Mountings
- a. Spring mountings as in specification 5 built into a ductile iron or steel housing to provide all directional seismic snubbing. The snubber shall be adjustable vertically and allow a maximum of 1/4" travel in all directions before contacting the resilient snubbing collars. Mountings shall have an Anchorage Preapproval "R" number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings.
 - b. Mountings shall be SSLFH as manufactured by Mason Industries, Inc.
8. Specification 8 – Air Springs
- a. Air springs shall be manufactured with upper and lower steel sections connected by a replaceable flexible nylon reinforced neoprene element. Air spring configuration shall be multiple bellows to achieve a maximum natural frequency of 3 Hz. Air Springs shall be designed for a burst pressure that is a minimum of three times the published maximum operating pressure. All air spring systems shall be connected to either the building control air or a supplementary air supply and equipped with three leveling valves to maintain leveling within plus or minus 1/8" Submittals shall include natural frequency, load and damping tests performed by an independent lab or acoustician.
 - b. Air Springs shall be Type MT and leveling valves Type LV as manufactured by Mason Industries, Inc.
9. Specification 9 – Restrained Air Springs
- a. Restrained air spring mountings shall have an MT air spring as described in Specification 8, within a rigid housing that includes vertical limit stops to prevent air spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and the air spring so as not to interfere with the air spring action. Limit stops shall be out of contact during normal operation. Housing shall be designed to resist all seismic forces.
 - b. Mountings shall be SLR-MT as manufactured by Mason Industries, Inc.
10. Specification 10 – Hangers
- a. Hangers shall consist of rigid steel frames containing minimum 1 1/4" thick neoprene elements at the top and a steel spring with general characteristics as in specification 5 seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. To maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the rod bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30° capability.

- b. Hangers shall be type 30N as manufactured by Mason Industries, Inc.
- 11. Specification 11 – Hangers
 - a. Hangers shall be as described in 10, but they shall be precompressed and locked at the rated deflection by means of a resilient seismic up-stop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30° capability.
 - b. Hangers shall be type PC30N as manufactured by Mason Industries, Inc.
- 12. Specification 12 – Not Used
- 13. Specification 13 – Not Used
- 14. Specification 14 – Rod Clamp Assemblies
 - a. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California.
 - b. Rod clamp assemblies shall be Type SRC as manufactured by Mason Industries, Inc.
- 15. Specification 15 – Clevis Hanger Cross Brace
 - a. Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California.
 - b. Clevis cross brace shall be type CCB as manufactured by Mason Industries, Inc.
- 16. Specification 16 - Not Used
- 17. Specification 17 – Inertia Foundations
 - a. Vibration isolation manufacturer shall furnish rectangular steel concrete pouring forms for floating and inertia foundations. Bases for split case pumps shall be large enough to provide for suction and discharge elbows. Bases shall be a minimum of 1/12 of the longest dimension of the base but not less than 6". The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of 1/2" bars welded in place on 6" centers running both ways in a layer 1 1/2" above the bottom. Forms shall be furnished with steel templates to hold the anchor bolts sleeves and anchors while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a 1" clearance below the base. Wooden formed bases leaving a concrete rather than a steel finish are not acceptable.
 - b. Base shall be type BMK or K as manufactured by Mason Industries, Inc.
- 18. Specification 18 – Stud Wedges
 - a. Stud wedge anchors shall be manufactured from full diameter wire, not from undersized wire that is "rolled up" to create the thread. The stud anchor shall also have a safety shoulder which fully supports the wedge ring under load. The stud anchors shall have an evaluation report number from the I.C.B.O Evaluation Service, Inc. verifying its allowable loads.

- b. Drill-in stud wedge anchors shall be type SAS as manufactured by Mason Industries, Inc.
19. Specification 19 – Female Wedge Anchors
- a. Female wedge anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed. Anchors shall be manufactured from full diameter wire, and shall have a safety shoulder to fully support the wedge ring under load. Female wedge anchors shall have an evaluation report number from the I.C.B.O Evaluation Service, Inc. verifying to its allowable loads.
- b. Drill-in female wedge anchors shall be type SAB as manufactured by Mason Industries, Inc.

20. Specification 20 – Flexible Stainless Steel Hoses
- a. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" and larger shall be flanged. Smaller sizes shall have male nipples. Minimum lengths shall be as tabulated:

<u>Flanged</u>		<u>Male Nipples</u>	
3 x 14	10 x 26	1/2 x 9	1 1/2 x 13
4 x 15	12 x 28	3/4 x 10	2 x 14
5 x 19	14 x 30	1 x 11	2 1/2 x 18
6 x 20	16 x 32	1 1/4 x 12	
8 x 22			

- b. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible.
- c. Hoses shall be type BSS as manufactured by Mason Industries, Inc.
21. Specification 21 - All-Directional Acoustical Pipe Anchor
- a. All-directional acoustical pipe anchor, consisting of two sizes of steel tubing separated by a minimum 1/2" thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 psi and the design shall be balanced for equal resistance in any direction.
- b. All-directional anchors shall be type ADA as manufactured by Mason Industries, Inc.
22. Specification 22 – Pipe Guides
- a. Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2" thickness of 60 durometer neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of $\pm 1 \frac{5}{8}$ " motion, or to meet location requirements.
- b. Pipe guides shall be type VSG as manufactured by Mason Industries, Inc.

23. Specification 23 - Split Wall Seals
 - a. Split Wall Seals consist of two bolted pipe halves with minimum 3/4" thick neoprene sponge bonded to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not already in place around the pipe prior to the construction of the building member. Seals shall project a minimum of 1" past either face of the wall. Where temperatures exceed 240° F. 10# density fiberglass may be used in lieu of the sponge.
 - b. Seals shall be Type SWS as manufactured by Mason Industries, Inc.
24. Specification 24 – Pipe Expansion Joints at Building Expansion Joints
 - a. Flexible Type 304 stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" and larger shall be flanged. Smaller sizes shall have male nipples.
 - b. Hoses shall be type 60 degree VEE as manufactured by Mason Industries, Inc.
25. Specification 25 – Roof Curbs with Vibration Isolation and Acoustical Panels:
 - a. Curbs shall provide continuous support for the equipment and shall be designed to resist wind and seismic forces. Construction shall be minimum 12 gauge galvanized steel. Provide support angles and cross braces for acoustical panels which shall be installed throughout the entire roof curb. All duct and piping penetrations in the panels shall be sealed with a non hardening caulk. All curbs shall be custom, pitched curbs; pitch shall match the roof steel / roof framing pitch to provide a level surface on top to mount equipment unless noted otherwise. Curb shall be Mason Industries Type RSC.
 - b. Provide acoustical panels constructed of 4" thick, 4 lb mineral wool insulation between 22 gauge and 18 gauge aluminized outer skins. Support channels shall be 18 gauge galvanized steel. The perforated metal side of the panel is to face the interior of the curb in order to provide acoustical absorption. The solid metal side of the panel shall face the roof decking and act as an acoustical barrier. Acoustical panels shall be as manufactured by George Koch Acoustical Panels.
26. Specification 26 – Roof Curbs
 - a. Curbs shall provide continuous support for the equipment and shall be designed to resist wind and seismic forces. Construction shall be minimum 12 gauge galvanized steel. Provide support angles and cross braces for acoustical panels which shall be installed throughout the entire roof curb. All duct and piping penetrations in the panels shall be sealed with a non-hardening caulk. All curbs shall be custom, pitched curbs; pitch shall match the roof steel / roof framing pitch to provide a level surface on top to mount equipment unless noted otherwise. Curb shall be Pate PC-4.
27. Specification 27 – Roof Rails Supporting Equipment
 - a. Supports shall be Novia Model FRR.
 - b. Description: Spring isolation rails that bear directly on the roof structure and are flashed and waterproofed into the roof's membrane waterproofing system. Field fabricated rails with external isolators shall not be used. Metal flashing that must be rigidly attached to the floating and non-floating portions of the rail which would short circuit the

- isolation effectiveness are not acceptable. Waterproofing shall be achieved by use of a continuous flexible water seal attached to the bottom counter flashing. The seal shall be protected from exposure to the elements by the top flashing. All rails shall be custom, pitched rails; pitch shall match the roof steel / roof framing pitch to provide a level surface on top to mount equipment unless noted otherwise.
- c. Rails shall include the following features:
 - 1) Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4-inch thick.
 - 2) Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist wind forces.
 - 3) Top rail to be formed of 14-gauge minimum G60 galvanized steel with a minimum of two nested layers (or equivalent thickness).
28. Specification 28 – Roof Rails Supporting Ductwork and Piping
- a. Supports shall be Novia Model FRR.
 - b. Description: Spring isolation rails or non-isolated away from equipment connections that bear directly on the roof structure and are flashed and waterproofed into the roof's membrane waterproofing system. Field fabricated rails with external isolators shall not be used. Metal flashing that must be rigidly attached to the floating and non-floating portions of the rail which would short circuit the isolation effectiveness are not acceptable. Waterproofing shall be achieved by use of a continuous flexible water seal attached to the bottom counter flashing. The seal shall be protected from exposure to the elements by the top flashing. All rails shall be custom, pitched rails; pitch shall match the roof steel / roof framing pitch to provide a level surface on top to mount equipment unless noted otherwise.
 - c. Rails shall include the following features:
 - 1) Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4-inch thick.
 - 2) Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist wind forces.
 - 3) Top rail to be formed of 14-gauge minimum G60 galvanized steel with a minimum of two nested layers (or equivalent thickness).

PART 3 EXECUTION

3.1 GENERAL

- A. Vibration isolators and seismic restraint systems shall control excessive noise and vibration in the buildings due to the operation of machinery or equipment, and/or due to interconnected piping, ductwork, or conduit. The installation of all vibration isolators and seismic restraint units, and associated hangers and bases, shall be under the direct supervision of the vibration isolation manufacturer's representative.

- B. All vibration isolators and seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.
- C. Installation of vibration isolators and seismic restraints must not cause any change of position of equipment, piping or ductwork resulting in stresses or misalignment.
- D. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.
- E. The contractor shall not install any equipment, piping, duct or conduit that makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.
- F. Coordinate work with other trades to avoid rigid contact with the building.
- G. Any conflicts with other trades that will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.
- H. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor's expense.
- I. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. Generally bracing may occur from:
 - 1. Flanges of structural beams.
 - 2. Upper truss cords in bar joist construction.
 - 3. Cast in place inserts or wedge type drill-in concrete anchors.
- J. Restraints and isolators installed outside or other locations exposed to weather shall be constructed of weather proof materials including galvanized steel structural frames, stainless steel threaded rods, stainless steel hardware, etc
- K. Specification 12 cable restraints shall be installed slightly slack to avoid short circuiting the isolated suspended equipment, piping or conduit.
- L. Specification 12 cable assemblies are installed taut on non-isolated systems.
- M. Where piping passes through walls, floors or ceilings the vibration isolation manufacturer shall provide specification 23 wall seals.
- N. Building Expansion Joints:
 - 1. Refer to architectural drawings for all locations of building expansion joints.
 - 2. All piping crossing building expansion joints shall be provided with Specification 24.

3. All ductwork crossing building expansion joints shall be provided with flexible ductwork connections.

3.2 VIBRATION ISOLATION AND SEISMIC RESTRAINT INSTALLATION

- A. Vibration Isolation of Horizontal Piping: The first 50' of piping connected to mechanical equipment including air handling units and pumps shall be isolated by hangers as described in specification 10 or 11. All piping in the boiler rooms / mechanical rooms shall be isolated by hangers as described in specification 10 or 11. Floor supported piping shall rest on isolators as described in specification 6. Air separators and expansion tanks are considered part of the piping run. The first three isolators from the isolated equipment will have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment and hangs from ceilings under occupied spaces the first three hangers shall have 0.75" (19mm) deflection for pipe sizes up to and including 3" (75mm), 1 1/2" (38mm) deflection for pipe sizes up to and including 6" (150mm), and 2 1/2" (64mm) deflection thereafter. Hangers shall be located as close to the overhead structure as practical.
- B. Vibration Isolation of Piping Risers: Risers shall be suspended from specification 10 hangers or supported by specification 5 mountings, anchored with specification 25 anchors, and guided with specification 26 sliding guides. Steel springs shall be a minimum of 0.75" (19mm) except in those expansion locations where additional deflection is required to limit load changes to $\pm 25\%$ of the initial load. Submittals must include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and seismic loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.
- C. Seismic Restraint of Piping
 1. Provide seismic restraints for any mechanical components with Component Importance Factor of $I_p = 1.5$ as defined by ASCE Chapter .7
 2. Transverse piping restraints shall be at 40' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
 3. Longitudinal restraints shall be at 80' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
- D. Vibration Isolation of Ductwork
 1. All discharge runs for a distance of 50' from the connected equipment shall be isolated from the building structure by means of specification 10 hangers or specification 5 floor isolators. Spring deflection shall be a minimum of 0.75".
 2. All duct runs having air velocity of 1000 fpm or more shall be isolated from the building structure by specification 11 hangers or specification 5 floor supports. Spring deflection shall be a minimum of 0.75".
- E. Concrete Inertia Bases
 1. Minimum operating clearance between concrete inertia and base and housekeeping pad or floor shall be 2".

2. The equipment structural steel or concrete inertia base shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the machine or isolators.
3. The isolators shall be installed without raising the machine and frame assembly.
4. After the entire installation is complete and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. When all isolators are properly adjusted, the blocks or shims shall be barely free and shall be removed.
5. Install equipment with flexibility in wiring connection.
6. Verify that all installed isolator and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to flexibly limit start-up equipment lateral motion to 1/4".
7. Prior to start-up, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base, isolators, or seismic restraints.

F. Vibration Isolation of Mechanical Equipment

1. All mechanical equipment shall be vibration isolated.
2. All floor mounted equipment shall be installed on housekeeping pads. Equipment shall be anchored to pads to meet acceleration criteria. Concrete pads shall be properly doweled or expansion shielded to deck.
3. Base mounted/floor mounted pumps and fans shall be installed on concrete inertia bases; Specification 17.
4. Pumps: All piping connections to pumps shall be made with specification 20.
5. All mechanical equipment suspended from the building's structure shall be vibration isolated and seismically restrained with combinations of Specification 5 thru 17.
6. Specification 25 - Roof Curbs with Acoustical Panels: Equipment listed below shall be anchored with this specification. Units shall be mounted at minimum 18" above roof to the bottom of the equipment – measurement is to be taken at the point where the curb is at the roof's highest point (pitched roofs). Roof curbs shall be anchored to the roof structure.
 - a. Roof Mounted Air Handling Units and DOAS Units.
 - b. Condensing Units serving VRF systems.
 - c. Condensing Units serving kitchen equipment.
 - d. Fans as identified at the Fan Schedule on the drawings.
 - e. Condensing Units (outdoor units) serving ductless split AC systems.
 - f. Condensing Units unless noted otherwise.
7. Specification 26 - Roof Curbs: Equipment listed below shall be anchored with this specification. Units shall be mounted at minimum 18" above roof to the bottom of the equipment – measurement is to be taken at the point where the curb is at the roof's highest point (pitched roofs). Roof curbs shall be anchored to the roof structure.
 - a. Radon Vents with curb for future fan.
8. Specification 27 - Roof Rails: Equipment listed below shall be anchored with this specification. Units shall be mounted at minimum 18" above roof to the bottom of the equipment – measurement is to be taken at the point where the curb is at the roof's highest point (pitched roofs). Rails shall be anchored to the roof

structure and shall be self-supporting without cross bracing allowing full access under the units.

- a. Condensing Units (outdoor units) serving chillers.
9. Specification 28 - Roof Rails: All items listed below shall be anchored with this specification. Units shall be mounted at minimum 18" above roof to the bottom of the equipment – measurement is to be taken at the point where the curb is at the roof's highest point (pitched roofs). Rails shall be anchored to the roof structure and shall be self-supporting without cross bracing allowing full access under the units.
- a. All piping installed above the roof.
 - b. All ductwork installed above the roof.
10. All hung equipment shall be installed with specification 10 cables if isolated. Specification 10 or 11 restraints may be used on un-isolated equipment and devices. Hung equipment includes VAV boxes, VRF indoor units, unit heaters, pipe mounted equipment, etc.

3.3 INSPECTION

- A. Examine systems under provisions of Division 1.
- B. On completion of installation of all vibration isolation devices herein specified, the local representative shall inspect the completed system and report in writing any installation error, improperly elected isolation devices, or other faults in the system that could affect the performance of the system. Contractor shall submit a report to the Owner, including the manufacturers representatives' final report, indicating all isolation reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.

END OF SECTION

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Testing, adjusting, and balancing of air systems.
 - 2. Testing, adjusting, and balancing of hydronic systems.
 - 3. Testing, adjusting, and balancing of refrigerant systems.
 - 4. Measurement of final operating condition of HVAC systems.
 - 5. Testing, adjusting, and balancing of domestic hot water recirculating systems.
- B. Related Sections:
 - 1. Section 23 04 00 – General Conditions for Mechanical Trades
 - 2. Section 23 09 23 - Direct-Digital Control System for HVAC: Requirements for coordination between DDC system and testing, adjusting, and balancing work.
 - 3. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation for HVAC equipment.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. Associated Air Balance Council:
 - 1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.
- C. Testing Adjusting and Balancing Bureau
 - 1. TABB- ANSI Accredited HVAC testing, adjusting and balancing certification program which conforms to ISO/IEC 17024 and endorsed by SMACNA.
- D. Natural Environmental Balancing Bureau:
 - 1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Prior to commencing Work, submit proof of latest calibration date of each instrument.
- C. Test Reports: Indicate data on AABC MN-1 National Standards for Total System Balance forms or NEBB Report forms containing information indicated in Schedules.
- D. Field Reports:
 - 1. Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - 2. Indicate suspected general deficiencies, even if not affected by testing and balancing.
- E. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty and/or Copy of NEBB Certificate of Conformance Certification.
- F. Submit draft copies of report for review prior to final acceptance of Project.
- G. Furnish reports in binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

- H. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of flow measuring stations balancing valves and rough setting.
- C. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with AABC MN-1 National Standards for Field Measurement and Instrumentation, Total System Balance NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
- B. Maintain one copy of each document on site.
- C. Prior to commencing Work, calibrate each instrument to be used. Upon completing Work, recalibrate each instrument to assure reliability.

- D. High Performance Building Requirements:
1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

- A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum three years documented experience certified by AABC, TABB, or NEBB.
- B. Perform Work under supervision of AABC, TABB or NEBB Certified Engineer or Supervisor.

1.9 PRE-INSTALLATION MEETINGS

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

1.10 SEQUENCING

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

1.11 SCHEDULING

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

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify systems are complete and operable before commencing work. Verify the following:
 - 1. Systems are started and operating in safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.
 - 12. Hydronic systems are flushed, filled, and vented.
 - 13. Pumps are rotating correctly.
 - 14. Proper strainer baskets are clean and in place or in normal position.
 - 15. Service and balancing valves are open.

3.2 PREPARATION

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

3.3 INSTALLATION TOLERANCES

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

3.4 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Verify recorded data represents actual measured or observed conditions.

- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.
- E. Report defects and deficiencies noted during performance of services, preventing system balance.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner.
- H. Check and adjust systems approximately six months after final acceptance and submit report.

3.5 DUCTLESS SPLIT UNITS - PROCEDURE

- A. Measure air temperature inlet and outlet under full cooling mode to verify operation.

3.6 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to obtain required or design outside, supply, return, and exhaust air quantities at site altitude.
- B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.
- E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.
- F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed (cost for material and labor shall be carried in the project). Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. At air handling units and air supply units, prepare system pressure profiles across all sections of the unit including mixing box, filters, coils and total pressure across fan. Make allowances for 50 percent loading of filters.

- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. At modulating damper locations, take measurements and balance at extreme conditions.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches positive static pressure near building entries.
- M. Balance variable volume systems at maximum airflow rate, full cooling, and at minimum airflow rate, full heating. Measure and record static pressure and velocity pressure setpoints at each box. Measure and record static pressure at duct mounted supply air static pressure controller(s).
- N. For variable air volume system units set volume controller to airflow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable-air-volume temperature control.

3.7 WATER SYSTEM PROCEDURE

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

3.8 SCHEDULES

- A. Equipment Requiring Testing, Adjusting, and Balancing:
 - 1. HVAC Pumps.
 - 2. Plumbing Pumps and Distribution.
 - 3. Packaged Roof Top Heating/Cooling Units.
 - 4. Pool HVAC \ Packaged Unit.
 - 5. Pool Water Heater
 - 6. Air Moving Equipment.
 - 7. Terminal Heat Transfer Units.
 - 8. Air Handling Units including DOAS Units.
 - 9. Fans.
 - 10. Energy Recovery Equipment
 - 11. Boilers.
 - 12. Chillers.
 - 13. Air Cooled Refrigerant Condensers.
 - 14. Condensing Units.
 - 15. Air Coils.
 - 16. Air Filters.
 - 17. Air Terminal Units.
 - 18. Air Inlets and Outlets.
 - 19. Water Coil.
 - 20. Heat Exchangers.

- B. Report Forms
 - 1. Title Page:
 - a. Name of Testing, Adjusting, and Balancing Agency
 - b. Address of Testing, Adjusting, and Balancing Agency
 - c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
 - d. Project name
 - e. Project location
 - f. Project Architect
 - g. Project Engineer
 - h. Project Contractor
 - i. Project altitude
 - j. Report date
 - 2. Summary Comments:
 - a. Design versus final performance
 - b. Notable characteristics of system
 - c. Description of systems operation sequence
 - d. Summary of outdoor and exhaust flows to indicate building pressurization
 - e. Nomenclature used throughout report
 - f. Test conditions
 - 3. Instrument List:
 - a. Instrument
 - b. Manufacturer
 - c. Model number

- d. Serial number
- e. Range
- f. Calibration date
- 4. Electric Motors:
 - a. Manufacturer
 - b. Model/Frame
 - c. HP/BHP and kW
 - d. Phase, voltage, amperage; nameplate, actual, no load
 - e. RPM
 - f. Service factor
 - g. Starter size, rating, heater elements
 - h. Sheave Make/Size/Bore
- 5. V-Belt Drive:
 - a. Identification/location
 - b. Required driven RPM
 - c. Driven sheave, diameter and RPM
 - d. Belt, size and quantity
 - e. Motor sheave diameter and RPM
 - f. Center to center distance, maximum, minimum, and actual
- 6. Pump Data:
 - a. Identification/number
 - b. Manufacturer
 - c. Size/model
 - d. Impeller
 - e. Service
 - f. Design flow rate, pressure drop, BHP and kW
 - g. Actual flow rate, pressure drop, BHP and kW
 - h. Discharge pressure
 - i. Suction pressure
 - j. Total operating head pressure
 - k. Shut off, discharge and suction pressures
 - l. Shut off, total head pressure
- 7. Cooling Coil Data:
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Entering air DB temperature, design and actual
 - g. Entering air WB temperature, design and actual
 - h. Leaving air DB temperature, design and actual
 - i. Leaving air WB temperature, design and actual
 - j. Water flow, design and actual
 - k. Water pressure drop, design and actual
 - l. Entering water temperature, design and actual
 - m. Leaving water temperature, design and actual
 - n. Saturated suction temperature, design and actual
 - o. Air pressure drop, design and actual

8. Heating Coil Data:
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Water flow, design and actual
 - g. Water pressure drop, design and actual
 - h. Entering water temperature, design and actual
 - i. Leaving water temperature, design and actual
 - j. Entering air temperature, design and actual
 - k. Leaving air temperature, design and actual
 - l. Air pressure drop, design and actual
9. Hydronic Heating Units:
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Water flow, design and actual
 - f. Entering water temperature, design and actual
 - g. Leaving water temperature, design and actual
 - h. For unit heaters and cabinet unit heaters:
 - 1) Entering air temperature, design and actual
 - 2) Leaving air temperature, design and actual
10. Plumbing Fixtures / Equipment:
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Balance data at hot water recirculating bypasses.
 - f. Fixture hot water outlet temperature.
 - g. Time for hot water temperature to be established.
11. Air Moving Equipment:
 - a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Arrangement/Class/Discharge
 - f. Air flow, specified and actual
 - g. Return air flow, specified and actual
 - h. Outside air flow, specified and actual
 - i. Total static pressure (total external), specified and actual
 - j. Inlet pressure
 - k. Discharge pressure
 - l. Sheave Make/Size/Bore
 - m. Number of Belts/Make/Size
 - n. Fan RPM

12. Return Air/Outside Air Data:
 - a. Identification/location
 - b. Design air flow
 - c. Actual air flow
 - d. Design return air flow
 - e. Actual return air flow
 - f. Design outside air flow
 - g. Actual outside air flow
 - h. Return air temperature
 - i. Outside air temperature
 - j. Required mixed air temperature
 - k. Actual mixed air temperature
 - l. Design outside/return air ratio
 - m. Actual outside/return air ratio
13. Exhaust Fan Data:
 - a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Air flow, specified and actual
 - f. Total static pressure (total external), specified and actual
 - g. Inlet pressure
 - h. Discharge pressure
 - i. Sheave Make/Size/Bore
 - j. Number of Belts/Make/Size
 - k. Fan RPM
14. Duct Traverse:
 - a. System zone/branch
 - b. Duct size
 - c. Area
 - d. Design velocity
 - e. Design air flow
 - f. Test velocity
 - g. Test air flow
 - h. Duct static pressure
 - i. Air temperature
 - j. Air correction factor
15. Energy Recovery Equipment:
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flows, design and actual
 - f. Entering air temperature, design and actual; dry bulb and wet bulb
 - g. Leaving air temperature, design and actual; dry bulb and wet bulb
 - h. Air pressure drop, design and actual

16. Air Monitoring Station Data:
 - a. Identification/location
 - b. System
 - c. Size
 - d. Area
 - e. Design velocity
 - f. Design air flow
 - g. Test velocity
 - h. Test air flow
17. Flow Measuring Station:
 - a. Identification/number
 - b. Location
 - c. Size
 - d. Manufacturer
 - e. Model number
 - f. Serial number
 - g. Design Flow rate
 - h. Design pressure drop
 - i. Actual/final pressure drop
 - j. Actual/final flow rate
 - k. Station calibrated setting
18. Terminal Unit Data:
 - a. Manufacturer
 - b. Type, constant, variable, single, dual duct
 - c. Identification/number
 - d. Location
 - e. Model number
 - f. Size
 - g. Minimum static pressure
 - h. Minimum design air flow
 - i. Maximum design air flow
 - j. Maximum actual air flow
 - k. Inlet static pressure
19. Air Distribution Test Sheet:
 - a. Air terminal number
 - b. Room number/location
 - c. Terminal type
 - d. Terminal size
 - e. Area factor
 - f. Design velocity
 - g. Design air flow
 - h. Test (final) velocity
 - i. Test (final) air flow
 - j. Percent of design air flow
20. Combustion Test:
 - a. Manufacturer
 - b. Model number
 - c. Firing rate
 - d. Overfire draft

- e. Gas meter timing dial size
- f. Gas meter time per revolution
- g. Gas pressure at meter outlet
- h. Gas flow rate
- i. Heat input
- j. Oil flow rate
- k. Burner manifold gas pressure
- l. Percent carbon monoxide (CO)
- m. Percent carbon dioxide (CO₂)
- n. Percent oxygen (O₂)
- o. Percent excess air
- p. Flue gas temperature at outlet
- q. Ambient temperature
- r. Net stack temperature
- s. Percent stack loss
- t. Percent combustion efficiency
- u. Heat output
- 21. Air Cooled Condensing Unit:
 - a. Location
 - b. Serial number
 - c. Entering DB air temperature, design and actual
 - d. Leaving DB air temperature, design and actual
 - e. Number of compressors
- 22. Ductless Split:
 - a. Location
 - b. Serial number
 - c. Entering DB air temperature, design and actual
 - d. Leaving DB air temperature, design and actual
- 23. Chillers – Air Cooled:
 - a. Capacity
 - b. Serial number
 - c. Evaporator entering water temperature, design and actual
 - d. Evaporator leaving water temperature, design and actual
 - e. Evaporator pressure drop, design and actual
 - f. Evaporator water flow rate, design and actual
 - g. Condenser entering air temperature, design and actual

3.9 POST OCCUPANCY BALANCING

- A. Contractor shall perform (2) additional site visits after spaces have been occupied to rebalance systems as directed by the Owner or Engineer. These site visits shall encompass changes as directed by the Owner and shall not encompass changes or modifications made by the contractor which have resulted in the need to rebalance systems. Each site visit shall be a duration of four hours and shall include balancing of air and/or water systems.

END OF SECTION

SECTION 230700 - HVAC INSULATION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. HVAC piping insulation, jackets and accessories.
 - 2. HVAC equipment insulation, jackets and accessories.
 - 3. HVAC ductwork insulation, jackets, and accessories.
 - 4. HVAC acoustical duct wrap.
 - 5. Electric heat tracing.
- B. Related Sections:
 - 1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
 - 2. Section 09 90 00 - Painting and Coating: Execution requirements for painting insulation jackets and covering specified by this section.
 - 3. Section 23 04 00 – General Conditions for Mechanical Trades

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. 2012 International Energy Conservation Code.
- B. ASTM International:
 - 1. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - 2. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 - 3. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - 4. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
 - 5. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - 6. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
 - 7. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 - 8. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
 - 9. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - 10. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
 - 11. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - 12. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - 13. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
 - 14. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
 - 15. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
 - 16. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
 - 17. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
 - 18. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
 - 19. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.
- C. Sheet Metal and Air Conditioning Contractors' National Association':
 - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
- D. Underwriters Laboratories Inc.:
 - 1. UL 1978 - Standard for Safety for Grease Ducts.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.
- C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- E. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 QUALITY ASSURANCE

- A. As a minimum requirement, all products and installation methods shall comply with 2012 International Energy Conservation Code.
- B. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84.
- C. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.
- D. Factory fabricated fitting covers manufactured in accordance with ASTM C450.

- E. Duct insulation, Coverings, and Linings: Maximum 25/50 flame spread/smoke developed index, when tested in accordance with ASTM E84, using specimen procedures and mounting procedures of ASTM E 2231.
- F. All insulating materials shall be free of asbestos.
- G. All insulating products and coverings shall be UL listed.
- H. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience as approved by manufacturer.

1.8 PRE-INSTALLATION MEETINGS

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

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.

- B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.
- C. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:
 - 1. CertainTeed.
 - 2. Knauf.
 - 3. Johns Manville.
 - 4. Owens-Corning.
- B. Manufacturers for Closed Cell Elastomeric Insulation Products:
 - 1. Aeroflex. Aerocel.
 - 2. Armacell, LLC. Armaflex.
 - 3. Nomaco. K-flex.
- C. Manufacturers for Adhesives and Sealers:
 - 1. Benjamin Foster (H.B. Fuller Co.)
 - 2. Rubatex.
 - 3. Minnesota Mining and Mfg Co. (3M)

2.2 PIPE INSULATION

- A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation.
 - 1. Thermal Conductivity: 0.23 at 75 degrees F.
 - 2. Operating Temperature Range: 0 to 850 degrees F.
 - 3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
 - 4. Jacket Temperature Limit: minus 20 to 150 degrees F.
- B. TYPE P-2: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
 - 1. Thermal Conductivity: 0.27 at 75 degrees F.
 - 2. Operating Temperature Range: Range: Minus 70 to 220 degrees F.
- C. TYPE P-3: "Acoustical Pipe Wrap" flexible, mass loaded vinyl laminated to fiberglass.
 - 1. Manufacturers: Sound Seal "B-10 LAG, Great Lakes Textiles, Inc." or approved equal.
 - 2. Thickness: 1".
 - 3. Density: 1.0 lb/sf ft.

2.3 PIPE INSULATION JACKETS

- A. PVC Plastic Pipe Jacket:
 - 1. Product Description: ASTM D1785, one piece molded type fitting covers and sheet material, off-white color.
 - 2. Thickness: 10 mil.
 - 3. Connections: Brush on welding adhesive; vapor retardant with pressure sensitive color matching vinyl tape.
 - 4. Fittings and Valves: provide factory precut inserts.
 - 5. For exterior locations, PVC jacket shall be UV resistant.

- B. Aluminum Pipe Jacket:
 - 1. ASTM B209.
 - 2. Thickness: 0.020 inch thick sheet.
 - 3. Finish: Smooth.
 - 4. Joining: Longitudinal slip joints and 2 inch laps.
 - 5. Fittings: Minimum 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 - 6. Metal Jacket Bands: Minimum 3/8 inch wide; 0.02inch thick aluminum.

2.4 PIPE INSULATION ACCESSORIES

- A. Vapor Retarder Lap Adhesive: Compatible with insulation.
- B. Covering Adhesive Mastic: Compatible with insulation.
- C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.
- D. Piping 2 inches diameter and larger: Insulation saddle. Insert length: not less than 6 inches long, matching thickness and contour of adjoining insulation.
- E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum jacket single piece construction with self-adhesive closure. Thickness to match pipe insulation.
- F. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.
- G. Adhesives: Compatible with insulation.

2.5 EQUIPMENT INSULATION

- A. TYPE E-1: ASTM C553; glass fiber, flexible or semi-rigid, noncombustible.
 - 1. Thermal Conductivity: 0.24 at 75 degrees F.
 - 2. Operating Temperature Range: 0 to 450 degrees F.
 - 3. Density: 1.65 pound per cubic foot.

- B. TYPE E-2: ASTM C612; glass fiber, rigid board, noncombustible with factory applied reinforced aluminum foil jacket.

1. Thermal Conductivity: 0.24 at 75 degrees F.
2. Operating Temperature Range: 0 to 450 degrees F.
3. Density: 3.0 pound per cubic foot.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

2.6 EQUIPMENT INSULATION JACKETS

- A. PVC Plastic Equipment Jacket:
 1. Product Description: ASTM D1785, sheet material, off-white color.
 2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
 3. Thickness: 20 mil.
 4. Connections: Brush on welding adhesive with tacks.
- B. Canvas Equipment Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.

2.7 EQUIPMENT INSULATION ACCESSORIES

- A. Vapor Retarder Lap Adhesive: Compatible with insulation.
- B. Covering Adhesive Mastic: Compatible with insulation.
- C. Adhesives: Compatible with insulation.

2.8 DUCTWORK INSULATION

- A. TYPE D-1: ASTM C1290, Type III, flexible glass fiber, commercial grade with factory applied reinforced aluminum foil jacket meeting ASTM C1136, Type II.
 1. Thermal Conductivity: 0.27 at 75 degrees F.
 2. Maximum Operating Temperature: 250 degrees F.
 3. Density: 1.0 pound per cubic foot.
- B. TYPE D-2: ASTM C612, Type IA or IB, rigid glass fiber, with factory applied reinforced aluminum foil facing meeting ASTM C1136, Type II.
 1. Thermal Conductivity: 0.23 at 75 degrees F.
 2. Density: 6.0 pound per cubic foot.
- C. TYPE D-3: ASTM C1071, ASTM, 1104 Type I, flexible, glass fiber duct liner with coated air side, Johns Manville Linacoustic RC or approved equal.
 1. Thermal Conductivity: 0.24 at 75 degrees F.
 2. Maximum Operating Temperature: 250 degrees F.
 3. Maximum Air Velocity: 6,000 feet per minute.
 4. Adhesive: Waterproof, ASTM E162 fire-retardant type.
 5. Liner Fasteners: Galvanized steel mechanical fasteners
 6. Coating: Polymer based.
 7. Round duct liner shall be Johns Manville Spiracoustics Plus or approved equal
- D. TYPE D-4: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.
 1. Thermal Conductivity: 0.27 at 75 degrees F.

2. Service Temperature Range: Range: Minus 58 to 180 degrees F.
- E. TYPE D-5: "Grease Duct Fire Wrap"; Inorganic blanket encapsulated with scrim reinforced foil meeting UL 1978 and ASTM E2336.
1. Manufacturers: Morgan Thermal Ceramics Firemaster Fast Wrap XL, Unifrax FyreWrap Max 2.0 or approved equal.
 2. Accessories: Thermal Ceramics Fast Door XL or approved equal.
 3. Through Penetration Firestop: Per manufacturer's recommendation to be in conformance with ASTM E814 or UL 1479
 4. Thermal Conductivity: 0.42 at 500 degrees F.
 5. Maximum Service Temperature: 2,000 degrees F.
 6. Weight: 1.4 pound per square foot.
 7. Surface Burning Characteristics: Maximum 0/0 flame spread/smoke developed index when tested in accordance with ASTM E84.
 8. Fire Rating: 2 Hrs (UL C-AJ 7014, UL C-AL 7021, UL W-7041).
 9. Fasteners: Stainless steel bands and galvanized steel speed clips.
 10. 0" clearance rating to non-combustible construction.
- F. TYPE D-6: "Acoustical Duct Wrap" flexible, mass loaded vinyl laminated to fiberglass.
1. Manufacturers: Sound Seal "B-20 LAG/QFA-9, Great Lakes Textiles, Inc." or approved equal.
 2. Thickness: 2".
 3. Density: 2.0 lb/sf ft.
- G. TYPE D-7: Ductwork Systems for supply air and return air installation at the exterior of the building.
1. Manufacturers: Dow Thermax Sheathing or approved equal.
 2. Material: Polyisocyanurate board.
 3. Thickness: 1" with R = 6.5 and 1.5" with R = 9.8.
 4. Supply Air: Provide two layers of 1.5" with staggered seams for total of 3" thickness and R = 19.6.
 5. Return Air: Provide two layers of 1" with staggered seams for total of 2" thickness and R = 13.
 6. Jacket shall be VentureClad Plus 1579CW, 13 ply, self-adhesive jacketing system. Flat material shall be minimum 17 mils thickness. Provide in white finish.
- H. TYPE D-8: Grease Exhaust Ductwork Systems for installation at the exterior of the building.
1. Material: ASTM C533; Type I, hydrous calcium silicate insulation, rigid molded white.
 2. Thickness: 2".
 3. Thermal Conductivity: 0.45 at 200 degrees F.
 4. Operating Temperature Range: 140 to 1200 degrees F.
 5. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
 6. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

7. Jacket shall be VentureClad Plus 1579CW, 13 ply, self-adhesive jacketing system. Flat material shall be minimum 17 mils thickness. Provide in white finish.

2.9 DUCTWORK INSULATION ACCESSORIES

- A. Vapor Retarder Tape: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
- B. Vapor Retarder Lap Adhesive: Compatible with insulation.
- C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- D. Lagging Adhesive: Fire retardant type with maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
- E. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.
- F. Adhesives: Compatible with insulation.

2.10 ELECTRIC HEAT TRACING

- A. Manufacturers: BriskHeat Type SLM-Cable or approved by Raychem or Heat-Trace.
- B. Characteristics:
 1. Self limiting, parallel circuit type which automatically self regulates heat output. Cable shall be acceptable for operating temperatures to 250 degrees F. Product shall be Factory Mutual approved or UL listed.
 2. Construction: 16 gauge nickel plated copper conductor, self regulating conductive core, thermoplastic elastomer inner jacket, metallic over-braid and thermoplastic outer jacket.
 3. Electrical Circuit #1: All Pool Water Supply and Return Piping, Valves and Accessories at the exterior of the building; Capacity shall be as follows: 3 watts per foot with 120 volt, 1 phase electrical power. Maximum length per circuit shall be 200 feet.
 4. Electrical Circuit #2: All Condensate Drain Piping, Valves and Accessories at the exterior of the building serving DU-1; Capacity shall be as follows: 3 watts per foot with 120 volt, 1 phase electrical power. Maximum length per circuit shall be 200 feet.
- C. Each Circuit shall be served by an individual Temperature Controller: BriskHeat Model TB250N controller with bulb type sensor and 10'0" long capillary, NEMA 3R enclosure, 22 amp SPDT switch and adjustable range of 0 to 150 degrees F.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify piping, equipment and ductwork has been tested before applying insulation materials.
- C. Verify surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION - GENERAL

- A. PVC piping covers for piping, equipment, etc. shall not be installed in spaces defined as plenums used for conveying air; such as ductwork plenums or return air ceiling plenums.

3.3 INSTALLATION - PIPING SYSTEMS

- A. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Division 7 for penetrations of assemblies with fire resistance rating greater than one hour.
- B. Multiple layers: Where multiple layers of glass fiber pipe insulation are required, inner layer shall not be provided with vapor barrier jacket. Piping Systems Conveying Fluids Below Ambient Temperature:
 - 1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, air separators and expansion joints.
 - 2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 - 3. Insulate fittings, joints, flanges, unions and valves with molded insulation of like material and thickness as adjacent pipe. Finish with PVC fitting covers.
 - 4. Coil Termination Point: Insulate piping and associated components up to coil connection.
- C. Piping Systems Conveying Fluids Above Ambient Temperature:
 - 1. Insulate all parts of system not requiring routine maintenance including: Fittings, valves, strainers and air separators.
 - 2. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
 - 3. Insulate fittings, joints, flanges, unions and valves with molded insulation of like material and thickness as adjacent pipe. Finish with PVC fitting covers.
 - 4. Coil Termination Point: For piping over 1" diameter, insulate piping and associated components up to coil connection. For piping 1" and smaller, terminate hot water piping at union connection to coil.

- D. Inserts and Shields:
 - 1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
 - 2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
 - a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
 - b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
 - 3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.
- E. Closed Cell Elastomeric Insulation:
 - 1. Push insulation on to piping.
 - 2. Miter joints at elbows.
 - 3. Seal seams and butt joints with manufacturer's recommended adhesive.
 - 4. When application requires multiple layers, apply with joints staggered.
 - 5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.
- F. Piping Exposed to View in Finished Spaces: Finish all with PVC jacket and fitting covers. Prepare for finish painting; Refer to Division 9.
- G. Piping Exposed in AHU Pipe Enclosures: Finish with PVC jacket and fitting covers.
- H. Pipe Exposed in Mechanical Equipment Rooms, Air Handling Rooms and Boiler Rooms (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.
- I. Refrigerant Piping Located at the exterior of the building: Finish all with PVC jacket and fitting covers.
- J. Pool heat recovery supply and return piping located at the exterior of the building: Finish all with aluminum jacket and fitting covers.
- K. All piping installed in the Natatorium / pool area and Pool Mechanical Rooms: Finish all with PVC jacket and fitting covers.
- L. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size insulation large enough to enclose pipe and heat tracer. Finish all with aluminum jacket and fitting covers.

3.4 INSTALLATION - EQUIPMENT

- A. Exposed Equipment: Locate insulation and cover seams in least visible locations.
- B. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface.

- C. Multiple layers: Where multiple layers of glass fiber insulation are required, inner layer shall not be provided with vapor barrier jacket.
- D. Equipment Containing Fluids Below Ambient Temperature:
 - 1. Insulate entire equipment surfaces.
 - 2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
 - 3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 - 4. Finish insulation at supports, protrusions, and interruptions.
- E. Equipment Containing Fluids Above Ambient Temperature:
 - 1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
 - 2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
 - 3. Finish insulation at supports, protrusions, and interruptions.
- F. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with PVC jacket and fitting covers.
- G. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.
- H. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

3.5 INSTALLATION - DUCTWORK SYSTEMS

- A. Duct dimensions indicated on Drawings are finished inside dimensions
- B. For all ductwork located within the building envelope, insulation shall be rated at a minimum installed value of R6. For all ductwork located outside the building envelope, insulation shall be rated at a minimum installed value of R8.
- C. Insulated ductwork conveying air below ambient temperature:
 - 1. Provide insulation with vapor retarder jackets.
 - 2. Finish with tape and vapor retarder jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- D. Insulated ductwork conveying air above ambient temperature:
 - 1. Provide with or without standard vapor retarder jacket.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

- E. External Glass Fiber Duct Insulation:
1. Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.
 2. Secure insulation without vapor retarder with staples, tape, or wires.
 3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
 4. Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.
 5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
- F. Duct and Plenum Liner:
1. Adhere insulation with adhesive for 100 percent coverage.
 2. Secure insulation with mechanical liner fasteners. Comply with SMACNA Standards for spacing.
 3. Seal and smooth joints. Seal and coat transverse joints.
 4. Seal liner surface penetrations with adhesive.
 5. Cut insulation for tight overlapped corner joints. Support top pieces of liner at edges with side pieces.
- G. External Closed Cell Elastomeric Duct Insulation:
1. Adhere to clean oil-free surfaces with full coverage of adhesive.
 2. Seal seams and butt joints with manufacturer's recommended adhesive.
 3. When application requires multiple layers, apply with joints staggered.
 4. Insulate standing metal duct seams with insulation of like material and thickness as adjacent duct surface. Apply adhesive at joints with flat duct surfaces.
 5. Lift ductwork off trapeze hangers and insert spacers.
- H. Grease Duct Fire Wrap Insulation:
1. Cover duct by wrapping with insulation by overlapping joints.
 2. Overlap seams of each method by 3 inches.
 3. Attach insulation using steel banding or by welded pins and clips.
 4. Install insulation without sag on underside of ductwork. Use additional fasteners to prevent sagging.

3.6 SCHEDULES

A. Cooling Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Chilled Water Supply and Return Piping unless noted otherwise	P-1	1-1/4 inch and smaller 1-1/2 inch and larger	0.5 1.0
Chilled Water Supply and Return Piping in Unconditioned Spaces (i.e. Mechanical Rooms)	P-1	1-1/4 inch and smaller 1-1/2 inch and larger	1.0 1.5
Chilled Water Supply and Return Piping in Pipe Enclosures serving AHU's and DOAS	P-1	1-1/4 inch and smaller 1-1/2 inch and larger	1.0 1.5
Condensate Piping from Cooling Coils (Copper Piping)	P-1	All sizes	0.75
Condensate Piping from DU-1 outside of the building	P- 2	1-1/4 inches and smaller 1-1/2 inches and larger	2.0 3.0
Refrigerant Piping – Suction Lines	P-2	Less than 1 inch 1 inch and larger	0.5 1.0
Refrigerant Piping – Liquid Lines and Hot Gas Lines	P-2	Less than 1-1/2 inch 1-1/2 inch and larger	1.0 1.5

B. Heating Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Heating Water Supply and Return unless noted otherwise	P-1	1-1/4 inches and smaller 1-1/2 inches and larger	1.5 2.0
Heating Water Supply and Return Piping in Pipe Enclosures serving AHU's and DOAS	P-1	1-1/4 inches and smaller 1-1/2 inches and larger	2.0 3.0
Heating Water Supply and Return Piping outside of the building	P- 2	1-1/4 inches and smaller 1-1/2 inches and larger	2.0 3.0
Heating Water Supply and Return: Piping Installed: Above the Auditorium Stage 155 Above General Music Room 143 and Band Room 137 Above Project Room 2055 and adjacent Office 2056 Where noted on the drawings to be installed with acoustical pipe wrap.	P-1 and P-3	All Sizes	P-1: 2.0 P-3: 1.0
Pool Water Heat Supply and Return and Pool Water Heat Recovery Supply and Return Piping inside of the building	P- 2	1-1/4 inches and smaller 1-1/2 inches and larger	1.5 2.0
Pool Water Heat Recovery Supply and Return Piping outside of the building	P- 2	1-1/4 inches and smaller 1-1/2 inches and larger	2.0 3.0

C. Equipment Insulation Schedule:

EQUIPMENT	INSULATION TYPE	INSULATION THICKNESS inches
Chilled Water Air Separators	E-2	1.5
Chilled Water pump impellers and suction diffusers	E-2	1.5

Chilled Water - Misc. pipe mounted devices	E-1	1.0
Heating Water - Air Separators and other misc. pipe mounted devices	E-1	2.0

D. Ductwork Insulation Schedule:

DUCTWORK SYSTEM	INSULATION TYPE	INSULATION THICKNESS inches
Outside Air Intake Ducts and Plenums In Concealed Spaces	D-1	2.0 / Min R6
Outside Air Intake Ducts and Plenums In Exposed Spaces	D-2	2.0 / Min R6
Exhaust Air Plenums and Ductwork In Concealed Spaces between louver or fan (exterior envelope penetration) and motorized damper	D-1	2.0 / Min R6
Exhaust Air Plenums and Ductwork In Exposed Spaces between louver or fan (exterior envelope penetration) and motorized damper	D-2	2.0 / Min R6
Supply Ducts In Concealed Spaces	D-1	2.0 / Min R6
Supply Ducts In Mechanical Rooms, Equipment Rooms, Boiler Rooms and Other spaces where the ductwork is exposed and susceptible to damage.	D-2	2.0 / Min R6
Supply Ducts installed in concealed spaces where the temperature differential is greater than 40 degrees F	D-1	3.0 / Min R8
Supply Ducts installed in fully conditioned spaces and exposed below ceilings	N/A	N/A
Return Ducts In Mechanical Rooms, Equipment Rooms, Boiler Rooms and other spaces which are not fully conditioned	D-2	2.0
Return Ducts installed concealed spaces where the temperature differential is greater than 40 degrees F	D-1	3.0
Exterior Ductwork: Supply Air and Return Air Ducts installed outside the building such as ductwork serving DU-1.	D-7	(2) layers; Refer to spec above
Grease Hood Exhaust Duct at interior of the building	D-5	(2) layers 1.5" thickness each
Grease Hood Exhaust Duct at exterior of the building	D-8	2.0" thickness
Combustion Air Ducts and Plenums	D-2	2.0
Refer to drawings for other requirements.		

E. Ductwork Insulation Schedule – Acoustical Treatment:

DUCTWORK SYSTEM	INSULATION TYPE	INSULATION THICKNESS inches
Transfer Air Ducts	D-3	1.0
SA Ductwork called to be internally lined or provided with duct liner on the drawings	D-1 and D-3	D-1: 1.5 D-3: 1.0
RA or Exhaust Ductwork called to be internally lined or provided with duct liner on the drawings	D-3	1.0
All SA Ductwork Serving AHU-1 except double wall ductwork as identified in Spec Section 233100	D-1 and D-3	D-1: 1.5 D-3: 1.0
All RA Ductwork Serving AHU-1 except double wall ductwork as identified in Spec Section 233100	D-3	1.0
SA Ductwork Serving AHU-2, AHU-3 and AHU-4: First 20 feet of ductwork starting at the discharge of the AHU and running out 20 feet including all branches	D-1 and D-3	D-1: 1.5 D-3: 1.0
RA Ductwork Serving AHU-2, AHU-3 and AHU-4: First 20 feet of ductwork starting at the inlet of the AHU and running out 20 feet including all branches	D-3	1.0
SA Ductwork Serving DOAS-1, DOAS-2, DOAS-3 and DOAS-4: First 20 feet of ductwork starting at the discharge of the AHU and running out 20 feet including all branches	D-1 and D-3	D-1: 1.5 D-3: 1.0
RA Ductwork Serving DOAS-1, DOAS-2, DOAS-3 and DOAS-4: First 20 feet of ductwork starting at the inlet of the AHU and running out 20 feet including all branches	D-3	1.0
VAV Boxes serving Supply Air: SA ductwork at the discharge of all VAV boxes (for a distance of 10 feet of ductwork downstream of VAV's)	D-1 and D-3	D-1: 1.5 D-3: 1.0
Return Air Serving all Classrooms: RA ductwork at each grille for a distance of 10 feet of ductwork downstream of each grille.	D-3	1.0
Refer to notes on the drawings for additional insulation requirements.		

Definitions:

Concealed spaces shall be defined as locations where ductwork is installed in soffits, ceiling plenums, and shafts.

END OF SECTION

SECTION 230800 - COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. ASHRAE Guideline 1-2007, HVAC&R Technical Requirements for the Commissioning Process
- C. OPR and BoD documentation are included by reference for information only.

1.2 SUMMARY

- A. This Section includes general requirements that apply to implementation of the commissioning process without regard to specific systems, assemblies, and components.
- B. Related Sections include the following:
 - 1. Division 01 Section 019113 General Commissioning Requirements for general commissioning process activities.
 - 2. Division 23 Mechanical
 - 3. Division 28 Electronic Safety and Security for interaction with fire alarm systems

1.3 DEFINITIONS

- A. Commissioning Plan: A document, prepared by CxA, that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. Quality Assurance: A program for the systematic monitoring and evaluation of the various aspects of a system, assembly, or component to ensure that standards of quality are being met. This is the responsibility of the CxA.
- D. Quality Control: A system for ensuring the maintenance of proper standards in systems, assemblies, and components. This is the responsibility of the Contractor.
- E. Official: State or Local official having jurisdiction over the HVAC&R systems
- F. Systems, Assemblies, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, equipment, and components.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION CHECKLISTS

- A. The CxA shall provide Construction Checklists to the Contractors for execution that will indicate expected Quality Control features required for a highest-quality installation. The contractor shall complete the checklists as construction progresses and return them to the CxA as indicated in Section 019113 General Commissioning Requirements.
- B. Checklists for this section will include:
 - 1. Heating, ventilation, air conditioning and refrigeration systems and associated controls
- C. A sample installation checklist is included to show the typical scope and rigor of the process.

3.2 PREREQUISITES TO TESTING

- A. Prior to the testing of these systems or assemblies, the Contractor shall certify that:
 - 1. The system or assembly is completely installed, functional, and documented through checklists.
 - 2. Work performed by other trades, but essential for this system or assembly's operation, is complete (e.g., electrical components are wired and power is provided)
 - 3. All contractor-performed start-up procedures and Pre-Functional Tests are complete and documented.
 - 4. Preliminary trending data provided to verify actual system operation.
 - 5. The system or assembly is ready for the Owner to take beneficial use.

3.3 SYSTEM OR ASSEMBLY TEST REQUIREMENTS

- A. The CxA will provide Functional Performance Test procedures to the Contractor for execution for the following specific systems, assemblies, and components:
 - 1. Heating, ventilation, air conditioning and refrigeration systems and associated controls
 - 2. Building automation system
- B. Acceptance criteria and test details will be in accordance with the related sections including the following:
 - 1. Division 01 Section 019113 General Commissioning Requirements for general commissioning process activities.
 - 2. Division 23 Mechanical
 - 3. Division 28 Electronic Safety and Security

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State Project No.s: 014-0034 EA / 014-0035 BE-EA

- C. A sample functional performance test is included to show the typical scope and rigor of the process.

3.4 TEST REPORTS

- A. Provide copies of all reports required in the listed reference sections (see Section 1.2 SUMMARY above for the sections) for review.

3.5 SAMPLE FORMS

Sample Installation Checklist

Roof Top Unit # _____ Serving Room/Area/Floor _____

Model Verification

	Specified	Submitted	Installed
Manufacturer			
Model Number			
Serial Number			
Inlet Size			
Cool CFM / Heat CFM			

Installation Checks

ID	Description	Pass/Fail	Comments
1	Verify the unit has been installed on a roof curb. Entire length and width under base shall be sealed for additional water management protection.	<input type="checkbox"/> <input type="checkbox"/>	
2	The piping cabinet shall have removable panels or optional access door of the same construction as unit door.	<input type="checkbox"/> <input type="checkbox"/>	
3	Verify view windows are provided for all fan section access doors and are made of tempered glass.	<input type="checkbox"/> <input type="checkbox"/>	
4	Verify that factory mounted light fixtures are provided in all sections of the unit that have access doors. Provide individual light switches installed adjacent to access doors.	<input type="checkbox"/> <input type="checkbox"/>	
5	Coils shall be removable by unbolting the wall panels in the coil section. Connections shall be clearly labeled on the outside of units.	<input type="checkbox"/> <input type="checkbox"/>	
6	Verify filter section shall have filter racks, an access door for filter removal and block offs as required to prevent air bypass around filters. Units shall be supplied with 4" flat and 12" cartridge bag filters.	<input type="checkbox"/> <input type="checkbox"/>	
7	Verify factory wired disconnect switches for each fan (VSDs are to be mounted in the building, not within the rooftop unit). Also provide factory wired lights and GFI receptacles (two per unit).	<input type="checkbox"/> <input type="checkbox"/>	
8	Provide smoke rated damper assembly for both supply and return air openings for RTU-1, 7 and 9.	<input type="checkbox"/> <input type="checkbox"/>	
9	Provide isolation damper assemblies for both supply and return air openings for all rooftop units except RTU-1, 7 and 9.	<input type="checkbox"/> <input type="checkbox"/>	
10	Verify the following piping components have been installed in the direction of flow for the CW/HW supply: a. Thermometer b. Butterfly Valve c. Strainer with hose end drain valve with cap and chain d. Union e. 3/4" Hose end drain valve with cap and drain.	<input type="checkbox"/> <input type="checkbox"/>	
11	Verify the following piping components have been installed in the direction of flow for the CW/HW return: a. Automatic Air Vent b. Union c. 2-Way Control Valve d. Union	<input type="checkbox"/> <input type="checkbox"/>	

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11/17/2017

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BOARD OF EDUCATION CENTRAL OFFICES
BRANFORD, CONNECTICUT
State Project No.s: 014-0034 EA / 014-0035 BE-EA

	e. Butterfly Valve with Memory Stop f. Thermometer		
--	---	--	--

Approvals (only one required)

	Name (printed neatly)	Signature	Date
Contractor/Manuf. Rep.			
Engineer			
Construction Administrator			
Commissioning Agent			

**Sample Functional Performance Test
Dedicated Outdoor Air System – DOAS-1**

1. Participants

<u>Name/Representing</u>	<u>Participation (Testing, Witness, etc)</u>
/	
/	
/	

Party filling out this form _____ Date of test _____

2. Prerequisite Checklist

- a. A completed and approved balancing report has been provided.
- b. An as-built version of the controls submittal has been provided.
- c. The controls contractor has certified that their internal commissioning is complete and the project is ready for third-party verification. CC initials: _____. Date: _____.
- d. The general contractor has certified that the construction is substantially complete and ready for third-party verification. GC initials: _____. Date: _____.
- e. Record all values for setpoints, control parameters, limits, delays, lockouts, schedules, etc., that have been changed to accommodate testing:

Parameter	Pre-Test Values	Returned to Pre-Test Values <input checked="" type="checkbox"/>
Occ/Unocc Schedule		<input type="checkbox"/>
DA Temp Reset (Average Space) Temp. Range		<input type="checkbox"/>
Discharge Air Dew Point Setpoint		<input type="checkbox"/>
Supply Fan Enabled Status		<input type="checkbox"/>
Unit Occupancy Schedule		<input type="checkbox"/>
Optimal Start Period Limit		<input type="checkbox"/>

Parameter	Pre-Test Values	Returned to Pre-Test Values <input checked="" type="checkbox"/>
Mode of Operation (Heat/Cool)		<input type="checkbox"/>
DAT Setpoint Summer		<input type="checkbox"/>
Supply Fan Speed Setpoint		<input type="checkbox"/>
Exhaust Fan Enabled Status		<input type="checkbox"/>
Freezestat Setpoint		<input type="checkbox"/>
		<input type="checkbox"/>

3. Sensor Calibration Checks. The sensors listed below are to be checked for calibration and adequate location.

Sensor	Location OK ¹	BAS Value	Measured Value	Pass Y/N
Outside Air Temperature	Y / N			Y / N
Heating Coil DA Temp	Y / N			Y / N
Return Air Temperature	Y / N			Y / N
Exhaust Air Temp	Y / N			Y / N
ERV Wheel LAT	Y / N			Y / N
ERV Wheel 1 st Pass Temp	Y / N			Y / N
CDQ Wheel 1st EA Pass Temp	Y / N			Y / N
CDQ Wheel EA 2nd Pass Temp	Y / N			Y / N
CDQ Wheel 2nd Pass Temp	Y / N			Y / N
	Y / N			Y / N
Supply Air Filter DP	Y / N			Y / N

Sensor	Location OK ¹	BAS Value	Measured Value	Pass Y/N
Outdoor Air Humidity	Y / N			Y / N
Cooling Coil DA Temp	Y / N			Y / N
Return Air Humidity	Y / N			Y / N
Exhaust Air Humidity	Y / N			Y / N
ERV Wheel LAH	Y / N			Y / N
ERV Wheel 1 st Pass Hum.	Y / N			Y / N
CDQ Wheel EA 1st Pass Hum	Y / N			Y / N
CDQ Wheel EA 2nd Pass Hum.	Y / N			Y / N
CDQ Wheel 2nd Pass Hum.	Y / N			Y / N
Leaving Air Humidity	Y / N			Y / N
Return Air Filter DP	Y / N			Y / N

¹ Sensor location is appropriate and away from causes of erratic operation.

Comments:

4. Device Calibration Checks. The actuators or devices listed below are to be checked for proper operation and/or calibration.

Device or Actuator	Procedure / State	BAS Value	Site Observation	Pass Y/N
Outside Air Damper (Typical of 2)	Closed	Closed		Y / N
	Open	Open		Y / N
Exhaust Air Damper	Closed	Closed		Y / N
	Open	Open		Y / N
Supply Fan status	Stop	Stop		Y / N
	Start	Start		Y / N
Supply Fan speed	0%	0%		Y / N
	50%	50%		Y / N
	100%	100%		Y / N
Exhaust Fan Status	Stop	Off		Y / N
	Start	On		Y / N
Exhaust Fan Speed	0%	0%		Y / N
	50%	50%		Y / N
	100%	100%		Y / N

Device or Actuator	Procedure / State	BAS Value	Site Observation	Pass Y/N
ERV Wheel Status*	On	On		Y / N
	Off	Off		Y / N
CDQ Wheel Status*	On	On		Y / N
	Off	On		Y / N
Heating Coil Valve Position	Closed	0%		Y / N
	50% Open	50%		Y / N
	100% Open	100%		Y / N
Cooling Coil Valve Position	Closed	0%		Y / N
	50% Open	50%		Y / N
	100% Open	100%		Y / N
Energy Recovery Wheel Bypass Damper (OA)	Open	Open		Y / N
	Closed	Closed		Y / N
Energy Recovery Wheel Bypass Damper (EA) %open	Open	Open		Y / N
	Closed	Closed		Y / N
CDQ Wheel Bypass Damper (Supply Air) %open	Open	Open		Y / N
	Closed	Closed		Y / N
CDQ Wheel Bypass Damper (Mixed Air)	Open	Open		Y / N
	Closed	Closed		Y / N

5. Notes

6. Functional Testing Record

Seq. ID	Mode ID	Test Procedure (including special conditions)	Expected Response	Pass Y/N	Notes
1.	DISABLED MODE (UNOCCUPIED)	1. At the BMS, place the DOAS unit to the OFF condition.	1. The unit supply and exhaust fans turn off, the OAD is closed, the RAD opens, the cooling and re-heat valves are closed and the ERW and CDQ wheels are OFF.	Y / N	
2.	UNOCCUPIED MODE	1. From the BMS place the unit into "Unoccupied" mode.	1. The return air damper opens 100%, the OA damper remains closed, the system recirculation dampers open and the supply fan VFD operates at a lower speed to satisfy the zone with the most out of tolerance space temperature. The exhaust fan and energy wheel will remain OFF and the CDQ wheel operates to maintain 55°F DB/49.5°F WB.	Y / N	

Seq. ID	Mode ID	Test Procedure (including special conditions)	Expected Response	Pass Y/N	Notes
3.	ENABLED MODE	1. Adjust the schedule to enable the unit to normal operating mode.	1. The SF starts at minimum speed and the OAD and EAD open. Once proven open, the SF VFD ramps up to maintain duct static pressure setpoint.	Y / N	
4.	UNOCCUPIED MODE DEHUMIDIFICATION	1. Manipulate the humidity setpoint to create a condition that requires dehumidification	1. The bypass damper opens, supply fan turns ON and controls to duct static pressure setpoint. The exhaust fan and enthalpy wheel will remain OFF. OA damper will open, and CDQ wheel rotates.	Y / N	
5.	UNOCCUPIED HEATING MODE	1. Increase the DAT setpoint above the current DAT while in unoccupied mode. 2. Decrease the DAT setpoint.	1. The ERV bypass damper closes and the hot water valve modulates to achieve DAT setpoint. 2. The heating valve modulates closed.	Y / N	
6.	SUPPLY/ EXHAUST AIRFLOW DIFFERENTIAL	1. Observe the supply and exhaust airflows during normal unit operation. 2. Adjust the airflow differential setpoint up to 5%.	1. The supply fan operates at a speed that provides 3% more CFM than exhaust CFM. 2. The supply fan will continue to maintain SP setpoint and the exhaust fan slows down to reach the 5% CFM differential.	Y / N	
7.	OCCUPIED MODE HEATING	1. With the unit in the occupied mode, adjust the DAT set point to 60 degrees. 2. Create a condition where space DB temp is less than the space DB, the OA DB temperature is less than the SA DB temp and airflow CFM = minimum setpoint.	1. The unit's first stage of heat will activate the Enthalpy Wheel. The next stage modulates the hot water control valve to maintain a DAT of 65 degrees. 2. The hot water control valve will modulate to maintain discharge air temperature of 65 to 55 degrees.	Y / N	

Seq. ID	Mode ID	Test Procedure (including special conditions)	Expected Response	Pass Y/N	Notes
8.	OCCUPIED HEATING MODE (NO HEAT REQUIRED)	1. With the unit in the occupied mode, adjust the DAT set point to 60 degrees.	1. The heating valve goes closed, the ERV bypass damper modulates to achieve DAT setpoint.	Y / N	
9.	OCCUPIED COOLING & DEHUMIDIFICATION	1. Create a condition where space %RH is greater than the %RH setpoint and the space temperature is greater than setpoint temp.	1. The CDQ wheel operates and cooling coil valve modulates open until %RH is 5% less than setpoint.	Y / N	
10.	SUPPLY/ EXHAUST AIRFLOW DIFFERENTIAL	1. Observe the supply and exhaust airflows during normal unit operation. 2. Increase the airflow differential setpoint by 5%.	1. The supply fan operates at a speed that provides 3% more CFM than exhaust CFM. 2. The supply fan will continue to maintain SP setpoint and the exhaust fan slows down to reach the 5% CFM differential.	Y / N	
ENERGY RECOVERY MODES					
11.	COOLING RECOVERY MODE	Mode Enabled 1. Initiate cooling recovery mode by creating a condition where the OA enthalpy > enable setpoint and >RA enthalpy. Mode Disabled 2. Disable cooling recovery mode by setting OA enthalpy enable setpoint below the current OA enthalpy.	1. ERW operates and the OA recovery bypass damper closes. 2. ERW is OFF and the OA recovery bypass damper opens.	Y / N	
12.	NO RECOVERY MODE	1. Initiate no recovery mode by creating a condition where the OA enthalpy is below RA enthalpy and OA dewpoint is less than SA dewpoint setpoint.	1. Energy Recovery Wheel is OFF and the bypass damper opens.	Y / N	

Seq. ID	Mode ID	Test Procedure (including special conditions)	Expected Response	Pass Y/N	Notes
13.	HEATING RECOVERY MODE	1. Create a condition where the OAT is less than SA temperature setpoint and OA dewpoint is less than the supply air dewpoint.	1. Energy recovery wheel is enabled and the bypass damper modulates to maintain SA temperature measured at ATS-1 temperature sensor.	Y / N	
14.	SAFETIES & ALARMS	<ol style="list-style-type: none"> 1. Fail the Supply Fan 2. Fail the Exhaust Fan 3. Energy Wheel Failure 4. CDQ Wheel Failure 5. Frost Protection Mode 6. Create OA filter DP alarm 7. Create filter DP alarm 8. Create filter DP alarm 9. Freezestat Low Limit 10. OAD Alarm 11. Initiate High DAT Alarm 12. Initiate Low DAT Alarm 13. Smoke alarm 14. Freeze Pump Failure 15. High Duct Static Pressure 16. Low Duct Static Pressure 	<ol style="list-style-type: none"> 1. The fan shuts down and manually reset alarm sent to BMS. 2. The fan shuts down and manually reset alarm sent to BMS. 3. ERW alarm to BMS 4. CDQ alarm to BMS 5. Frost Protection alarm to BMS 6. OA Filter alarm to BMS 7. Filter alarm to BMS 8. Filter alarm to BMS 9. Freezestat alarm to BMS 10. Outside Air Damper Alarm 11. DA High Temp Alarm (5°F > Stpt.) 12. DA Low Temp Alarm (5°F < Stpt.) 13. DOAU disables/ alarm to BMS 14. Freeze pump failure alarm to BMS 15. High Static alarm to BMS 16. Low Static alarm to BMS 	Y / N	
15.	TRENDS	<p>Trend the following points for 5 minute trend samples and review in 96 hours:</p> <ol style="list-style-type: none"> 1. Discharge Air Temperature 2. Discharge Air Humidity 3. Space temperature 4. Exhaust air temperature 5. Exhaust fan status 6. Supply fan status 	TRENDS		

NOTES:

END OF SECTION 230800

SECTION 230923 – DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Control equipment.
 - 2. Software.
 - 3. Sensors and input devices.
 - 4. Dampers, valves, actuators and output devices.
 - 5. Variable frequency drives.
 - 6. Copper tubing and gauges.

- B. Related Sections:
 - 1. Section 01 91 13 – General Commissioning Requirements
 - 2. Section 23 08 00 – Commissioning of HVAC Systems
 - 3. Section 23 04 00 – General Conditions for Mechanical Trades
 - 4. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation implemented using products specified in this section.
 - 5. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI MC85.1 - Terminology for Automatic Control.

1.5 DESCRIPTION

- A. The Building Management System (BMS) shall be as indicated on the drawings and described in these specifications. System must be fully integrated and coordinated with mechanical equipment DDC controllers furnished and installed in the equipment manufacturer's factory as specified in those sections. The intent of the BMS is to integrate all mechanical equipment into one system for global monitoring, control, and alarming associated with the building. It is the BMS manufacturer's responsibility to provide all the design, engineering, and field coordination required to ensure all equipment sequence of operations are met as specified and the designated BMS operators have the capability of managing the building mechanical system to ensure occupant comfort while maintaining energy efficiency.
- B. The BMS shall meet both BACnet and LonTalk communication standards to ensure the system maintains "interoperability" to avoid proprietary arrangements that will make it difficult for the Owner to consider other BMS manufacturers in future projects. These open protocol communication standards are discussed in more detail later in this specification.
- C. Direct Digital Control (DDC) technology shall be used to provide the functions necessary for control of mechanical systems and terminal devices on this project.
- D. The BMS shall accommodate simultaneous multiple user operation. Access to the control system data should be limited only by operator password. Multiple users shall have access to all valid system data. An operator shall be able to log onto any workstation on the control system and have access to all appropriate data.
- E. Communication between DDC controllers and all workstation(s) shall be over a high-speed network. All nodes on this network shall be peers. The operator shall not have to know the controller identifier or location to view or control a point (object). Application Specific Controllers shall be constantly scanned by the Building Controllers to update point information and alarm information globally.
- F. The BMS manufacturer shall provide all hardware and software necessary to implement the functions and sequence of operations specified.
- G. It shall be understood that the drawings and specifications describe the approximate locations of the work. Do not scale the drawings to determine exact positions and clearances. Obtain from Architect, Engineer or the Owner any dimensions not shown.
- H. Details of construction and of workmanship where not specifically described herein or indicated on the drawings shall be subject to the Engineer's or Owner's approval. It is the intent of these specifications to provide complete systems, left in good working order,

ready for operation, including necessary labor and materials, whether or not specifically shown on the drawings or mentioned herein.

- I. The Controls System Operator Workstation software shall be graphically oriented and shall be designed and implemented for use on the Internet and the Owner's Intranet. All aspects of the Controls Systems Operator Interface shall be provided to operate through an IT industry standard Web Browsers. The Web Browser based Operator Interface provided shall not require the procurement or licensing of any special or proprietary software from the Controls Contractor or its suppliers for the BMS.

1.6 SYSTEM PERFORMANCE

- A. Performance Standards. The BMS system shall conform to the following:
 1. Graphic Display. The system shall display a graphic with a minimum of 20 dynamic points. All current data shall be displayed within 20 seconds of the operator's request.
 2. Graphic Refresh. The system shall update all dynamic points with current data within 30 seconds.
 3. Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be 10 seconds. Analog objects shall start to adjust within 10 seconds.
 4. Object Scan. All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will be current within the prior 60 seconds.
 5. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 45 seconds.
 6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
 7. Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every 5 seconds. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
 8. Multiple Alarm Annunciations. All workstations on the network shall receive alarms within 5 seconds of each other.
 9. Reporting Accuracy. Table 1 lists minimum acceptable reporting accuracies for all values reported by the specified system.

1.7 WIRING

- A. Installation of the entire building management system shall be by skilled electricians and mechanics, all of who are properly licensed, trained and qualified for this work.
- B. All control and interlock wiring shall comply with the national and local electrical codes and Division 26 of these specifications.
- C. Where Class 2 wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used provided that:

- D. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)
- E. All cables shall be UL listed for application, i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose.
- F. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).
- G. Where class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it, and bundled, using approved wire ties at no greater than 10 ft intervals. Such bundled cable shall be fastened to the structure, using specified fasteners, at 5 ft intervals or more often to achieve a neat and workmanlike result.
- H. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- I. All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.
- J. Follow manufacturer's installation recommendations for all communication and network cabling. Network or communication cabling shall be run separately from other wiring.
- K. Supervision and checkout of the system shall be by local branch engineers and technicians directly employed by the Control contractor.
- L. Power wiring for the DDCP's, ASC's, and TEC's, shall be provided by the BMS contractor from the nearest power panel for this purpose.
- M. Electrical wiring shall be performed by qualified electricians directly subcontracted by the BMS contractor.

1.8 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Drawings shall be submitted electronically and be capable of being printed out on 11 X 17 ANSI B.
 - 1. Nomenclature of fans, pumps, etc. shall match nomenclature on the contract documents.
 - 2. Valve Schedule showing part number, description, configuration, actuator type, body and disc composition, pressure drop, and GPM.
 - 3. Damper Schedule showing dimensions, opposed or parallel, function, and actuator type.
 - 4. Schematic of each air handling system, hydronic system, etc., locating each control component on its respective unit with proper termination point identifiers

- (include legend). One schematic shall be included for each individual air handling system.
5. Each schematic shall show a chart detailing all hardware components used. The chart shall include:
 - a. Schematic Control Symbol
 - b. Quantity
 - c. Manufacturer's Part Number
 - d. Technical Sheet Reference
 - e. Description of Part
 6. Each Direct Digital Control Panel (DDCP) shall be detailed in the submittal to identify termination boards within each panel and termination of their respective field points. Each termination point shall define the point name and point description by each terminal within the field panel. Point names and descriptors shall be consistent throughout the submittal on schematics, wiring diagrams, equipment lists, etc.
 7. The Control manufacturer's technical reference sheets for each hardware component and application program shall be included in the submittal.
- C. Shop Drawings: Indicate the following:
1. Trunk cable schematic showing programmable control-unit locations and trunk data conductors.
 2. Connected data points, including connected control unit and input device.
 3. System graphic displays showing monitored systems, data (connected and calculated) point addresses, and operator notations. Submit demonstration CD or web-link containing graphics.
 4. System configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
 5. Description and sequence of operation for operating, user, and application software.
 6. Use terminology in submittals conforming to ASME MC85.1.
 7. Coordinate submittals with information requested in Section 23 09 93.
- D. Each submitted product literature and drawings shall clearly reference the specification page and section number and/or drawing number associated with the product. Include:
1. Building Controllers
 2. Custom Application Controllers
 3. Application Specific Controllers
 4. Operator Workstations
 5. Portable Operator Terminals
 6. Auxiliary Control Devices
 7. Proposed Building Automation System architectural diagram depicting various controller types, workstations, device locations, addresses, and communication cable requirements.
 8. Detailed termination drawings showing all required field and factory terminations, as well as terminal tie-ins to DDC controls provided by mechanical equipment manufacturers. Terminal numbers shall be clearly labeled.

- E. Points List: Provide a separate list of all system points. This list shall be used for sign-off by BMS contractor that each point is connected, programmed, functioning properly and mapped correctly to associated BMS graphics.
- F. Product Data: Submit data for each system component and software module.
- G. Manufacturer's Installation Instructions: Submit installation instruction for each control system component.
- H. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- I. Samples:
 - 1. Provide (1) sample of each type of space temperature sensor and carbon dioxide sensor to be installed for review by Owner.
 - 2. Provide listing of all rooms where all space sensors are to be installed; indicating the type of sensor to be installed in each room for review by Owner.
- J. Submit the following within 60 days of contract award:
- K. Project Record Documents: Upon completion of installation, submit record (as-built) documents with changes made electronically. The documents shall be submitted for approval prior to final completion and include:
 - 1. Project Record Drawings - These shall be as-built versions of the submittal shop drawings.
 - 2. Testing and Commissioning Reports and Checklists signed off by trained factory (equipment manufacturers) and field (BMS) commissioning personnel.
 - 3. Operating and Maintenance (O & M) Manuals - These shall be as-built versions of the submittal product data. In addition to the information required for the submittals, Operating & Maintenance manual shall include:
 - a. Names, address and 24-hour/7-day per week telephone numbers of Contractor personnel managing and installing equipment, along with service personnel responsible for supporting the ongoing warranty and services of the control system.
 - b. Procedures for operating the BMS including logging on/off, alarm management, generation of reports, trends, overrides of computer control, modification of setpoints, and other interactive system requirements.
 - c. Description of the programming language including syntax, statement descriptions, algorithms, calculations, point dataBMS_e creation and modification, program creation and modification, and operator use of the editor.
 - d. Explanation of how to design and install new points, new DDC controllers, and other BMS hardware.
 - e. Preventative Maintenance and calibration procedures; hardware troubleshooting; and hardware repair and/or replacement procedures.
 - f. Documentation of all software program logic created for Custom Programmable Controllers including the overall point dataBMS_e. Provide one set of magnetic media containing files of the software and point dataBMS_e.

- g. One set of electronic media containing files of all operator color graphic screens for the project.
 - h. A list of recommended spare parts including pricing, manufacturer, supplier, and part numbers.
 - i. Documentation, installation, and maintenance information for all third party hardware/software products provided including personal computers, printers, hubs, sensors, valves, etc.
 - j. Original issue media for all software provided, including operating systems, programming language, operator workstation software, and graphics software.
 - k. Licenses, Guarantee, and Warranty documents for all equipment and systems.
 - l. Recommended preventive maintenance procedures for all system components including a schedule of tasks (inspection, cleaning, calibration, etc.) and task descriptions.
- L. Training Manuals: The BMS manufacturer shall provide a course outline and copies of training manuals at least two weeks prior to the start of any corporate training class to be attended by the Owner.
- M. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
- 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.9 WARRANTY

- A. Refer to Division 1.
- B. Warrant all work as follows:
 - 1. BMS system labor and materials shall be warranted free from defects for a period of twelve (12) months after final completion acceptance by the Owner. BMS failures during the warranty period shall be adjusted, repaired, or replaced at no charge to the Owner. The BMS manufacturer shall respond to the Owner's request for warranty service within 24 hours of the initiated call and will occur during normal business hours (8AM-5PM).
 - 2. At the end of the final start-up/testing with the Cx Agent, if equipment and systems are operating satisfactorily to the Cx Agent, the Owner shall certify that the BMS is operational, and has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of the warranty period.
 - 3. Operator workstation software, project specific software, graphics, dataBMS, and firmware updates shall be provided to the Owner at no charge during the warranty period. Written authorization by the Owner must be granted prior to the installation of these updates.
 - 4. The BMS manufacturer shall provide a web-accessible Users Network for the proposed System and give the Owner free access to question/answer forum, graphics library, user tips, upgrades, and training schedules for a one year period of time correlating with the warranty period.

1.10 QUALITY ASSURANCE

- A. BMS Manufacturer Qualifications
 - 1. The BMS manufacturer shall have an established business office within 50 miles of the project site and must provide 24 hours/day, 7 days/week response in the event of a customer warranty or service call.
 - 2. The BMS Manufacturer shall have factory trained and certified personnel providing all engineering, service, startup, and commissioning field labor for the project from their local office location. BMS manufacturer shall be able to provide training certifications for all local office personnel upon request.
 - 3. The BMS shall be provided by a single manufacturer and this manufacturer's equipment must consist of operator workstation software, Web-BMS hardware/software, Open Standard Protocol hardware/software, Custom application Programming Language, Graphical Programming Language, Building Controllers, Custom Application Controllers, and Application Specific Controllers. All other products specified herein (i.e., sensors, valves, dampers, actuators, etc.) need not be manufactured by the BMS manufacturer listed in Section 2.02 of this specification.
 - 4. Independent representatives of BMS manufacturers are not acceptable. BMS vendor must be corporate owned entity of BMS manufacturer.

- B. Codes and Standards: Meet requirements of all applicable standards and codes, except when more detailed or stringent requirements are indicated by the Contract Documents, including requirements of this Section.
1. Underwriters Laboratories: Products shall be UL-916-PAZX listed.
 2. National Electrical Code -- NFPA 70.
 3. Federal Communications Commission -- Part J.
 4. ASHRAE/ANSI 135-1995 (BACnet) - (System Level Devices) - Building Controllers and PC Operator Workstations communicating on an Ethernet/IP protocol shall permit interoperability with other various building system manufacturers that are BACnet approved systems.
 5. EIA-709.1 LonTalk Standard and EIA 901.2 (LonMark Certification) - (Unit Level Devices) - Custom Application Controllers and Application Specific Controllers shall use FTT-10A transceivers and support the LonTalk communication protocol utilizing Standard Network Variable Types (SNVT) as defined by Echelon Corporation. This standard communication protocol provides interoperability with hundreds of other various building system manufacturers' control systems and devices.
- C. All products used in this installation shall be currently manufactured, and shall have been applied to a minimum of three previous projects. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner's representative in writing prior to bid date. Spare parts shall be available for at least 5 years after completion of this contract.
- D. High Performance Building Requirements:
1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.11 REMOTE MONITORING/ ALARMING

- A. As part of this contract the manufacturer shall provide system components enabling remote monitoring of the control system from a remote centralized location. (Building owner shall provide TCP/IP connection to enable remote access)
- B. Remote Monitoring shall consist of: Active Monitoring:
1. Timely detection and automatic notification of critical building system alarms 24 hours a day.
 2. Custom notification procedure by email, text message, and/or pager.
 3. Critical alarm history archive, system data backup, and reporting available by request.

1.12 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish, program and install five extra wall mounted space temperature sensors per owner/Engineer direction.

1.13 OWNERSHIP OF PROPRIETARY MATERIAL

- A. All project developed hardware and software shall become the property of the Owner. This includes but is not limited to:
 - 1. Operator Graphic files
 - 2. As-built hardware design drawings
 - 3. Operating & Maintenance Manuals
 - 4. BMS System software
 - 5. Controller application programming
 - 6. Application Specific Controller configuration files
 - 7. Required Licensed software

PART 2 PRODUCTS

2.1 DIRECT DIGITAL CONTROLS

- A. Manufacturers: Trane
 - 1. Substitutions: Not Permitted.

2.2 ARCHITECTURE/COMMUNICATION

- A. This project shall be comprised of a high speed Ethernet network utilizing BACnet/IP communications between System Controllers and Workstations. Communications between System Controllers and sub-networks of Custom Application Controllers and/or Application Specific Controllers shall utilize BACnet MSTP (RS485) communications.
 - 1. Main server shall be provided by Trane and shall be installed in the new building (Phase 1).
 - 2. Each System Controller shall perform communications to a network of Custom Application and Application Specific Controllers using BACnet/MSTP (RS485) as prescribed by the BACnet standard.
 - a. Each System Controller shall function as a BACnet Router to each unit controller providing a unique BACnet Device ID for all controllers within the system.
 - 3. The Owner will provide one high speed Ethernet network connection. An active Ethernet port will be provided adjacent to the server.
 - 4. All values within the system (i.e. schedules, datalogs, points, software variables, custom program variables) shall be readable and controllable (where appropriate) by any System Controller or BACnet Workstation on the communications network via BACnet.

2.3 OPERATOR INTERFACE

1. Provide one (1) operator's workstation and printer Workstation minimum requirements:
 2. 1 TB hard disk
 3. Dual core processor.
 4. Wireless keyboard
 5. Wireless mouse
 6. 19" LCD monitor
 7. CD-DVD-R/R
 8. Windows 8 or higher.
 9. High-performance graphics adapter
 10. Ethernet network interface card
 11. Wireless network card
 12. Color Laserjet type printer.
- B. In addition to the workstation, the building owner shall have the ability to connect to the system using any existing system on the network or that will have access to the network. Via the building owners Local Area Network the facilities personnel shall have the access to all information in the system. The operator interface shall reside on the Enterprise wide network, which is same high-speed communications network as the System Controllers. The Enterprise wide network will be provided by the owner and supports the Internet Protocol (IP). The PC BMSed operator interface must support the following:
1. Each PC BMSed operator interface shall include the following:
 - a. Hardware type
 - 1) PC
 - 2) Laptop
 - b. Operating Systems
 - 1) Windows 7
 - 2) Windows 8
 2. Operator Interface
 - a. The operator interface shall be accessible via a web browser.
 - b. Access to the operator interface shall not require any "plug-ins" (i.e. JAVA Runtime Environment (JRE), Adobe Flash) in addition to the web browsers identified below.
 - c. The operator interface shall support the following Internet web browsers:
 - 1) Internet Explorer 10.0+
 - 2) Firefox 29.0+
 - 3) Chrome 35.0+
 - d. The operator interface shall support the following mobile web browsers:
 - 1) iOS (iPad/iPhone) V6.0+
 - 2) Android (Tablet) V4.3+
 - 3) Android (Phone) V2.3+
 3. Mobile App Operator Interface
 - a. Mobile App Operator Interface shall support the following Operating systems
 - 1) Apple iOS 6
 - 2) Apple iOS 7
 - 3) Android V2.3
 - 4) Android V4.3

- 5) Android V4.4
- b. The operator interface shall support system access on a mobile device via a mobile app to:
 - 1) Alarm log
 - 2) System Status
 - 3) Equipment status
 - 4) Space Status
 - 5) Standard Equipment graphics
- c. The operator interface shall support actions on a mobile device via a mobile app to:
 - 1) Override set points
 - 2) Override occupancy
 - 3) Acknowledge Alarms
 - 4) Comment on Alarms
4. Operators Interfaces
 - a. The operator interfaces shall enable the user to view and edit data. A system security password shall be available to prevent unauthorized use of the keypad and display:
 - b. The display shall show an editable time of day schedule (with exception creating ability) for standalone applications.
 - c. Icon-Labeled Alarm Categories (Ability to easily and quickly identify alarm severities with distinctive, colorful icons)
 - d. Three Customizable Reports (Ability to select up to 36 pieces of data per report with a maximum of 3 custom reports)
 - e. Point Overrides With Timeout Feature (Ability to set up point overrides to expire at designated times)
 - f. Optional User Security (Ability to setup security for overriding/releasing points, release all overrides, custom report editing, date and time edit)
 - g. Multiple Mounting Options (Ability to be mounted inside a Trane metal enclosure, on a VESA mount (75 mm x 75 mm), or remotely mounted up to 100 meters)
 - h. Language Options (24 built in languages are supported and selectable for all screen displays)
 - i. The Local Operator Display shall have a cleaning mode that allows the screen to be cleaned while preventing inadvertent activation of touch controls.
 - j. Additional Local Operator Touch Sensitive Display Requirements
 - 1) Input power: 24 VAC +/- 15%, 50 or 60 Hz
 - 2) Storage conditions:
 - a) Temperature: -67°F to 203°F (-55°C to 95°C)
 - b) Humidity: Between 5% to 100% (condensing)
 - k. Operating Conditions:
 - 1) Temperature: -40°F to 158°F (-40°C to 70°C)
 - 2) Humidity: Between 5% to 100% (condensing)
 - l. Mounting Type: VESA (75 mm x 75 mm)
 - m. Environmental rating (enclosure): IP56 (dust and strong water jet protected)
 - n. Local Operator Touch Sensitive Display must meet the following Agency Compliance

- 1) UL916 PAZX, Open Energy Management Equipment
 - 2) UL94-5V, Flammability
 - 3) FCC CFR Title 47, Part 15.109: Class A Limit, (30 MHz – 4 GHz)
 - 4) CE EMC Directive 2004/108/EC
5. System Security
- a. Each operator shall be required to login to the system with a user name and password in order to view, edit, add, or delete data.
 - b. User Profiles shall restrict the user to only the objects, applications, and system functions as assigned by the system administrator.
 - c. Each operator shall be allowed to change their user password.
 - d. The System Administrator shall be able to manage the security for all other users.
 - e. The system shall include pre-defined “roles” that allow a system administrator to quickly assign permissions to a user.
 - f. User logon/logoff attempts shall be recorded.
 - g. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user definable.
 - h. All system security data shall be stored in an encrypted formatted dataBMSe.
 - i. DataBMSe Save. A system operator with the proper password clearance shall be able to archive the dataBMSe on the designated operator interface PC.
 - j. DataBMSe Restore. The system operator shall also be able to clear a panel dataBMSe and manually initiate a download of a specified dataBMSe to any panel in the system.
6. On-Line Help and Training
- a. Provide a context sensitive, on line help system to assist the operator in operation and configuration of the system.
 - b. On-line help shall be available for all system functions and shall provide the relevant data for each particular screen.
 - c. System Diagnostics
 - 1) The system shall automatically monitor the operation of all network connections, building management panels, and controllers.
 - 2) The failure of any device shall be annunciated to the operators.
7. Equipment & Application Pages
- a. The operator interface shall include standard pages for all equipment and applications. These pages shall allow an operator to obtain information relevant to the operation of the equipment and/or application, including:
 - 1) Animated Equipment Graphics for each major piece of equipment and floor plan in the System.
 - 2) These graphics shall show all points dynamically as specified in the points list.
 - 3) Animation capabilities shall include the ability to show a sequence of images reflecting the position of analog outputs, such as valve or damper positions. Graphics shall be capable of launching other web pages.

- 4) Alarms relevant to the equipment or application without requiring a user to navigate to an alarm page and perform a filter.
- 5) Historical Data (As defined in Automatic Trend Log section below) for the equipment or application without requiring a user to navigate to a data log page and perform a filter.
- b. System Graphics. Operator interface shall be graphically BMSed and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using colors to represent zone temperature relative to zone set point.
- c. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit set points and other specified parameters.
- d. Graphic imagery – graphics shall use 3D images for all standard and custom graphics. The only allowable exceptions will be photo images, maps, schematic drawings, and selected floor plans.
- e. Animation. Graphics shall be able to animate by displaying different Image lies for changed object status.
- f. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.
- g. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-BMSed system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).
8. Custom Graphics
 - a. The operator interface shall be capable of displaying custom graphics in order to convey the status of the facility to its operators.
 - b. Graphical Navigation. The operator interface shall provide dynamic color graphics of building areas, systems and equipment.
 - c. Graphical Data Visualization. The operator interface shall support dynamic points including analog and binary values, dynamic text, static text, and animation files.
 - d. Custom background images. Custom background images shall be created with the use of commonly available graphics packages such as Adobe Photoshop. The graphics generation package shall create and modify graphics that are saved in industry standard formats such as GIF and JPEG.
 - e. Graphics Library. Furnish a library of standard HVAC equipment such as chillers, air handlers, terminals, fan coils, unit ventilators, rooftop units, and VAV boxes, in 3-dimensional graphic depictions. The library shall be furnished in a file format compatible with the graphics generation package program.
 - f. Manual Control and Override.
 - g. Point Control. Provide a method for a user to view, override, and edit if applicable, the status of any object and property in the system. The point

- status shall be available by menu, on graphics or through custom programs.
- h. Temporary Overrides. The user shall be able to perform a temporary override wherever an override is allowed, automatically removing the override after a specified period of time.
 - i. Override Owners. The system shall convey to the user the owner of each override for all priorities that an override exists.
 - j. Provide a specific icon to show timed override or operator override, when a point, unit controller or application has been overridden manually.
9. Engineering Units
- a. Allow for selection of the desired engineering units (i.e. Inch pound or SI) in the system.
 - b. Unit selection shall be able to be customized by locality to select the desired units for each measurement.
 - c. Engineering units on this project shall be SI.
10. Scheduling. A user shall be able to perform the following tasks utilizing the operator interface:
- a. Create a new schedule, defining the default values, events and membership.
 - b. Create exceptions to a schedule for any given day.
 - c. Apply an exception that spans a single day or multiple days.
 - d. View a schedule by day, week and month.
 - e. Exception schedules and holidays shall be shown clearly on the calendar.
 - f. Modify the schedule events, members and exceptions.
11. Trend Logs
- a. Trend Logs Definition.
 - 1) The operator interface shall allow a user with the appropriate security permissions to define a trend log for any data in the system.
 - 2) The operator interface shall allow a user to define any trend log options as described in the Application and Control Software section.
 - b. Trend Log Viewer.
 - 1) The operator interface shall allow Trend Log data to be viewed and printed.
 - 2) The operator interface shall allow a user to view trend log data in text-BMSed (time –stamp/value).
 - 3) The operator shall be able to view the data collected by a trend log in a graphical chart in the operator interface.
 - 4) Trend log viewing capabilities shall include the ability to show a minimum of 5 points on a chart.
 - 5) Each data point trend line shall be displayed as a unique color.
 - 6) The operator shall be able to specify the duration of historical data to view by scrolling and zooming.
 - 7) The system shall provide a graphical trace display of the associated time stamp and value for any selected point along the x-axis.

- c. Export Trend Logs.
 - 1) The operator interface shall allow a user to export trend log data in CSV or PDF format for use by other industry standard word processing and spreadsheet packages.
12. Alarm/Event Notification
- a. An operator shall be notified of new alarms/events as they occur while navigating through any part of the system via an alarm icon.
 - b. Alarm/Event Log. The operator shall be able to view all logged system alarms/events from any operator interface.
 - 1) The operator shall be able to sort and filter alarms from events. Alarms shall be sorted in a minimum of 4 categories BMSed on severity.
 - 2) Alarm/event messages shall use full language, easily recognized descriptors.
 - 3) An operator with the proper security level may acknowledge and clear alarms/events.
 - 4) All alarms/events that have not been cleared by the operator shall be stored by the building controller.
 - 5) The alarm/event log shall include a comment field for each alarm/event that allows a user to add specific comments associated with any alarm.
 - c. Alarm Processing.
 - 1) The operator shall be able to configure any object in the system to generate an alarm when transitioning in and out of a normal state.
 - 2) The operator shall be able to configure the alarm limits, warning limits, states, and reactions for each object in the system.
13. Reports and Logs.
- a. The operator interface shall provide a reporting package that allows the operator to select reports.
 - b. The operator interface shall provide the ability to schedule reports to run at specified intervals of time.
 - c. The operator interface shall allow a user to export reports and logs from the building controller in a format that is readily accessible by other standard software applications including spreadsheets and word processing. Acceptable formats include:
 - 1) CSV, HTML, XML, PDF
 - d. Reports and logs shall be readily printed to the system printer.
 - e. Provide a means to list and access the last 10 reports viewed by the user.
 - f. The following standard reports shall be available without requiring a user to manually configure the report:
 - 1) All Points in Alarm Report: Provide an on demand report showing all current alarms.
 - 2) All Points in Override Report: Provide an on demand report showing all overrides in effect.
 - 3) Commissioning Report: Provide a one-time report that lists all equipment with the unit configuration and present operation.
 - 4) Points report: Provide a report that lists the current value of all points

14. Custom Application Programming. Provide the tools to create, modify, and debug custom application programming. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The system shall be fully operable while custom routines are edited, compiled, and downloaded.
15. Custom Graphic Editor. Provide the tools to create, modify, and debug custom graphics. The operator shall be able to create, edit, and download custom graphics at the same time that all other system applications are operating. The system shall be fully operable while custom graphics are edited, compiled, and downloaded.

2.4 APPLICATION AND CONTROL SOFTWARE

- A. Furnish the following applications software for building and energy management. All software applications shall reside and run in the system controllers. Editing of applications shall occur at the operator interface.
 1. Scheduling. Provide the capability to schedule each object or group of objects in the system. Each of these schedules shall include the capability for start, stop, optimal start, optimal stop, and night economizer actions. Each schedule may consist of up to [10] events. When a group of objects are scheduled together, provide the capability to define advances and delays for each member. Each schedule shall consist of the following:
 - a. Weekly Schedule. Provide separate schedules for each day of the week.
 - b. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. This exception schedule shall override the standard schedule for that day. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed it will be discarded and replaced by the standard schedule for that day of the week.
 - c. Holiday Schedules. Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.
 - d. Optimal Start. The scheduling application outlined above shall support an optimal start algorithm. This shall calculate the thermal characteristics of a zone and start the equipment prior to occupancy to achieve the desired space temperature at the specified occupancy time. The algorithm shall calculate separate sets of heating and cooling rates for zones that have been unoccupied for less than and greater than 24 hours. Provide the ability to modify the start algorithm BMSed on outdoor air temperature. Provide an early start limit in minutes to prevent the system from starting before an operator determined time limit.
 2. Trend Log Application
 - a. Trend log data shall be sampled and stored on the System Controller panel and shall be capable of being archived to a BACnet Workstation for longer term storage.
 - 1) Trend logs shall include interval, start-time, and stop-time.

- 2) Trend log intervals shall be configurable as frequently as 1 minute and as infrequently as 1 year.
- b. Automated Trend Logs.
 - 1) The system controller shall automatically create trend logs for defined key measurements for all controlled HVAC devices and HVAC application.
 - 2) The automatic trend logs shall monitor these parameters for a minimum of 7 days at 15 minute intervals. The automatic trend logs shall be user adjustable.
3. Alarm/Event Log
 - a. Any object in the system shall be configurable to generate an alarm when transitioning in and out of a normal or fault state.
 - b. Any object in the system shall allow the alarm limits, warning limits, states, and reactions to be configured for each object in the system.
 - c. An alarm/event shall be capable of triggering any of the following actions:
 - 1) Route the alarm/event to one or more alarm log
 - a) The alarm message shall include the name of the alarm location, the device that generated the alarm, and the alarm message itself.
 - b) Route an e-mail message to an operator(s).
 - c) Log a data point(s) for a period of time.
 - d) Run a custom control program.
4. VAV System Coordination. Provide applications software to properly coordinate and control the VAV system to ensure equipment safety and minimize energy use. This application shall perform the following functions:
 - a. Startup and shutdown the air handler safely. Ensure the VAV boxes are open sufficiently when the air handler is running, to prevent damage to the ductwork and VAV boxes due to high air pressure.
 - b. Calibrate VAV boxes.

2.5 SYSTEM CONTROLLERS

- A. There shall be one or more independent, standalone microprocessor BMSed System Controllers to manage the global strategies described in Application and Control Software section.
- B. The System Controller shall have sufficient memory to support its operating system, dataBMSe, and programming requirements.
- C. The controller shall provide a USB communications port for connection to a PC
- D. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
- E. All System Controllers shall have a real time clock.
- F. Data shall be shared between networked System Controllers.

- G. The System Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
 - 1. Assume a predetermined failure mode.
 - 2. Generate an alarm notification.
 - 3. Create a retrievable file of the state of all applicable memory locations at the time of the failure.
 - 4. Automatically reset the System Controller to return to a normal operating mode.
- H. Environment. Controller hardware shall be suitable for the anticipated ambient conditions. Controller used in conditioned ambient shall be mounted in an enclosure, and shall be rated for operation at -40 F to 122 F.
- I. Clock Synchronization.
 - 1. All System Controllers shall be able to synchronize with a NTP server for automatic time synchronization.
 - 2. All System Controllers shall be able to accept a BACnet time synchronization command for automatic time synchronization.
 - 3. All System Controllers shall automatically adjust for daylight savings time if applicable.
- J. Serviceability
 - 1. Provide diagnostic LEDs for power, communications, and processor.
 - 2. The System Controller shall have a display on the main board that indicates the current operating mode of the controller.
 - 3. All wiring connections shall be made to field removable, modular terminal connectors.
 - 4. The System controller shall utilize standard DIN mounting methods for installation and replacement.
- K. Memory. The System Controller shall maintain all BIOS and programming information indefinitely without power to the System controller
- L. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shut-down below 80% nominal voltage
- M. BACnet Test Labs (BTL) Listing. Each System Controller shall be listed as a Building Controller (B-BC) by the BACnet Test Labs with a minimum BACnet Protocol Revision of 14.

2.6 EQUIPMENT CONTROLLERS

- A. Definition: Central Plant and Air Handling Controllers are controllers that are used to control equipment or applications of medium and high complexity. Examples are controllers for Air Handlers, Boiler Plants and Chiller Plants.

- B. For Stand-Alone Operation the Central Plant and Air Handling Controllers:
1. Shall operate a schedule in a standalone application using a Real Time Clock with a 7 day power backup.
 - a. The Controller shall have a built in schedule (assessable with or without a display)\
 - b. Support will be for at least 3 schedules with up to 10 events for each day of the week.
 - c. Each of the 3 schedules can be Analog, Binary or Multi-State
 - d. The controller shall support a minimum of 25 exceptions each with up to 10 events.
 2. For ease of troubleshooting, the Controller shall support data trend logging
 - a. 25,000 samples minimum
 - b. Trends shall be capable of being collected at a minimum sample rate of once every second
 - c. Trends shall be capable of being scheduled or triggered.
 3. To meet the sequence of operation for each application, the Controller shall use library programs provided by the controller manufacturer that are either factory loaded or downloaded with service tool to the Controller.
 4. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.
 - a. Storage conditions:
 - 1) Temperature: -67°F to 203°F (-55°C to 95°C).
 - 2) Humidity: Between 5% to 100% RH (non-condensing)
 - b. Operating conditions:
 - 1) Temperature: -40°F to 158°F (-40°C to 70°C).
 - 2) Humidity: Between 5% to 100% RH (non-condensing)
 - c. Controllers used indoors shall be mounted in a NEMA 1 enclosure at a minimum
 - d. Controllers used outdoors and/or in wet ambient shall be mounted within NEMA 4 type waterproof enclosures, and shall be rated for operation at -40 F to 158 F [-40 C to 70 C].
 5. Input/Output: The Controller shall have on board or through expansion module all I/O capable of performing all functionality needed for the application. Controls provided by the equipment manufacture must supply the required I/O for the equipment. In addition other controls must meet the following requirements:
 - a. Shall support flexibility in valve type, the controllers shall be capable of supporting the following valve control types 0-10VDC, 0-5VDC, 4-20mA, 24VAC - 2 position.
 - b. Shall support flexibility in sensor type, the Controller shall be of reading sensor input ranges of 0 to10V, 0 to 20mA, 50ms or longer pulses, 200 to 20Kohm and RTD input.
 - c. Shall support flexibility in sensor type, all Analog Outputs shall have the additional capability of being programmed to operate as Universal Inputs or Pulse Width Modulation Outputs.
 - d. Shall support flexibility in sensor type, the Controller and/or expansion modules shall support dry and wetted (24VAC) binary inputs.
 - e. The controller support pulse accumulator for connecting devices like energy meters.

- f. In order to support a wide range of devices, the Controller's binary output shall be able to drive at least 10VA each.
- g. Any I/O that is unused by functionality needed for the equipment shall be available to be used by custom program on the Controller and by any other controller on the network.
- h. The Controller shall provide 24VAC and 24VDC power terminals sensors and other devices required.
- i. The Controller shall provide a dedicated static pressure input.
- 6. Input/Output Expandability – The Controller shall provide the following functionality in order to meet current and future application needs:
 - a. For the application flexibility, the Controller shall be capable of expanding to a total of at least 100 hardware I/O terminations.
 - b. Expansion I/O can be mounted up to 200m from control
 - c. Expansion I/O can be added in as small as 4 point increments.
 - d. To keep BACnet MS/TP network traffic to a minimum, expansion I/O must communicate via an internal controller communication bus (point expansion via the BACnet MS/TP network is not allowed)
- 7. Serviceability – The Controller shall provide the following in order to improve serviceability of the Controller.
 - a. Diagnostic LEDs for power/normal operation/status, BACnet communications, sensor bus communications, and binary outputs. All wiring connections shall be clearly labeled and made to be field removable.
 - b. Binary and analog inputs and outputs shall use removable connectors or be connected to terminal strip external to the control box.
 - c. Software service tool connection through all of the following methods: direct cable connection to the Controller, connection through another controller on BACnet link and through the Controller's zone sensor.
 - d. For configuration, programming, and testing of controller programs must, for safety purposes, be able to be accomplished with the power off to the equipment and the controller.
 - e. The Controller software tool service port shall utilize standard of-the-shelf USB printer cable.
 - f. Capabilities to temporarily override the BACnet point values with built-in time expiration in the Controller.
 - g. To aid in service replacement, the Controller shall easily attached to standard DIN rail mounting.
 - h. For future expansion, the Controller shall be capable of adding sequence of operation programming utilizing service tools software with a graphical programming interface (editing or programming in line code is not permissible).
 - i. To aid in service replacement, the Controller shall allow for setting its BACnet address must be rotary switches that correspond to a numerical value for the address to allow the setting of the address without the need of a service tool or the control being powered (DIP switch methodologies are not allowed).
 - j. Controller data shall persist through a power failure.

8. Software Retention: All Controller operating parameters, setpoints, BIOS, and sequence of operation code must be stored in non-volatile memory in order to maintain such information for months without power.
9. Transformer for the Controller must be rated at minimum of 115% of ASC power consumption, and shall be fused or current limiting type. 24 VAC, +/- 15% nominal, 50-60 Hz, 24 VA plus binary output loads for a maximum of 12 VA for each binary output.
10. Controller must meet the following Agency Compliance:
 - a. UL916 PAZX, Open Energy Management Equipment
 - b. UL94-5V, Flammability
 - c. FCC Part 15, Subpart B, Class B Limit
 - d. BACnet Testing Laboratory (BTL) Listed
 - e. cUL Marked for international compliance
 - f. CE Marked for international compliance

2.7 AUXILIARY CONTROL DEVICES

- A. All space temperature sensors shall be the thermistor or RTD type. The range shall be 40 - 120 degrees F. at a factory calibration point of 77 degrees F. Accuracy shall be ± 0.5 degrees F at calibration point.
 1. Vandal resistant sensors located in gymnasiums, cafeteria, locker rooms and corridors shall be stainless steel plate type with reset button.
 2. Sensors located in administrative areas, offices, classrooms, mechanical rooms, electrical rooms shall be wall mounted unless noted otherwise with bias levers and push-button bypass switches.
 - a. Override time may be set and viewed in half-hour increments; maximum override time set through BMS (adjustable). Override time count down shall be automatic, but may be reset to zero by occupant from the sensor. Time remaining shall be displayed. Display shall show the word "OFF" in unoccupied mode unless a function button is pressed.
- B. Single point duct temperature sensors shall be the thermistor or RTD type. The range shall be 40 - 150 degrees F with a factory calibration point of 77 degrees F. Accuracy shall be ± 0.5 degrees F at calibration point. These sensors shall be used in unit discharge and return air ducts.
- C. Averaging element sensors shall be the platinum element RTD type with 4 - 20 ma transmitters to eliminate any necessary calibration adjustment for wiring length. The range shall be 20 - 120 degrees F at a factory calibration point of 70 degrees F. Accuracy of the sensor at calibration point shall be ± 1.1 degrees F. These sensors shall be used in unit mixed air or preheat coil discharge sections.
- D. Outside air temperature sensor shall be the platinum element RTD type with 4 - 20 ma transmitters to eliminate any necessary calibration adjustment for wiring length. The range shall be -58 - 122 degrees F and have accuracy at calibration point ± 0.5 degrees F.
- E. Low temperature detectors (freezestats) shall be the manual reset type, two-position snap acting. Capillary shall have minimum sensitive length of 20 feet and shall be installed in serpentine fashion downstream from coil it is protecting. Each square foot of coil shall

be protected by a section of the capillary. Where large coil size or multiple coil construction exceeds the limit of coverage of one unit, provide additional units placed in series to that coil area coverage is maintained.

- F. Humidity sensors shall be commercial grade with standard 4 - 20 ma outputs. The range shall be 0 -99% RH. Stated accuracy shall be + 5% RH minimum.
- G. CO2 Sensors: Veris C Series or approved equal, microprocessor based, with LCD display, demand control ventilation interfacing, self-calibrating, five year warranty. OSensors shall use single or dual-beam absorption infrared diffusion technology (non-dispersive infrared), and shall have integral programming to perform automatic baseline calibration without user interface. The recommended manual recalibration period shall not be less than five years. Sensors shall meet or exceed the following specifications.
1. Operating conditions: 60oF to 90oF; 0 to 95% relative humidity, non-condensing
 2. CO2 sampling method: diffusion or flow-through
 3. CO2 measurement range: 0 to 10,000 ppm
 4. Sensitivity: +10 ppm
 5. Accuracy: +50 ppm from 0 to 2000 ppm, +5% of reading above 2,000 ppm
 6. The sensors shall be provided with the manufacturer's recommended calibration kit. The kit shall include sufficient material to initially calibrate every sensor provided for the project. Combination temperature/CO2 sensors are acceptable (see paragraph A, above).
- H. Carbon monoxide (CO) Sensors: Vulcain VA-201CAC or approved equal. The Control panel shall have both LED indications of alarm level status as well as LEDs for both power on and fault indication. In addition the panel shall have an LCD display which will display the location, name and gas concentration of each transmitter one at a time. The panel shall be capable of controlling up to 32 total transmitters if required in future expansions. The panel shall contain an internal silence-able alarm rated at 65dB at 3 feet. Three programmable DPDT relays shall be in the panel to control alarms or ventilation (see below).
1. CO Gas Sensors/Transmitters shall be Vulcain model VA-201T-Q1-CO-NET Transmitters for monitoring CO. These to be networked via a daisy chain wiring configuration to the VA-201CAC controller. Provide tow transmitters for each CO sensor shown.
 2. Meet the following requirements:
 - a. Range 0-500 PPM (typical setpoint shall be 300 to 400 ppm)
 - b. Two Alarm Levels
 - c. Time Delays
 - d. 10-Step LED Display
 - e. LCD Display and Keypad
 - f. Local Audible and Visual Indicators
 - g. Microprocessor-Based Operating System
 - h. Electrochemical Cells
- I. Water temperature sensors shall be well-mounted insertion liquid temperature sensor, platinum element with a 4 - 20 ma signal. The ranges used shall be appropriate with the application. The range applied for sensing hot water temperature shall be 70-220 degrees F and for sensing chilled and condenser water temperatures shall be 20-120 degrees F.

- J. Differential Pressure Switches: The differential pressure range of the switch shall be selected to suit the application and shall have an adjustable set point. The switch shall have SPDT contacts rated at 9 amperes at 120 volt AC and be UL approved. The switch shall be mounted with the diagram in a vertical plan. The switch shall be capable of withstanding full system pressure on either side of the sensing element with atmospheric pressure on the other side, without damage to the switch or degradation of its calibration. Dwyer AFS-262 for air and Penn P74 for liquid or approved equal.
- K. Temperature, Pressure, Flow and Level Transmitters: Transmitters shall produce a 4 to 20 mA output linearly proportional to the measured variable, with a minimum accuracy of .5% of the transmitter range. The range shall not exceed 200% of the measured variable's normal maximum value. Differential pressure transmitters shall be Kele and Associates Model 360C or approved equal.
- L. Duct (or System) Static Pressure Measuring Devices: Provide, where indicated, duct static measuring devices capable of continuously monitoring the duct or system static pressure it serves.
1. The pressure range of the switch shall be selected to suit the application and shall have an adjustable set point and deadband. The switch shall have at least one SPDT contact rated at 9 amperes at 120 volt AC and be UL approved.
 2. The duct static traverse probe shall be of extruded aluminum construction and (except for 3/4" diameter probes with lengths of 24" or less) be complete with threaded end support rod, sealing washer and nut, and mounting plate with gasket and static pressure signal fitting. The static traverse probe shall be capable of producing a steady, non-pulsating signal of standard static pressure, without need for correction factors, with an instrument accuracy of 0.5%.
 3. Pressure Transmitters shall be the 4 - 20 ma output type with zero and span adjustments. The range shall be 0-00.5", 0-1", 0-2", 0-5", or 0-10" w.c. as required by the application. Combined static error (non-linearity and hysteresis) shall be $\pm 1\%$ of full range output. Transmitters shall be supplied to transmit a 4-20 ma signal to the DDCP for every flow measuring station and duct static pressure traverse probe.
- M. Airflow Measuring / Monitoring Stations - Fan inlets with round cowlings:
1. Air Monitor Corporation VOLU-probe/FI or approved equal. The measuring station shall not significantly impact fan performance or contribute to fan generated noise levels. The probes shall be capable of producing steady, non-pulsating signals of standard total and static pressure, without need for flow corrections or factors, with an accuracy of 3% of actual flow over a fan operating range of 6 to 1 capacity turndown.
 2. Transmitter shall be the Air Monitor Corporation VELTRON DPT 2500I; 24 VAC power with 4-20 ma output signal. Transmitter shall have an accuracy of $\pm 0.5\%$ of Natural Span and be furnished with a built-in 3-way zeroing valve, user selectable square root function, and integral 3½ digit scalable LCD for display of measured process. The Transmitter shall be housed in a NEMA 12 steel enclosure with universal 1/8" FPT signal connection ports

- N. Airflow Measuring / Monitoring Stations – Duct mounted, outside air hoods, exhaust hoods and all other applications:
1. EBTRON, Inc. Model GTx116 transmitter with Model GP1 Gold Series Probes. Gold Series probes shall be thermal dispersion airflow and temperature measurement device. Accuracy shall be 3% or better of actual flow over 0 to 5,000 fpm velocities. Each measurement device shall consist of one or more sensor probe assemblies. Multiple sensor housings shall be equally weighted and averaged by the transmitter prior to output. Provide stand-off mounting hardware when installing probes inside the casing of air handling equipment. Modify air handling unit hoods to provide laminar airflow across measuring station to guarantee 3% or better accuracy.
 2. Transmitter shall be 24 VAC power with 4-20 ma output signal. Transmitter shall include LCD for display.
- O. Aquastats shall be pipe mounted, 24 VAC.
- P. Wall mounted switches shall be toggle type, 24 VAC.
- Q. Water leak detectors shall be probe type, 24 VAC; Dwyer WD3 with mounting bracket or approved equal. Provide with DPDT relay and audible alarm.
- R. Refrigerant Monitor shall be MSA Chillgard LE Photoacoustic Infrared, TOX-ALERT or approved equal. Monitor shall be 4 point pump, 120 volt power, with 4-20 ma and RS-485 output signals. Monitor shall have a 1 to 1000 ppm operating range with minimum delectability of 20 ppm. Provide with alarm beacon and 100 db horn. Provide standard filters and two extra filters as spares.
- S. Audio/Visual Alarms shall be Kele Model AIS alarm indication station with visual alarm, audible alarm, silence button dry input contact and 24 VAC power.
- T. Occupancy sensors shall be ceiling mounted, 24 VAC power, with two (2) dry contacts, programmable off time period and programmable sensitivity level. Provide two sensors in rooms as required by manufacturer to provide proper room coverage.
- U. Glycol Refractometer (GR) shall be AFAB Enterprises Model PR-111, Misco Model M-111 or approved equal. Power supply shall be 120V, 1 phase or 24 VAC, 1 phase. BMS contractor shall provide branch circuit power to device. GR shall be provided with stainless steel sensing element, 4-20 mA output and 0-100% analog display meter. Provide adapters for varying pipe sizes. GR shall be calibrated over a 60°F range for types of glycol and % of solution as shown on the drawings.
- V. Pressure gauges and differential pressure gauges shall be Trerice 600 Series or approved equal. Provide Type M copper tubing with shut-off cocks.
- W. Other miscellaneous devices shall be 24 volt power.

2.8 CONTROL DAMPERS AND MOTORIZED DAMPERS

- A. All dampers shall be Tamco Model 9000 BF; thermally insulated and thermally broken or approved equal.
- B. Extruded aluminum (6063T5) damper frame shall not be less than .080" thickness. Damper frame to be 4" deep. Entire frame shall be thermally broken by means of polyurethane resin pockets, complete with thermal cuts.
- C. Blades to be extruded aluminum (6063T5) profiles, internally insulated with expanded polyurethane foam and shall be thermally broken. Complete blade shall have an insulating factor of R-2.29 and a temperature index of 55. Blade and frame seals shall be of extruded silicone and be secured in an integral slot within the aluminum extrusions.
- D. Maintenance-free bearings are to be composed of a Celcon inner bearing fixed to a 7/16" (11.11mm) aluminum hexagon blade pin, rotating within a polycarbonate outer bearing inserted in the frame, resulting in no metal-to-metal or metal-to-plastic contact.
- E. Linkage hardware shall be installed in the frame side and constructed of aluminum and corrosion-resistant, zinc-plated steel, complete with cup-point trunnion screws for a slip-proof grip.
- F. Modulating dampers (designated with "AO" shall be opposed blade action. Open/close dampers (designated with "DO") shall be parallel blade action.
- G. Leakage shall not exceed 3 cfm/ft² against 1" w.g. differential static pressure. Pressure drop of a fully open 48" x 48" damper shall not exceed .03" w.g. at 1000 fpm.
- H. Dampers shall be made to size required without blanking off free area. Dampers shall be available as "Flanged to Duct" mounting type.
- I. Damper Actuators shall be Belimo electronic type and shall be either fully proportional spring return or two-position spring return as described in the sequence of operation and as shown on the control drawings. Damper operators shall be located outside the air stream. Damper actuators shall be of sufficient size to operate their respective dampers effectively. End switches shall be provided for all actuators. BMS shall connect and monitor end switches as indicated on Mechanical Control Drawings, related mechanical drawings and Specification Section 230993.

2.9 CONTROL VALVES – DIGITAL SIGNAL

- A. Control valves shall be 24VAC, two-position, spring-return, normally open with a maximum differential pressure of 60 PSIG. MNG zone valve with therm electric zone valve actuator or approved equal
- B. Spring return, electronic motor actuators shall position control valves. All valves shall have shutoff discs and V-ring packing. Valve sizes of 1/2 through 2 inches shall be furnished with screwed or soldered ends with stainless steel or bronze trim to suit the application. Flanged valves with bronze trim shall be furnished for sizes 2 1/2 inch and

larger. Lug type butterfly valves with bronze discs and disc seals suitable for the medium and expected temperature range may be used for valve sizes of 5 inch or larger provided that the control signal for modulating valve applications employs both proportional and integral algorithms. The minimum rating for valve bodies shall be ANSI class 125.

- C. The BMS contractor shall size each control valve to provide the proper flow rate at the available differential pressure, and shall include the Cv of each valve in his submittal.

2.10 CONTROL VALVES – ANALOG SIGNAL

- A. The electronic actuator shall mount on the valve body and provide complete modulating control of the valve. The electronic actuator shall receive a 24 VAC floating control signal, 0-10vdc or 4-20ma to control the valve. Valves shall be bronze body with stainless steel trim. The minimum rating for valve bodies shall be ANSI class 125, Belimo or approved equal.
- B. Valves 2 1/2 inches or less shall be globe valve style or ball valve produced for modulating control (“equal percentage valve”). Globe valves shall be bronze body, bronze trim, screwed bonnet, non-asbestos packing, renewable composition disc and bronze seat, Class 125, threaded or solder ends. Ball valves shall be bronze two piece body, blowout-proof stem, stainless steel ball with Teflon insert, Teflon seats and packing with solder or threaded ends
- C. Valves 3 inches and over shall be globe valve style with iron body, bronze trim, bolted bonnet, non-asbestos packing, rotating plug-type disc with renewable seat ring and disc, Class 125, flanged ends.

2.11 VARIABLE FREQUENCY DRIVES

- A. Manufacturers: Allen Bradley ACH500; no substitutions.
- B. DESCRIPTION
 1. Enclosed variable frequency controllers suitable for operating the indicated loads, in conformance with requirements of NEMA ICS 7.
 2. Select unspecified features and options in accordance with NEMA ICS 3.1.
- C. RATINGS
 1. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.
 2. Operating Ambient: 0 degrees C to 40 degrees C.
- D. DESIGN
 1. Employ microprocessor-based inverter logic isolated from power circuits.
 2. Employ pulse-width-modulated inverter system.
 3. Design for ability to operate controller with motor disconnected from output.
 4. Design to attempt five automatic restarts following fault condition before locking out and requiring manual restart.

E. PRODUCT OPTIONS AND FEATURES

1. Display: Provide integral digital display to indicate output voltage, output frequency, and output current.
2. Status Indicators: Separate indicators for overcurrent, overvoltage, ground fault, overtemperature, and input power ON.
3. Volts Per Hertz Adjustment: Plus or minus 10 percent.
4. Current Limit Adjustment: 60 - 110 percent of rated.
5. Acceleration Rate Adjustment: 0.5 - 30 seconds.
6. Deceleration Rate Adjustment: 1 - 30 seconds.
7. Furnish HAND-OFF-AUTOMATIC selector switch and manual speed control.
8. Input/Output Signals:
 - a. 4-20 mA input central signal.
 - b. 4-20 mA output feedback signal.
 - c. Contact closure for general alarm output.
9. Door Interlocks: Furnish mechanical means to prevent opening of equipment with power connected, or to disconnect power if door is opened; include means for defeating interlock by qualified persons.
10. Safety Interlocks: Furnish terminals for remote contact to inhibit starting under both manual and automatic mode.
11. Control Interlocks: Furnish terminals for remote contact to allow starting in automatic mode.
12. Manual Bypass: Furnish contactor, motor running overload protection, and short circuit protection for full voltage, non-reversing operation of the motor. Include isolation switch to allow maintenance of inverter during bypass operation.
13. Disconnecting Means: Include integral fused disconnect switch on the line side of each controller.

F. FABRICATION

1. Wiring Terminations: Match conductor materials and sizes indicated.
2. Enclosure: NEMA 250, Type 1.
3. Finish: Manufacturer's standard enamel.

PART 3 EXECUTION

3.1 EXAMINATION

- A. The Contract Documents shall be thoroughly examined for coordination of control devices their installation, wiring, and commissioning. Coordinate and review mechanical equipment specifications, locations, and identify any discrepancies, conflicts, or omissions that shall be reported to the Architect/Engineer for resolution before rough-in work is started.
- B. The BMS manufacturer shall inspect the jobsite in order to verify that control equipment can be installed as required, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

3.2 GENERAL WORKMANSHIP

- A. Install equipment, piping, wiring/conduit, parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Install all equipment in readily accessible location as defined by National Electric Code (NEC). Control panels shall be attached to structural walls or properly supported in a free-standing configuration, unless mounted in equipment enclosure specifically designed for that purpose. Panels shall be mounted to allow for unobstructed access for service.
- D. Verify integrity of all control wiring to ensure continuity and freedom from shorts and grounds prior to commencing the startup and commissioning procedures.
- E. All control device installation, and wiring shall comply with Contract Documents, acceptable industry specifications, and industry standards for performance, reliability, and compatibility. Installation and wiring shall be executed in strict adherence to local codes and standard practices referenced in Contract Documents.

3.3 INSTALLATION OF COMPONENTS

- A. Locate and install components for easy accessibility; in general, mount 48 inches above floor with minimum 3'-0" clear access space in front of units where not subject to excessive vibration. Obtain approval on locations from owner's representative prior to installation.
- B. Install software in control units and in operator workstation. Implement features of programs to specified requirements and appropriate to sequence of operations.
- C. Extend 120 VAC power to control transformers at locations shown on the drawings. Provide control transformers and low voltage wiring to all control components including sensors, actuators, etc.
- D. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture and high or low temperatures.
- E. Provide stainless steel or brass thermowells suitable for respective application and for installation under other sections—sized to suit pipe diameter without restricting flow.
- F. Glycol Refractometer (GR) shall be installed in 1" bypass line with isolation valves and manual type balance valve. Bypass line shall be installed from pump suction to pump discharge.
- G. Install outdoor air temperature sensors on north wall complete with sun shield at manufacturer's recommended location.

- H. Control components shall be calibrated against actual measurement of flow, temperature, humidity, etc. as recorded in conjunction with Specification Section 230593.

3.4 IDENTIFICATION OF HARDWARE AND WIRING

- A. BMS manufacturer to coordinate labeling nomenclature with mechanical equipment manufacturer and other contractors.
- B. All field wiring and cabling shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information for troubleshooting, maintenance, and service purposes.
- C. At each control panel and controller, provide as-built drawing (maximum size 11x17) inside each controller listing each terminal point and descriptive information for troubleshooting, maintenance, and service purposes.
- D. Identify control panels and controllers with minimum 1-cm letters on laminated plastic nameplates.
- E. Identify relays with P-touch type labeler.
- F. Identifiers shall match record documents. All plug-in components shall be labeled such that removal of the component does not remove the label.

3.5 PROGRAMMING

- A. Provide sufficient internal memory for all controllers to ensure specified sequence of operations, alarming, trending, and reporting requirements are achieved. BMS manufacturer shall provide a minimum of 25% spare memory capacity for future use.
- B. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index.
- C. Software Programming
 - 1. Provide programming for individual mechanical systems to achieve all aspects of the sequence of operation specified. It is the BMS manufacturer's responsibility to ensure all mechanical equipment functions and operates as specified in sequence of operations. Provide sufficient programming comments in controller application software to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations.
- D. BMS Operator's Interface
 - 1. At the Operator Workstations, provide color graphics for each piece of mechanical equipment depicting sufficient I/O to monitor and troubleshoot operation. Additionally, provide individual floor plans of the building allowing an operator to quickly view the overall floor plan area for any out of tolerance conditions that may need addressing. These standard graphics shall depict all points dynamically as specified in the points list and/or indicated in sequence of operation.

2. The BMS manufacturer shall provide all the labor necessary to install, initialize, start-up, and trouble-shoot all operator interface software and their functions as described in this section. This includes any operating system software, the operator interface data BMSe, and any third party software installation and integration required for successful operation of the operator interface.
3. As part of this execution phase, the BMS manufacturer shall perform a complete test of the operator interface.

3.6 TRAINING

- A. Provide minimum of (2) classroom training sessions, and (4) hours for each session, throughout the contract period. The training will be provided for personnel designated by the Owner.
- B. The Owner training shall enable personnel to proficiently operate the BMS by being able to create, modify and delete programming; add, remove and modify physical points for individual controllers; and add additional controllers when required.
- C. These objectives will be divided into three logical groupings; participants may attend one or more of these, depending on level of knowledge required:
 1. Day-to-day BMS Operators
 2. BMS Troubleshooting & Maintenance
 3. Maintenance Manager: Parts Inventory
- D. Provide course outline and materials prior to schedule training session. The instructor(s) shall provide one copy of training material per student.
- E. The instructor(s) shall be factory-trained and experienced in teaching this technical material.
- F. In addition to classroom training, provide 32 hours of training on site during normal working hours.

3.7 ACCEPTANCE

- A. The BMS will not be accepted as meeting the requirements of Completion until all tests described on the Contract Documents have been performed to the satisfaction of both the Cx Agent and Owner.

END OF SECTION

SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes sequence of operation for:
1. Air handling units.
 2. ERV's
 3. DOAS
 4. Fans.
 5. Variable refrigerant flow (VRF) systems.
 6. Radiation
 7. Refrigeration systems.
 8. Air terminal units.
 9. Unit heaters and cabinet unit heaters.
 10. Boiler Plant.
 11. Chiller Plant.
 12. Hot and chilled water pumps.
 13. Combustion air.
 14. Pool water heating and heat recovery.
 15. Pressure controls.
 16. Dehumidification Unit DU-1.
 17. Heating and cooling monitoring and controls.
 18. Airflow monitoring and controls.
 19. Utility monitoring.
 20. Miscellaneous monitoring.
- B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
 2. Section 23 08 00 –Commissioning of HVAC Systems
 3. Section 23 09 23 - Direct-Digital Control System for HVAC: For equipment, devices, system components, and software to implement sequences of operation.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate mechanical system controlled and control system components.
 - 1. Label with settings, adjustable range of control and limits. Submit written description of control sequence.
 - 2. Submit flow diagrams for each control system, graphically depicting control logic.
 - 3. Submit draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
 - 4. Coordinate submittals with information requested in Section 23 09 23.
- C. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

1.6 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 CONTROL DEVICES

- A. All devices and sensors shall be adjustable. BMS shall display setpoints and actual conditions of all control devices and position of all actuators at the central personal computer (PC).

3.2 GENERAL DEVICES

- A. Variable Frequency Drives: BMS shall control start/stop of each VFD and shall monitor a general alarm contact at the VFD. If the VFD is in alarm mode, an alarm shall be activated at the central PC. BMS shall control speed of each VFD and monitor speed feedback.
- B. Alarm Contacts: BMS shall monitor alarm contacts as shown on the drawings. If a device is in alarm mode, an alarm shall be activated at the central PC.
- C. Fire Alarm: If fire alarm system is in alarm mode, BMS shall disengage controls associated with all fan system (in addition to hard wire shutdowns). When signal is received from the fire alarm system that all alarms are "cleared"; BMS shall restart all fan system incrementally.

- D. Filter Differential Pressure Transmitters: BMS shall monitor DPT's and alarm if the differential pressure is above setpoint.
- E. Space Differential Pressure Sensors: BMS shall monitor space sensors as shown on the drawings.
- F. Carbon Monoxide: BMS shall monitor and display alarms. If levels rise above setpoint, respective exhaust fan(s) shall start and heating and ventilating units shall start and provide 100% outside air. At the boiler room, boilers, chiller and water heater shall be shut down.
- G. Carbon Dioxide at Exterior of the Building: BMS shall monitor and record carbon dioxide levels.
- H. Leak Detector: If a detector is in alarm mode, the BMS shall shut down the respect fan, AC unit, VRF, etc. and an alarm shall be activated at the central PC.
- I. Ductless Split AC Units: BMS shall monitor temperature sensor for alarm conditions. BMS shall monitor leak detector. If BMS detect water in the secondary drain pan, AC unit shall be shut down and an alarm shall occur at central PC
- J. Emergency Generator: BMS shall monitor operations of the generator. If generator is on (not test mode), BMS shall shut down operation of chiller plant, AHU's, DOAS units, VRF units and CU's serving VRF units. After normal power is restored (signal from generator), BMS shall stage equipment back on incrementally.

3.3 DOMESTIC HOT WATER AND PUMPS

- A. Water Heater Scheduling: Water heater on-off shall be controlled per a time of day schedule and shall be activated during occupied modes.
- B. Domestic Hot Water Recirculating Pump: Pump shall be controlled per a time of day schedule and shall be activated during occupied modes.

3.4 GLYCOL/WATER SOLUTION MAKEUP AND REFRACTOMETER FOR GLYCOL

- A. Glycol Make-up: BMS shall monitor pressure transmitter. When pressure is below setpoint, BMS shall activate respective glycol makeup pump. When pressure is at setpoint, pump shall stop.
- B. BMS shall monitor general alarm output at each glycol makeup unit.
- C. Glycol refractometer: BMS shall alarm when % glycol is below setpoint.

3.5 FAN SEQUENCES OF OPERATION

- A. All Fans: BMS shall monitor the operation or failure (fan status) through a current sensing relay switch. For fans with variable frequency drives (VFD), BMS shall monitor fan status through an alarm output contact at the VFD. If fan has been signaled to start

and feedback from the relay or VFD does not indicate the fan has started after 30 seconds, fan shall be shut down and an alarm shall be activated at the central PC. If damper end switches do not indicate respective dampers are open, fan shall be shut down and an alarm shall be activated at the central PC. Conversely, if status is detected while the fan is turned off or a damper is indicated open, a separate "Hand" alarm shall be generated.

- B. All fans shall be programmed to operate or allow to be operated per individual time of day program.
- C. Lab Prep Room (LEF's): Fans shall be monitored for failure by both DPT and current sensing transformer.
- D. Lab Exhaust Fan Serving Room: Fan shall operate continuously.
- E. Lab Exhaust Fan serving Hood: Fans shall be interlocked with the makeup air VAV boxes serving the spaces. LEF shall be activated via a toggle switch on the fume hood.
- F. Temperature Controls: Upon a rise in space temperature above sensor setpoint, respective fan shall start. Respective intake damper shall open (where shown on the drawings).
- G. Time of Day: Associated motorized dampers shall open and respective fan shall start only during scheduled occupied modes.
- H. Fans Controlled by Toggle Switches and Twist Type Timer Switches. Associated motorized dampers shall open and respective fan(s) shall start only when switch is in the "on" position.
- I. EF-4 serving outdoor storage: Fan shall run continuously on low speed. If switch is activated, fan shall operate at high speed. If temp rises above 90F, fan shall operate at high speed.
- J. Fans Served by a Differential Pressure Transmitters: If differential pressure is below setpoint, an alarm shall be activated at the central PC.
- K. Fan serving Boiler Room:
 - 1. Refrigerant Monitor: If the trouble contact closes, an alarm shall be activated at the central PC. If the alarm contact closes, fan shall start and boilers, chillers and water heaters shall be de-activated and an alarm shall be activated at the central PC.
- L. KEF-1 and KEF-2:
 - 1. Fan shall start when switch is in the "on" position. Operation shall be subject to a Time of Day schedule.
 - 2. Fan shall automatically start if the temperature at the hood sensor is above setpoint. This operation shall not be subject to a time of day schedule.

3. If an alarm signal is received from the Kitchen fire suppression panel or Kitchen refrigerant monitoring panel, KEF-1 shall start. This operation shall not be subject to a time of day schedule
4. If KEF-1 is signaled to be on, respective AHU shall start and outside air damper shall be at maximum open position as listed at the unit's equipment schedule.
5. BMS shall monitor kitchen space temperature (monitor only).

3.6 HYDRONIC HEATING UNITS

- A. Cabinet Unit Heater/Unit Heater: Upon a drop in space temperature below sensor setpoint, respective heating valve shall open and fan shall be energized subject to aquastat sensing hot water at the supply branch piping. Temp sensors shall be analog input signals to BMS. Control wiring shall be low voltage, not line voltage. Fan shall not start until aquastat senses hot water.
- B. Fin Tube Radiation: Upon a drop in space temperature below sensor setpoint, respective heating valve shall open in order to maintain desired space temperature setpoint. Radiation control for areas served by VAV boxes shall be sequenced together with the respective VAV box valve in order to maintain desired space temperature setpoint.
- C. Duct Mounted Coils: Upon a drop in space temperature below sensor setpoint, respective heating valve shall modulate to maintain supply air temperature setpoint, reset in accordance with space temperature. Duct mounted temperature sensors and space temperature sensors shall be analog input signals.

3.7 DUCT MOUNTED HEATING COILS

- A. Duct Mounted Coils: Upon a drop in space temperature below sensor setpoint, respective heating valve shall modulate to maintain supply air temperature setpoint, reset in accordance with space temperature. Duct mounted temperature sensors and space temperature sensors shall be analog input signals.

3.8 DUCTLESS SPLIT AC UNIT

- A. BMS shall monitor temperature independent of unit's sensor. If temperature rises above 85F, BMS shall send an alarm to central PC.
- B. BMS shall monitor lead detector in the secondary drain pan. If sensor detects leak, BMS shall shut down the AC unit and send an alarm to central PC

3.9 VAV AND CV BOXES (TYPICAL SOP UNLESS NOTED OTHERWISE)

- A. Occupied Mode
 1. When zone temperature rises above its cooling setpoint and cool air is available from the AHU, a cooling PID algorithm will modulate the control damper between the minimum occupied airflow and the maximum design cooling airflow until the zone is satisfied.

2. When the zone temperature is between the cooling setpoint and the heating setpoint, the zone controller will maintain the minimum occupied airflow, providing no less than the minimum required zone ventilation.
 3. When zone temperature falls below its heating setpoint, a heating PID algorithm will modulate open the heating valve to maintain the zone temperature at its heating setpoint. Additionally, if warm air is available from the AHU, the heating PID algorithm can modulate the control damper between the greater of the minimum occupied airflow or the minimum heating airflow and the maximum design heating airflow until the zone is satisfied.
 4. Where more than one space temperature sensor serves a VAV box, the temperatures shall be averaged with absolute minimum –maximum setpoint programmed to override the average temperature.
- B. Night Setback / Unoccupied Mode: When the zone is unoccupied, the zone controller will raise the cooling setpoint to 85°F, drop the heating setpoint to 65°F, and drop the minimum required airflow to 0 CFM. Space temperature sensors shall have an override button to change the VAV box from unoccupied to occupied mode for 3 hours.
- C. Airflow monitoring: Pressure readings at the inlet of each VAV box shall be monitored to determine actual airflow at each box. Airflow shall be displayed at central PC graphics. Airflow setpoints (minimum, maximum and heating mode) shall be displayed on the graphic for each individual VAV box.
- D. Hot Water Coils: See sequences below.
- E. Demand Control Ventilation
1. BMS shall monitor carbon dioxide (CO₂) sensors. If CO₂ levels rise above high level setpoint, BMS shall modulate respective VAV box open.
 2. Also refer to AHU control sequences of operation.
 3. If CO₂ levels rise above high level setpoint for a period of 30 minutes, an alarm shall occur at the central PC.
- F. Alarms
1. An alarm will be generated if the space temperature remains 4°F higher than its cooling setpoint or 4°F lower than its heating setpoint for 5 minutes. This alarm will not be enabled until the zone has been running for 30 minutes.
 2. Temperature sensor at the discharge of the VAV box shall be monitored.
 3. An alarm shall be generated if the supply air temperature is below 50°F or above 120°F. An alarm shall be generated if the supply air temperature is below 50°F or above 120°F. This alarm will not be enabled until the zone has been running for 30 minutes.

3.10 VAV BOXES – OCCUPANCY SENSOR

- A. Space Occupied Mode: BMS shall monitor space occupancy sensor. If sensor indicates space is occupied, respective Supply Air and Exhaust Air VAV boxes shall move to the maximum airflow position.

- B. Space Unoccupied Mode: BMS shall monitor space occupancy sensor. If sensor indicates space is unoccupied after a period of 10 minutes (adjustable), respective Supply Air and Exhaust Air VAV boxes shall move to the minimum airflow position.
- C. BMS shall monitor airflows at each VAV box and shall adjust output signal to maintain correct airflow setting.
- D. Airflow monitoring: Pressure readings at the inlet of each VAV box shall be monitored to determine actual airflow at each box. Airflow shall be displayed at central PC graphics. Airflow setpoints (minimum and maximum modes) shall be displayed on the graphic for each individual VAV box.

3.11 VAV BOXES SERVING VRF UNITS

- A. BMS shall monitor CO2 space sensors.
- B. If CO2 levels rise above setpoint, BMS shall modulate the respective Supply Air and Exhaust Air VAV boxes open incrementally.
- C. If CO2 levels fall below setpoint, BMS shall modulate the respective Supply Air and Exhaust Air VAV boxes closed incrementally.
- D. Airflow monitoring: Pressure readings at the inlet of each VAV box shall be monitored to determine actual airflow at each box. Airflow shall be displayed at central PC graphics. Airflow setpoints (minimum and maximum modes) shall be displayed on the graphic for each individual VAV box.

3.12 VAV BOXES – CORRIDORS WITHOUT HOT WATER COILS

- A. BMS shall monitor airflows at each VAV box and shall adjust output signal to maintain correct airflow setting (constant volume).
- B. Airflow monitoring: Pressure readings at the inlet of each VAV box shall be monitored to determine actual airflow at each box. Airflow shall be displayed at central PC graphics. Airflow setpoints shall be displayed on the graphic for each individual VAV box.

3.13 VARIABLE REFRIGERANT VOLUME (VRF) SYSTEM

- A. The BMS Contractor shall be responsible for installing and wiring all VRF manufacturer supplied control material including system controller, area controllers, and sensors. BMS Contractor will also provide all interlock communication wiring between VRF controllers, indoor units and outdoor units.
- B. The BMS system shall communicate with the VRF control system via BACnet IP communication protocol.
- C. Occupied: The VRF supply fan shall run continuously and the unit shall cycle the heating or cooling capacity on based upon zone demand.

- D. Unoccupied: The VRF supply fan shall be off. The unit shall cycle the fan and the heating or cooling capacity on based upon zone demand.
- E. BMS shall monitor space temperature and control cooling mode or heating mode at each VRF. If space temperature rises above the cooling setpoint, the BMS shall command the VRF zone to cooling mode. When cooling or heating is commanded on, the VRF shall modulate capacity based on its own return air temperature. The BMS shall monitor the VRF for status and fault and display the information at the central PC.
 - 1. VRF's with duct mounted hot water coil: If zone temperature falls below the heating setpoint, BMS shall command the VRF to heating mode. If the temperature continues to fall below setpoint, the respective duct mounted hot water coil shall be activated as a second stage of heat.
 - 2. VRF's with fin-tube radiation: If zone temperature falls below the heating setpoint, the BMS shall command the VRF and fin-tube radiation together to heating mode.

3.14 CHILLERS AND PRIMARY CHILLED WATER (CHW) PUMPING SYSTEMS

- A. Operation of Chillers. Chiller Plant shall be enabled when the outside air temperature rises above 80°F (adjustable). Minimum ON/OFF times will prevent short-cycling of chillers and pumps. When chiller plant is enabled, lead secondary chilled water pump shall start (see Secondary Pumping Systems Description below).
 - 1. When a chiller is enabled, respective primary chilled water pump shall start and control valve shall open. Chiller shall not start until flow is proven through respective flow switches. If flow status is not proven, lead chiller shall not be energized, lag chiller shall be energized and an alarm shall be activated at the central PC. Pumps are equipped with VFD's for balancing purposes only purposes.
 - 2. Chillers shall be sequenced as required to maintain desired set point through a lead/lag array. Alternation of chiller lead/lag designation shall be based on operator defined run times. BMS shall monitor secondary chilled water flow rates and temperatures and chiller control panel for demand to start and stop lag chiller.
 - 3. Each chiller shall stage through its internal controls to maintain chilled water supply setpoint. Chiller shall monitor CHW return temperature to determine staging.
 - 4. Shut down: When chiller is de-energized, respective pumps shall continue to run for 5 minutes and then turn off. Pumps shall not stop until confirmation that respective chiller's compressor has shut down (chiller stop confirmation).
 - 5. CHW supply temperature setpoint shall be reset based upon position and demand at each CHW valve. If no zone is in the maximum cooling position, the CHW supply temperature setpoint is decreased. This reset function is based on the following operator changeable variables. They are:
 - a. The length of time between reset adjustments.
 - b. The decrease in CHW supply temperature setpoint that is desired when the CHW valve its maximum open position.
 - c. The increase in CHW supply temperature setpoint that is desired when none of the CHW valves are in a maximum open position.
 - d. Demand for dehumidification.

- B. Refrigerant Monitor: BMS shall monitor the refrigerant monitor. Upon an alarm signal, boilers and water heater shall be deactivated, EF-1 shall start and respective outside air motorized damper shall open. An alarm shall occur through the central BMS.
- C. Chiller Demand Limiting: Chiller sequencing through chillers or BMS shall be capable of monitoring and reducing peak power demand through the limiting of chiller system capacity.

3.15 BOILERS AND BOILER PRIMARY HOT WATER (HW) PUMPING SYSTEMS

- A. The BMS contractor shall be responsible for installation and wiring of the Boiler Manufacturer Control Panel, Outdoor Sensors, Supply and Return Temperature Sensors, Individual Boiler Supply and Return Temperature sensors, and interlock wiring of the primary pumps and individual boiler isolation valves.
- B. Boiler plant shall be allowed to operate (enable / disable) when OA temperature is below 65F.
- C. BMS shall interface with controls listed below and shall be capable of reading and displaying the follow points from the boiler's BMS interface:
 - 1. Enable / disable output signal
 - 2. Boiler status feedback – on/ off
 - 3. Burner operating status – on/off.
 - 4. General alarm output signal
 - 5. Hot water supply temperature
 - 6. Hot water return temperature
- D. Once the hot water system flow is established, the BMS shall enable the Boiler Manufacturer Control Panel via the BACnet communication interface. The BMS shall monitor the boilers status and alarms via the communication interface, and monitor the dry contact alarm at the central Boiler Control Panel. The BMS contractor shall be responsible for installation and wiring of the Boiler Manufacturer Control Panel, Outdoor, System Supply and Return Temperature, and Individual Boiler Supply and Return Temperature sensors, and interlock wiring of the primary pumps and individual boiler isolation valves.
- E. Once enable, the boiler manufacturer control panel will command the isolation valves and primary pumps, and enable and modulate the boilers in sequence based on its on outdoor air reset curve (adj.) to maintain supply water temperature at the reset setpoint.
- F. The BMS shall monitor boiler room CO. If either gas is detected, the BMS shall command the combustion air dampers open, and disable the boiler control panel via the BACnet interface. Fan serving the boiler room shall start.
- G. The BMS shall monitor hot water supply and return temperatures at locations shown on the floor plans independent form the boiler controls.
- H. The BMS shall monitor outdoor temperature and humidity via its own sensors and display at the central PC.

- I. Lead hot water pump shall start per sequences of operation described above. BMS shall monitor downstream hydronic differential pressure transmitters compared to user defined setpoints and modulate the pump VFD in order to maintain desired setpoints. VFD ramp-up and VFD ramp-down timing shall be user defined.
- J. Designation of lead and standby pump shall be automatically alternated based on user defined run times or day of the week.
- K. When the pump is enabled, the pump VFD status determines if the motor is operating. After an operator definable feedback time delay, if there is an indication that the pump is not operating, the standby pump shall be enabled and an alarm shall be generated. Conversely, if status is detected while pump is turned off, a separate alarm shall be generated.

3.16 SECONDARY PUMPING SYSTEMS (CHILLED WATER AND HOT WATER)

- A. Lead hot water pump or lead chilled water pump shall start per sequences of operation described in other sections of this specification. BMS shall monitor downstream hydronic differential pressure transmitters compared to user defined setpoints and modulate the pump VFD in order to maintain desired setpoints. VFD ramp-up and VFD ramp-down timing shall be user defined.
- B. The s operating setpoint at the differential pressure transmitters shall be set based on values determined during Testing, Adjusting and Balancing. The operating setpoint shall automatically be reset by BMS to a lower value based upon demand at control valves. The user shall be able to lock the output signal to the pump VFD (“manual override”).
- C. Designation of lead and standby pump shall be automatically alternated based on user defined run times or day of the week.
- D. When the pump is enabled, the pump VFD status determines if the motor is operating. After an operator definable feedback time delay, if there is an indication that the pump is not operating, the standby pump shall be enabled and an alarm shall be generated. Conversely, if status is detected while pump is turned off, a separate alarm shall be generated.
- E. Additional Alarms: If the differential pressure remains 25% higher or lower at all the transmitters serving a hydronic system for 5 minutes, an alarm shall be activated at the central PC.

3.17 AIR HANDLING UNITS (AHU) & DEDICATED OUTSIDE AIR SYSTEMS (DOAS)

- A. Unoccupied Mode:
 - 1. Outside air, exhaust air and relief air dampers shall be closed.
 - 2. Return air dampers shall be open.
 - 3. Fan and energy recovery motors shall be deactivated.
 - 4. When unit is signaled to stop, BMS shall slowly ramp down the fan speed. Once fans are at 10% speed, (where required) shall start to close.

5. BMS shall raise the zone temperature cooling setpoint to 85°F and drop the zone temperature heating setpoint of 65°F. If two or more zones are calling for heating or cooling the fans shall cycle on. When the call for heating or cooling is satisfied the fans shall be deactivated.
6. Chilled water and hot water valves shall be closed.
7. Freezestat and temperature sensor within the unit's casing shall be monitored during unoccupied mode. If temperature drops below setpoint of either device, the main heating valve shall be fully open, fans shall be de-activated and an alarm shall be activated at the central PC.
8. At units where duct mounted smoke detectors are installed outside of the envelope of the building: When unit is off or in unoccupied mode, unit shall cycle on to maintain minimum duct temperature of 40F at the duct mounted return air and supply air temperature sensors.

B. Occupied Mode:

1. The zone will calculate how long it will take to return from its unoccupied state to its occupied setpoint based on the heating or cooling capacity and the outside air temperature. The zone will then adjust its effective setpoint at the time necessary in order to ensure the desired zone conditions at occupancy.
2. The system will not start more than 4 hours before a scheduled occupancy.
3. When BMS has signaled a unit to start, the smoke dampers shall open first. Once the dampers are fully open, the fans shall start.
4. BMS shall track the supply fan's accumulated runtime. When runtime exceeds 10,000 hours, the controller will generate a runtime expiration message.
5. Fans shall operate continuously. Speed of duplex fans shall operate in unison.
6. Energy recovery motors shall be energized
7. Outside air and relief air dampers shall be at minimum open positions. Coordinate setpoints of motorized dampers serving outside air and relief air dampers with air balancer.
8. BMS shall monitor airflow at the outside air AFMS and shall modulate the OA damper to maintain setpoint.

C. Supply Air and Return Air Fans – VFD / Static Pressure Control

1. BMS shall modulate the supply and return fan VFD's with a reverse acting static pressure PID to maintain the duct static pressure at the static pressure setpoint (1.5" w.c.). The static pressure setpoint shall be reset based upon demand at VAV boxes (see SOP below). When cooling is activated, the fan VFD shall not be allowed to drop below a speed setting that will produce a flow rate equal to the total of the minimum flow settings of all the VAV boxes served by the respective unit. Each unit shall be served by multiple duct mounted static pressure sensors. The operating setpoint at the pressure transmitters shall be set based on values determined during Testing, Adjusting and Balancing.
2. The user will be able to lock the output signal to the supply fan VFD.
3. If the supply static pressure remains 25% higher than setpoint for 1 minute, an alarm shall be activated at the central PC.
4. BMS shall generate an alarm if the supply static pressure remains 25% lower than minimum setpoint for 5 minutes. This alarm will not be enabled until the supply fan has been running for 2 minutes.

- D. Airflow Monitoring Stations: BMS shall monitor and record airflows. For outside air, BMS shall monitor the flow rate and adjust the outside air damper to maintain outside air flow rate setpoint.
- E. Duct Static Pressure Setpoint Optimization: Fans shall operate continuously and modulate to maintain the duct static pressure setpoint. The duct static pressure setpoint is sent by the BMS and is reset per the optimization sequences of operation listed below:
1. When any VAV damper is more than 75% (adj.) open, the supply fan discharge duct static pressure setpoint shall be reset upward by 0.1 in W.C. (adj.), at a frequency of 15 minutes (adj.), until no damper is more than 75% open or the static pressure setpoint has reset upward to the system maximum duct static pressure setpoint or the AHU variable-frequency drive is at the maximum speed setting.
 2. When all VAV dampers are less than 65% (adj.) open, the supply fan discharge duct static pressure setpoint shall be reset downward by 0.1 in W.C.(adj.), at a frequency of 15 minutes (adj.), until at least one damper is more than 65% open or the static pressure setpoint has reset downward to the system minimum duct static pressure setpoint or the AHU variable-frequency drive is at the minimum speed setting.
 3. The control bands, setpoint increment values, setpoint decrement values and adjustment frequencies shall be adjusted to maintain maximum static pressure optimization with stable system control and maximum comfort control.
 4. The BMS shall have the capability to allow the operator to exclude “problem” zones that should not be considered when determining the optimized setpoint.
 5. The BMS shall also read the status of the supply air static pressure sensor and display the active duct static pressure reading on the status screen.
 6. The BMS shall have the ability to identify, and display to the user, the VAV box that serves the Critical Zone (that is, the zone with the most wide-open VAV damper). This information shall update dynamically as the location of the Critical Zone changes based on building load, and duct static pressure setpoint optimization control.
- F. Exhaust Air Static Pressure Control
1. When the fans have flow, the AHU controller will modulate the exhaust fan VFD's (in unison where served by two fans) with a reverse acting static pressure PID to maintain the duct static pressure at the static pressure setpoint (1.0" w.c.). The static pressure setpoint shall be reset based upon demand at VAV boxes. The fan VFD shall not be allowed to drop below a speed setting that will produce a flow rate equal to the total of the minimum flow settings of all the VAV boxes served by the respective unit.
 2. The user will be able to lock the output signal to the fan VFD.
 3. If the supply static pressure remains 25% higher than setpoint for 1 minute, an alarm shall be activated at the central PC.
 4. BMS shall generate an alarm if the supply static pressure remains 25% lower than minimum setpoint for 5 minutes. This alarm will not be enabled until the supply fan has been running for 2 minutes.

- G. Fan Control:
1. When called to run, the fan will run for a minimum of 5 minutes.
 2. When the fan cycles off, it will remain off for a minimum of 5 minutes.
- H. Alarm Conditions:
1. If a freeze stat trips, the hot water chilled water valve at the respective unit shall be fully open, fans shall stop, outside air damper shall be fully closed and an alarm shall be activated at the central PC.
 2. Current sensing relays/VFD feedback: If fan has been signaled to start and feedback from respective relay or VFD does not indicate the fan has started after 30 seconds, unit shall be shut down and an alarm shall be activated at the central PC. Conversely, if fan on status is detected while the fan is turned off, a separate "Hand" alarm shall be activated at the central PC.
 3. Damper end switches: If end switch does not indicate respective damper is open after 30 seconds, unit shall be shut down and an alarm shall be activated at the central PC. Conversely, if a damper is indicated open, a separate "Hand" alarm shall be activated at the central PC.
 4. Duct mounted smoke detectors: When a detector is in alarm mode the fire alarm system shall be notified, respective fans shall be de-energized and an alarm shall be activated at the central PC.
 5. The controller will generate an alarm if the zone temperature remains 4°F higher than its cooling setpoint for 5 minutes. This alarm will not be enabled until the zone has been running for 30 minutes.
 6. The controller will generate an alarm if the zone temperature remains 4°F lower than its heating setpoint for 5 minutes. This alarm will not be enabled until the zone has been running for 30 minutes.
 7. The controller will generate an alarm if the discharge air temperature remains higher than 120°F with a hysteresis of 5°F for 5 minutes. This alarm will not be enabled until the zone has been running for 30 minutes.
 8. The controller will generate an alarm if the discharge air temperature remains lower than 45°F with a hysteresis of 5°F for 5 minutes. This alarm will not be enabled until the zone has been running for 30 minutes.
- I. Supply Air Temperature Setpoint Control
1. BMS will run a cooling setpoint optimization algorithm and a heating setpoint optimization algorithm simultaneously.
 - a. The initial cooling setpoint will be 55°F, with a minimum of 53°F and a maximum of 72°F.
 - b. If any zones are still calling for cooling at the end of a 5 minute period, the setpoint algorithm will respond by lowering the setpoint by 1°F for every zone requesting cooling.
 - c. If no zones are still calling for cooling at the end of a period, the setpoint algorithm will respond by raising the setpoint by 1°F.
 - d. The cooling setpoint algorithm will not adjust the cooling setpoint by more than 2°F in any period.
 - e. The initial heating setpoint will be 82°F with a minimum of 72°F and a maximum of 85°F.

- f. If any zones are still calling for heating at the end of a 5 minute period, the setpoint algorithm will respond by raising the setpoint by 2°F for every zone requesting heating.
 - g. If no zones are still calling for heating at the end of a period, the setpoint algorithm will respond by lowering the setpoint by 1°F.
 - h. The heating setpoint algorithm will not adjust the heating setpoint by more than 4°F in any period.
2. BMS shall determine the AHU supply air temperature setpoint based on the number of heating requests and cooling requests the AHU is receiving.
 - a. If there are more cooling requests than heating requests coming into the AHU, or if there is the same number of heating requests as cooling requests, the AHU controller will use the cooling setpoint.
 - b. If there are more heating requests than cooling requests coming into the AHU, the AHU controller will use the heating setpoint.
 - c. When the BMS switches from the heating setpoint to the cooling setpoint, the setpoint control algorithm will ramp from the heating setpoint to the cooling setpoint at a rate of 1°F/minute.
 - d. When the BMS switches from the cooling setpoint to the heating setpoint, the setpoint control algorithm will ramp from the cooling setpoint to the heating setpoint at a rate of 1°F/1.5 minute.
 3. The user will be able to override the supply air temperature setpoint.
- J. Heating Control
1. If the outside air temperature is less than 65°F with a 2°F hysteresis and the outside air temperature is valid, BMS will allow heating based on outside air conditions.
 2. If the outside air temperature reading is not valid, BMS will still allow heating.
 3. Upon a call for heating, dampers at energy recovery units shall be modulated to increase flow rate through the energy recovery section and reduce flow rate at the energy recovery's bypass. Energy recovery modules shall be the first stage of heating
 4. Upon a further call for heating, BMS shall modulate the hot water valve to maintain temperature setpoints if cooling has been off for at least 5 minutes.
- K. Cooling Control
1. If the outside air temperature is greater than 50°F with a 2°F hysteresis and the outside air temperature is valid, the AHU controller will enable cooling based on outside air conditions.
 2. If the outside air temperature reading is not valid, the AHU controller will still enable cooling.
 3. Upon a call for cooling, BMS shall modulate the chilled water valve to maintain temperature setpoints if heating has been off for at least 5 minutes.
 4. Upon a call for cooling, BMS shall
 - a. Stage the compressors to maintain temperature setpoints if heating been off for at least 5 minutes.
 - b. Monitor amp draw at each compressor to confirm it is operating; via field installed CSR.

- L. Economizer Control
1. BMS will allow economizer cycles to be activated based on outside air conditions if the return air temperature and enthalpy is greater than the outside air temperature and enthalpy with a hysteresis of 5°F, the outside air enthalpy is less than 22 Btu/lb with a hysteresis of 2 Btu/lb, the outside air temperature is less than 65°F with a hysteresis of 2°F, and the outside air readings are valid.
 2. If the outside air readings are not valid, BMS will disable the economizer. The user will be able to enable the economizer if the outside air readings are not valid.
 3. When economizer cycles are activated, energy recovery motors shall stop and energy recovery bypass dampers shall open.
 4. An economizer PID will modulate the economizer/ventilation dampers and relief air/exhaust fans between minimum setpoint and 100% to maintain the zone temperature at 2°F below the zone temperature cooling setpoint if heating has been off for at least 5 minutes. The relief air fans and exhaust fans shall and activated.
 - a. The user will be able to adjust all PID parameters (P, I, and D gains, loop bias, and loop interval).
 - b. The user will be able to lock the economizer damper position.
 - c. The controller will limit the signal change sent to the economizer to 1% every 2 sec. when increasing.
 5. The controller will limit the signal change sent to the economizer to 1% every 2 sec. when increasing.
 6. If the mixed air temperature drops below 45°F, the AHU controller will begin to close the economizer to protect the coil. The controller will continue to close the damper linearly until the temperature drops to 40°F, when the economizer/ventilation damper will be 100% closed.
 7. If the AHU loses flow or the freezestat trips, the AHU controller will close the economizer dampers.
 8. The AHU controller will generate an alarm if the mixed air temperature remains lower than 45°F for 5 minutes with a 5°F hysteresis. This alarm will not be enabled until the supply fan has been running for 30 minutes.
 9. The AHU controller will generate an alarm if the mixed air temperature remains higher than 90°F for 5 minutes with a 5°F hysteresis. This alarm will not be enabled until the supply fan has been running for 30 minutes.
- M. Air Flow Monitoring Stations
1. Outside Air: BMS shall monitor the outside air flow station(s) and modulate the outside air and relief air dampers to maintain minimum outside air flow setpoint.
 2. Supply air and return air flow rates at fans shall monitored as shown on the drawings.
- N. Outside Air – Demand Control Ventilation
1. BMS shall monitor carbon dioxide (CO₂) sensors. If CO₂ levels rise above high level setpoint, BMS shall modulate the outside air and relief air dampers open.
 2. If CO₂ levels at all sensors are below low level setpoints, BMS shall modulate the outside air and relief air dampers closed to minimum position.
 3. Also refer to VAV control sequences of operation.

3.18 ERV SECTIONS

- A. Heating Mode: If the outside air temperature is less than the economizer changeover and the discharge air temperature is less than the discharge air temperature setpoint the following shall occur:
1. The supply and exhaust fans shall operate as sequenced above.
- B. Stage 1 Free Heat:
1. The energy recovery wheel shall be enabled.
 2. The outside air (wheel) by pass damper and the exhaust air (wheel) bypass damper shall modulate so as to maintain the discharge air temperature setpoint.
 3. The outside air damper shall modulate to their minimum outside airflow CFM.
 4. The recirculation damper shall modulate to its corresponding position.
 5. The hot water control valve shall modulate closed.
- C. Stage 2 Heating:
1. The energy recovery wheel shall be enabled.
 2. The outside air (wheel) bypass damper shall close.
 3. The exhaust air (wheel) bypass damper shall close.
 4. The outside air damper shall modulate to their minimum outside airflow CFM.
 5. The recirculation damper shall modulate to its corresponding position.
 6. The hot water control valve shall modulate so as to maintain the discharge air temperature setpoint.
- D. Heating - General
1. Upon a call for heating with the outside air is between 65°F and 40°F, BMS shall modulate the hot water valve, with the face and bypass damper full open to the coil, to maintain temperature setpoints if cooling has been off for at least 5 minutes.
 2. Upon a call for heating with the outside air below 40°F outside air, the hot water valve shall be fully open and the face and bypass damper shall be modulated to maintain temperature setpoint if cooling has been off for at least 5 minutes.
 - a. The user will be able to lock the signal to the hot water valve.
 - b. The user will be able to lock the signal to the face and bypass damper.
 3. Energy Recovery Modules - Frost Control: When outside air temperature is below unit's individual specific setpoint, bypass damper at the outside air side of the energy recovery module shall modulate open. If unit does not have a damper at the outside air, relief air/exhaust air bypass damper at the energy recovery module shall modulate open. Dampers shall modulate to maintain discharge air temperature setpoint.
- E. Energy Wheel Frost Protection Control
1. During the cold winter months, frost formation on the energy recovery wheel is a possibility. Frost formation can restrict or reduce the air flow across the energy wheel. To prevent frost build up on the wheel, the Delta controller shall monitor the outside air temperature, if the entering outside air temperature is less than the "Frost Control Setpoint" the controller shall initiate "De-Frost Mode". When in the "De-Frost Mode" the following shall occur:
 2. The energy recovery wheel shall be enabled.

3. The outside air (wheel) bypass damper shall modulate to ensure that the exhaust air temperature is at or above the frost control setpoint.
4. The outside air dampers and the recirculation damper shall modulate so as to maintain the discharge air temperature setpoint.
5. The exhaust air (wheel) bypass damper shall be closed.
6. The hot water control valve shall modulate so as to maintain the discharge air temperature setpoint.

- F. The temperature below which frost will begin to accumulate on heat exchanger surfaces is referred to as the frost threshold temperature. It is a function of outdoor temperature and indoor relative humidity. The following table lists typical frost threshold temperatures over a wide range of indoor air temperatures and relative humidity. Frost control is not required until outdoor air temperatures are below the threshold.

FROST THRESHOLD TEMPERATURE (°F)				
INDOOR AIR RH%	INDOOR AIR DRY BULB TEMPERATURE (°F)			
	70°F	72°F	75°F	80°F
20	-14	-13	-11	-8
30	-3	-2	-1	3
40	5	7	9	11
50	12	13	15	18
60	18	19	21	26

G. Cooling Control

1. If the outside air temperature is greater than 50°F with a 2°F hysteresis and the outside air temperature is valid, the AHU controller will enable cooling based on outside air conditions.
2. If the outside air temperature reading is not valid, the AHU controller will still enable cooling.
3. Upon a call for cooling, BMS shall modulate the chilled water valve, to maintain temperature setpoints if heating been off for at least 5 minutes.

H. Cooling Mode with Energy Recovery

1. If the outside air temperature is greater than the economizer changeover setpoint and the outside air temperature is greater than the return air temperature the Delta controller shall control the AHU as follows:
2. The supply and exhaust fans shall operate as sequenced above.
3. The energy recovery wheel shall be enabled.
4. The outside air (wheel) bypass damper shall close.
5. The exhaust air (wheel) bypass damper shall close.
6. The outside air damper shall open to their minimum outside airflow CFM.
7. The recirculation damper shall modulate to its corresponding position.
8. The chilled water valve shall modulate so as to maintain the required supply air temperature setpoint.

3.19 OUTDOOR AIR CONDITIONS MONITORING

- A. Functional Control
 - 1. Carbon Dioxide at Exterior of the Building: BMS shall monitor and record carbon dioxide levels.
 - 2. The controller shall monitor outside air temperature and humidity and calculate the outside air enthalpy, and will make these values available to the system.
 - 3. If the outside air temperature sensor indicates a reading lower than -25°F with a hysteresis of 10 or higher than 225°F with a hysteresis of 10 the controller will make the alternate outside air temperature sensor available to the system. If the sensor still indicates these readings after 5 minutes, the controller will generate a sensor failure alarm.

- B. Temperature History
 - 1. Once the controller has established communication with the system after any interruption in communication, it will record a temperature history for the system.
 - a. At 12:05 am every night, the controller will reset the high and low daily temperature peak recorders for the next day. The reset signal will last no longer than 5 seconds.
 - b. When the high and low daily temperature peak recorders are reset for the first day of each month, the high and low month-to-date peak recorders will also be reset.
 - c. When the high and low month-to-date peak recorders are reset for January, the high and low year-to-date peak recorders will also be reset.

3.20 ALARM NOTIFICATION

- A. Events and alarms shall be indicated on the appropriate equipment graphics page viewable and with automatic display updates available at the central server level. The graphic display will indicate an alarm condition by showing the appropriate object in red on the graphic display.

- B. Alarms and events shall be displayed on the Event Log Page viewable and with automatic display updates available at the central server level. Date and time of occurrence shall be recorded.

- C. Alarms and events shall be transferred out of the automation system to other network services for remote notification to devices such as: Printers on the customer's network, e-mail systems, voice mail systems, paging systems, local alarms, or other reporting actions, depending on user configuration. Contractor shall coordinate with the Owner with programming and wiring remote alarms and trouble shooting them for accuracy.

3.21 TRENDING

- A. All I/O points shall be linked to a trend log.
 - 1. BMS shall record a trend sample every 10 minutes on each of the trend objects.
 - 2. The controller will save the most recent 144 samples of each trended point in the control module for viewing or printing.
 - 3. The user will be able to enable or disable trending of any of the points listed. Points marked with an asterisk will automatically be trended in the default configuration.
 - 4. For the first year of operation, the system will trend and record all data at 10 minute increments which can then be backed up on CD's.
 - 5. A dedicated trend log page shall be setup to permanently monitor and record all indoor and outdoor conditions as follows (per State of CT HPB requirements): Temperature, humidity, relative humidity, dewpoint, CO2.

3.22 COMMISSIONING

- A. Engage a factory-authorized service representative, to perform startup service as per functional test sheets and requirements of Section 23 08 00.
- B. Verify that equipment is installed and commissioned as per requirements of Section 23 08 000 and manufacturer's written instructions.
- C. Complete installation and startup checks and functional tests according to Section 23 08 00 and manufacturer's written instructions.
- D. Operational Test: After electrical and control systems have been energized, start units to confirm proper unit operation. Rectify malfunctions, replace defective parts with new one and repeat the start up procedure.
- E. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

END OF SECTION

SECTION 232113 - HYDRONIC PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Heating hot water piping.
2. Chilled water piping.
3. Pool water piping.
4. Equipment drains and over flows.
5. Unions and flanges.

B. Related Sections:

1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
2. Section 08 31 13 - Access Doors and Frames: Product requirements for access doors for placement by this section.
3. Section 09 90 00 - Painting and Coating: Product requirements Painting for placement by this section.
4. Section 23 04 00 – General Conditions for Mechanical Trades
5. Section 23 05 00 – Common Work Results for HVAC
6. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping: Product and execution requirements for expansion compensation devices use in heating and cooling piping systems.
7. Section 23 05 23 - General-Duty Valves for HVAC Piping: Product requirements for valves for placement by this section.
8. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports, sleeves, [and firestopping] for placement by this section.
9. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for Vibration Isolation for placement by this section.
10. Section 23 07 00 - HVAC Insulation: Product requirements for Piping Insulation for placement by this section.
11. Section 23 21 16 - Hydronic Piping Specialties: Product and execution requirements for piping specialties used in heating and cooling piping systems.
12. Section 23 21 23 - Hydronic Pumps: Product and execution requirements for pumps used in heating and cooling piping systems.
13. Section 23 25 00 - HVAC Water Treatment: Product and execution requirements for cleaning and chemical treatment of heating and cooling piping systems.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other

sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 PHASE 2 SUPPORT REQUIREMENTS

- A. All mechanical systems including equipment, ductwork, piping and accessories being hung from above shall not be supported from the existing "space truss" roof structure unless noted otherwise. Systems shall be supported from new framing only. Refer to structural drawings for locations of new framing. Provide supplemental framing as required.

1.5 REFERENCES

- A. American Society of Mechanical Engineers:
 - 1. ASME B16.3 - Malleable Iron Threaded Fittings.
 - 2. ASME B16.4 - Gray Iron Threaded Fittings.
 - 3. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
 - 4. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - 5. ASME B31.1 - Power Piping.
 - 6. ASME B31.9 - Building Services Piping.
 - 7. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.
- B. ASTM International:
 - 1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 - 3. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
 - 4. ASTM A536 - Standard Specification for Ductile Iron Castings.

5. ASTM B32 - Standard Specification for Solder Metal.
 6. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
 7. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
 8. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
 9. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
 10. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
 11. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
 12. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
- C. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
 2. AWS D1.1 - Structural Welding Code - Steel.
- D. American Water Works Association:
1. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
 2. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
 3. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 4. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
- E. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 2. MSS SP 67 - Butterfly Valves.
 3. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
 4. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
 5. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
 6. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
 7. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
 8. MSS SP 85 - Cast Iron Globe & Angle Valves, Flanged and Threaded.
 9. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
 10. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate layout of piping system, including equipment, critical dimensions, and sizes.

- C. Product Data:
 - 1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
 - 2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
 - 3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
- D. Test Reports: Indicate results of piping system pressure test.
- E. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- G. Welders' Certificate: Include welders' certification of compliance with ASME Section IX and AWS D1.1.
- H. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.7 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of valves, equipment and accessories.

- C. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.8 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.1 and ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- B. Maintain one copy of each document on site.
- C. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.
- B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.10 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum two weeks prior to commencing work of this section.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.12 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.13 WARRANTY

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

PART 2 PRODUCTS

2.1 HEATING HOT WATER PIPING AND CHILLED WATER PIPING, ABOVE GROUND

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black.
 - 1. Fittings (150 lb rating): ASME B16.3, malleable iron or ASTM A234/A234M, carbon steel welding type, long radius type. Tees and fittings shall be prefabricated except Weldolet type fittings may be used where branch line is less than ½ the size of the main. Reducers shall be eccentric
 - 2. Joints: Threaded for pipe 2 inch and smaller; welded or flanged for pipe 2-1/2 inches and larger.
 - 3. Flanges: Class 150 socket or welding neck type with raised face and spiral serrated finish conforming to ASTM A105. Gaskets shall be red rubber wire reinforced. Bolts shall be unfinished square head machine bolts conforming to ASTM A307.
- B. Copper Tubing: ASTM B88, Type L, drawn.
 - 1. Fittings: ASME B16.22 solder wrought copper.
 - 2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.
- C. Steel Pipe: ASTM A53/A53M, Schedule 40, black, rolled grooved ends.
 - 1. Fittings: ASTM A395/A395M and ASTM A536 ductile iron, or ASTM A234/A234M carbon steel, grooved ends.
 - 2. Joints: Grooved mechanical couplings meeting ASTM F1476; Victaulic models listed below or approved equal as manufactured by Tyco-Grinnell or Viking.
 - 3. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron, enamel coated, compatible with steel piping sizes, rigid or flexible type.
 - a. Rigid: Housings 12" and smaller shall be cast with offsetting, angled-pattern bolt pads for system rigidity upon visual confirmation of metal-to-metal bolt pad contact with no torque requirement. Sizes 8" and smaller: Installation-Ready Style Victaulic 107H. Sizes 10" and 12" Style 07. Sizes 14" and larger Style W07.
 - b. Flexible: Use in areas requiring vibration attenuation or stress relief. Three (3) Victaulic Style 177, 77 or W77 may be used in lieu of each flexible connector and shall be placed in close proximity to the vibrating source.
 - 4. Gasket: Elastomer composition for operating temperature range from -30°F to 250°F for sizes 8" and smaller.

5. Grooved joint flange adapter, flat face, for direct connection to ANSI Class 125 and 150 flanges Victaulic Style 741/W741. For direct connection to ANSI Class 300 flanges, Victaulic Style 743.
6. Accessories: Heat-treated plated steel or Stainless steel bolts, nuts, and washers.

- D. Copper Tubing (up to 4" diameter) ASTM B88, Type L, drawn.
1. Fittings: ASME B16.22 wrought copper with EPDM sealing element and press end type, fitting bead collars as manufactured by Viega Pro -Press or approved equal. 2 1/2" to 4" sizes shall include stainless steel grip ring.
 2. Joints: Mechanically connected with Viega Pro-Press crimping tool.

2.2 CONDENSATE DRAINS

- A. Copper Tubing: ASTM B88, Type L drawn.
1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
 2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

2.3 EQUIPMENT DRAINS, PRESSURE RELIEFS AND OVERFLOWS

- A. Steel Pipe: ASTM A53/A53M Schedule 40, galvanized.
1. Fittings: ASME B16.3, malleable iron or ASME B16.4, cast iron.
 2. Joints: Threaded for pipe 2 inch and smaller; flanged for pipe 2-1/2 inches and larger.
- B. Copper Tubing: ASTM B88, Type L] drawn.
1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
 2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

2.4 UNIONS AND FLANGES

- A. Unions for Pipe 2 inches and Smaller:
1. Ferrous Piping: Class 150, malleable iron, threaded.
 2. Copper Piping: Class 150, bronze unions with soldered.
 3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
 4. PVC Piping: PVC.
- B. Flanges for Pipe 2-1/2 inches and Larger:
1. Ferrous Piping: Class 150 forged steel, slip-on flanges.
 2. Copper Piping: Class 150, slip-on bronze flanges.
 3. PVC Piping: PVC flanges.
 4. Gaskets: 1/16 inch thick preformed neoprene gaskets.

2.5 POOL WATER PIPING

- A. Manufacturers:
1. Vanguard.

2. Charter Plastics.
 3. Performance/Phillips-Drisco.
- B. Piping Up to 3 inch: High Density Polyethylene Piping: ASTM D3035 with DR 15.5 ASTM D2447, Schedule 80.
1. Fittings: ASTM D3261, butt or sidewall ASTM D2683, socket ASTM F1055, electrofusion.
 2. Joints: Electrofusion.
- C. Piping 3 inch and larger: High Density Polyethylene Piping: ASTM D3035, DR 11, ASTM D2447, Schedule 80.
1. Fittings: ASTM D2683, socket ASTM F1055, electrofusion.
 2. Joints: Electrofusion.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 INSTALLATION – GENERAL REQUIREMENTS

- A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.
- B. Provide flanges, union, and couplings at locations requiring servicing. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- C. Flexible Connectors: Use at or near pumps and equipment connections where piping configuration does not absorb vibration.

3.4 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

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

- B. Install piping in accordance with ASME B31.9.
- C. Route piping parallel to building structure and maintain gradient.
- D. Install piping to conserve building space, and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Sleeve pipe passing through partitions, walls and floors.
- G. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping. Refer to Division 7.
- H. Install pipe identification in accordance with Section 23 05 00.
- I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.
- J. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Division 8.
- K. Slope hydronic piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe aligned. Provide 3/4" drain valves with hose and connections at all low points, bases of vertical risers, main shut-off valves and at equipment
- L. Provide manual air vents at all system high points. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- M. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- N. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Division 9.
- O. All strainer blow-down connections shall be provided with a 3/4" drain valve with hose connection and brass cap.
- P. PVC and ABS piping shall not be installed in ceiling plenum spaces or ductwork plenums.
- Q. Coil Condensate Drains: Provide pipe trap at all cooling coil drain pans. Pipe to nearest drain at 1/4" per foot pitch.
- R. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 07 00.
- S. Insulate piping; refer to Section 23 07 00.
- T. Grooved joints shall be installed in accordance with the latest manufacturer's installation instructions.

1. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
2. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove.
3. Gaskets shall be verified as suitable for the intended service prior to installation. Gaskets shall be molded and produced by the coupling manufacturer.
4. The grooved coupling manufacturer's factory trained representative (direct employee) shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer's representative (direct employee) shall periodically visit the jobsite and review installation. Contractor shall remove and replace any joints deemed improperly installed.

U. Glycol/water solutions: Upon completion of flushing and testing of the system, all piping and equipment shall be drained to ensure a proper propylene glycol/water mixture. Blow out piping and equipment with air as required to remove all water from system.

3.5 CLEANING AND FLUSHING

- A. Upon completion of all work, all piping systems shall be flushed with water or liquid alkaline solution with emulsifying agents and detergents, to remove dirt, grease, grit, chips and foreign matter.
- B. Solution for flushing shall be used in sufficient quantity to produce a velocity of at least 2.5 feet per second. Flushing shall continue until discharge solution shows no discoloration or evidence of foreign materials.
- C. During flushing operation, all valves shall be operated several times, bypasses opened, pumps operated and equipment flushed.
- D. Upon completion of flushing operations, all strainers, filters and blowdowns shall be removed and cleaned of accumulated waste.
- E. Systems with propylene glycol solutions: Upon completion of flushing and testing, all piping and equipment shall be drained to ensure a proper propylene glycol/water mixture. Blow out piping and equipment with air as required to remove all water from system.
- F. After completion, fill, clean, and treat systems. Refer to Section 23 25 00.

3.6 TESTING

- A. All piping systems installed under this Contract shall be pressure tested with clean, clear water to insure tightness.
- B. Contractor shall be responsible for furnishing all plugs, piping, valves, hoses, and pumps necessary for required tests and for proper disposal of the water upon completion of the tests. All lines shall be thoroughly cleaned before testing.

- C. Items which are not to be subjected to the hydrostatic test shall be either removed or blanked off. Short sections of piping which must be removed to permit the installation of blinds or blanks must be tested separately.
- D. The test pump hook-up for hydrostatic test shall be such that the pressure may be applied gradually under perfect control. A valve shall be provided for blocking in the piping during the test period. The systems should be filled with water thru a low connection point, care being taken that air is completely vented so that there are no air pockets remain. The pressure shall be applied gradually and held at the specified value for the time required to visually check each weld, connection, joint, flange, etc., but not less than a minimum of two hours. Test readings may be taken at the lowest point of the line or system of lines providing static head is added to the minimum hydrostatic test pressure. Care shall be taken to insure that at no point a dangerous over-pressure is experienced.
- E. The hydrostatic test shall be considered satisfactory if no visible leakage, cracks or other signs of distress are discovered on the piping or at any joints. There is no requirement for minimum pressure drop during the test period; however, the cause of any pressure loss other than that due to temperature change or similar reasons shall be justified to the satisfaction of the Owner's representative.
- F. Minor leaks in screwed or flanged joints may be repaired without retesting subject to the approval of the Owner.
- G. After completion of the hydrostatic testing, the system shall be completely drained at all low points. All test blinds, temporary supports, test equipment, etc., shall then be removed, and any valves, orifice plates, short sections of piping, miscellaneous in-line equipment or instruments that were left ready for service. New gaskets shall be used when re-installing flanged items.
- H. If there is any danger of contamination or freezing, blow out the piping system with dry, oil-free air as necessary.
- I. At completion of tests Contractor shall submit a typewritten log of test data for Owner's permanent file including:
 - 1. Data of test.
 - 2. Section tested-attach sketch.
 - 3. Equipment used.
 - 4. Personnel involved.
 - 5. Owner or Owner's witness in attendance.
 - 6. Results.
- J. After repair any failed test shall be repeated until all requirements of this Section are met.
- K. Test Pressures:
 - 1. All piping systems unless notes otherwise shall be tested at 100 psig or 1.5 times the operating pressure, whichever is greater.
 - 2. Cooling coil condensate drain piping shall be tested at 10 ft head.

16030
11/17/2017

FRANCIS WALSH INTERMEDIATE SCHOOL /
BOARD OF EDUCATION CENTRAL OFFICES
BRANFORD, CONNECTICUT
State Project No.s: 014-0034 EA / 014-0035 BE-EA

END OF SECTION

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Pressure gages.
 2. Thermometers.
 3. Test plugs.
 4. Flow indicator (bullet type).
 5. Bladder-type expansion tanks.
 6. Air vents.
 7. Air separators.
 8. Strainers.
 9. Pump suction fittings.
 10. Combination pump discharge valves.
 11. Relief valves.
 12. Manual balancing valves.
 13. Autoflow / automatic balancing valves.
- B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
 2. Section 23 21 13 - Hydronic Piping: Execution requirements for piping connections to products specified by this section.
 3. Section 23 21 23 - Hydronic Pumps: Execution requirements for piping connections to products specified by this section.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. American Society of Mechanical Engineers:
 - 1. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
 - 2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
- B. ASTM International:
 - 1. ASTM E1 - Standard Specification for ASTM Thermometers.
 - 2. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.
- C. Underwriters Laboratories Inc.:
 - 1. UL 393 - Indicating Pressure Gauges for Fire-Protection Service.
 - 2. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit for manufactured products and assemblies used in this Project.
 - 1. Manufacturer's data and list indicating use, operating range, total range, accuracy, and location for manufactured components.
 - 2. Submit product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
 - 3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each piping specialty.
 - 4. Submit electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures, application, selection, and hookup configuration. Include pipe and accessory elevations.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- E. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).

- c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.7 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of actual locations of components and instrumentation.
- C. Operation and Maintenance Data: Submit instructions for calibrating instruments, installation instructions, assembly views, servicing requirements, lubrication instruction, and replacement parts list.

1.8 QUALIFICATIONS

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

1.9 PRE-INSTALLATION MEETINGS

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

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Accept piping specialties on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Protect systems from entry of foreign materials by temporary covers, caps and closures, completing sections of the work, and isolating parts of completed system until installation.

1.11 ENVIRONMENTAL REQUIREMENTS

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

1.12 FIELD MEASUREMENTS

- A. Verify field measurements before fabrication.

1.13 WARRANTY

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

PART 2 PRODUCTS

2.1 PRESSURE GAGES AND TAPS

- A. Manufacturers:
 - 1. Trerice 600 Series or approved equal by:
 - 2. Ernst.
 - 3. Davis
- B. Gage: ASME B40.1, UL 393 or UL 404 with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background, clear glass window.
 - 1. Case: Cast aluminum.
 - 2. Bourdon Tube: Brass.

3. Dial Size: 3-1/2 inch diameter.
 4. Mid-Scale Accuracy: One percent.
 5. Scale: Both psi and kPa.
- C. Needle Valve or Ball Valve: Brass, 1/4 inch NPT for minimum 250 psi.
- D. Pulsation Damper: Pressure snubber, brass with 1/4 inch NPT connections.
- E. Siphon: Brass 1/4 inch NPT angle or straight pattern.

2.2 STEM TYPE THERMOMETERS

- A. Manufacturers:
1. Trerice B91 Series or approved equal by:
 2. Ernst
 3. Davis Model
- B. Thermometer: ASTM E1, adjustable angle, red appearing mercury, lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device.
1. Size: 9 inch scale.
 2. Window: Clear glass.
 3. Stem: Brass, 3/4 inch NPT, 3-1/2 inch long.
 4. Accuracy: ASTM E77 2 percent.
 5. Calibration: Both degrees F and degrees C.
- C. Socket: Brass separable sockets for thermometer stems with or without extensions.

2.3 TEST PLUGS

- A. Manufacturers:
1. Omega
 2. Imac
 3. Peterson
- B. 1/4 inch NPT or 1/2 inch NPT brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with:
1. Neoprene core for temperatures up to 200 degrees F.
 2. Nordel core for temperatures up to 350 degrees F.
 3. Viton core for temperatures up to 400 degrees F.

2.4 AIR VENTS

- A. Manufacturers:
1. Taco
 2. B+G.
 3. Amtrol.

- B. Manual Type: Taco Model 417 combination manual/automatic, Nickel plated brass body with hydroscopic fiber discs, screwed fitting and slotted/threaded venting.
- C. Float Type: B+G Model 87, brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

2.5 FLOW INDICATOR (BULLET OR IMPELLER TYPE)

- A. Manufacturers:
 - 1. Dwyer
 - 2. Cole Parmer.
 - 3. W.E. Anderson
- B. Paddle wheel with double window. Body shall be brass or carbon steel body.

2.6 STRAINERS

- A. Manufacturers:
 - 1. Spirax Sarco Models listed below or approved equal by:
 - 2. Armstrong.
 - 3. Yarway.
- B. Size 2 inch and Under: Screwed cast iron body for 175 psig working pressure, Y pattern with 1/32" stainless steel perforated screen. Spirax Sarco Model IT.
- C. Size 2-1/2 inch and Larger: Flanged iron body for 150 psig working pressure, basket pattern with 3/64" screen for size up to 4", 1/8" screen for 4" and larger; stainless steel perforated screen. Spirax Sarco Model F-125.

2.7 RELIEF VALVES

- A. Manufacturers:
 - 1. B+G Safety Relief Valve or approved equal by:
 - 2. Watts.
 - 3. Taco.
 - 4. Parker Hannifin.
- B. Brass body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled. Provide with drip pan elbow at outlet.
- C. Bronze body, Teflon seat, stem and springs, automatic, direct pressure actuated capacities ASME certified and labeled.

2.8 EXPANSION TANKS

- A. Manufacturers:
 - 1. Amtrol Extrol L series, full acceptance or approved equal by:
 - 2. Taco

3. B+G:

- B. Hot water system shall be served by three (3) Model 2000-L tanks. Acceptance volume for each tank shall be 528 gallons water.
- C. Chilled water system shall be served by two (2) Model 300-L tanks. Acceptance volume for each tank shall be 80 gallons water.
- D. Tank volume shall be gallons with acceptance volume of gallons.
- E. Construction: Welded steel, tested and stamped in accordance with ASME Section VIII; supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible butyl diaphragm sealed into tank and steel support stand.
- F. Accessories: Pressure gage and air-charging fitting, tank drain; pre-charge to 12 psig.
- G. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check back flow prevention device, test cocks, strainer, vacuum breaker, and by-pass valves.

2.9 AIR SEPARATORS

- A. Manufacturers:
 - 1. B+G Model Rolairtrol
 - 2. Taco.
 - 3. Spirotherm.
- B. Cast iron for sizes 2-1/2 inch and smaller, steel for sizes 3 inch and larger; perforated stainless steel air collection tube, tested and stamped in accordance with ASME SEC 8-D for 125 psig operating pressure. Pressure drop shall be less the 1.0 psig and air removal shall be minimum 91% for flows shown on the drawings. Equipment size shall match the pipe size as shown on the drawings.

2.10 PUMP SUCTION FITTINGS

- A. Manufacturers:
 - 1. B+G
 - 2. Taco
 - 3. Armstrong
- B. Fitting: Angle pattern, cast-iron body. Threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger. Rated for 175 psig working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning.
- C. Accessories: Adjustable foot support, blow-down tapping in bottom, gage tapping in side.

2.11 COMBINATION PUMP DISCHARGE VALVES

- A. Manufacturers:
 - 1. B+G Model Triple Duty Valve or approved equal by:
 - 2. Taco
 - 3. Armstrong

- B. Valves: Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet for 175 psig operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

2.12 MANUAL BALANCE VALVES

- A. Manufacturers:
 - 1. Armstrong CBV or approved equal by:
 - 2. Taco
 - 3. Macon
 - 4. TA Hydronics

- B. Construction:
 - 1. Ametal® brass copper alloy (1/2"-2") or ASTM A536 ductile iron (2-1/2"-12") body, Y-pattern globe style, temperature and pressure test plug on inlet and outlet with check valves and screw on caps.
 - 2. Minimum of 4-360 degree handwheel turns for precise flow measurement, precise flow balancing, and shutoff eliminating the need for an additional isolation valve. EPDM O-ring seals, hidden memory feature with tamper-proof setting and digital readout. For insulation against heat loss or condensation, provide preformed rigid polyurethane insulation for sizes 1/2" through 6".

2.13 "AUTOFLOW" / AUTOMATIC BALANCING VALVES

- A. Manufacturers:
 - 1. Flow Design Inc/Autoflow
 - 2. Nexus.
 - 3. Griswold Controls
 - 4. Macon
 - 5. Nutech.

- B. General:
 - 1. Automatic flow control valve cartridges shall be fabricated of type 304 stainless steel and shall be factory calibrated to automatically control flow rates with ±5% accuracy over the control range of the valve.
 - 2. The automatic flow control valve shall be permanently marked to show direction of flow; and shall be provided with a valve tag to indicate flow rate, model number and equipment served.
 - 3. All automatic flow control valve cartridges shall be warranted by the manufacturer for a minimum period of five years.

C. Construction

1. Valves 2" and smaller shall consist of brass, Y-pattern body with integral ball valve, a flow control cartridge assembly, dual pressure/temperature test ports, and interchangeable union end with O-ring seal which will accept various end pieces. The body design shall allow inspection or removal of flow control cartridge without disturbing piping connections. Valves shall be rated for a minimum working pressure of 400 psi at 250°F.
2. Valves 2½" and larger shall consist of ductile iron, wafer-style body designed to fit between standard 125/150 ANSI flanges. Valves shall include dual pressure/temperature test ports and single or multiple, parallel-installed flow control cartridge assemblies. Flange bolts and nuts shall be provided with each valve. Valves shall be able to incorporate drains and vents as required. Valves shall be rated for a minimum working pressure of 200 psi at 250°F.

D. Accessories:

1. Strainers
 - a. 2" and under: Y strainer shall be made of bronze with a brass cap.
 - b. 2-1/2" and larger: Y-strainer shall be made of iron (ASTM A126-61T, Class 30) Maximum pressure rating of 300 PSI.
 - c. Strainer screen shall be stainless steel and rated for 20 mesh, easily accessible for cleaning.
 - d. Strainer shall be provided with a hose end blowdown valve with cap and chain
2. Automatic Air Vents
 - a. Forged brass body; manual shut-off cap; polypropylene float; body designed to be disassembled for cleaning, and vent capacity of one SCFM @ 60 psig.
 - b. Minimum Ratings: 150 psi at 240°F.
3. Manual Air Vents
 - a. Brass body, knurled slotted handle, blowout-proof needle style valve, side vent, 1/4" NPT standard with extended length available.
 - b. Minimum Ratings: 400 PSIG at 250°F.
4. Test Kit:
 - a. Meter kit shall be provided as either a permanently mounted or as a single-hose portable or double-hose portable kit; pressure gauge with 4-1/2" dial shall have range of -14.7 to 150 PSI; portable kits shall be available with end connections for either pressure only or pressure/temperature test valves and shall include carrying cases; all kits shall include flow rate chart for determining flow rate.
5. Hoses
 - a. All hoses shall be equipped with swivel end connections at terminal unit. All end connections shall be crimped to meet stated pressure ratings. Serrated/slip fit connections are not acceptable.
 - b. Hose materials shall be stainless steel braided over a synthetic polymer liner.
 - c. Hoses shall meet or exceed the ASTM-D380-83 standard and withstand working pressures of minimum 225 psig. Hoses shall be maximum 1".

- d. Hoses shall meet or exceed flame retardant testing per standard ASTM-E84 and not exceed the following; Flame Spread - 25, Fuel Contribution - 25, Smoke Density - 50.
- E. Balancing valve selection shall be determined by the flow rate and velocity limit of the flow cartridge (per ASHRAE standards). Contractor shall provide a complete project valve list including item number, quantity, vendor model number, size, design flow rate, psid range and location tag to the engineer and the balancing contractor. The balancing contractor shall complete this list by adding field-verified psid for each terminal unit and submit to the engineer for record purposes.

PART 3 EXECUTION

3.1 INSTALLATION - HYDRONIC PIPING SPECIALTIES

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with ASME B31.9.
- C. Provide access to devices where not exposed.
- D. Provide clearance around devices for maintenance.
- E. Use unions, flanges, and couplings downstream of devices and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- F. Locate test plugs adjacent to thermometers and thermometer sockets, at coil inlet and outlets and equipment inlet and outlets
- G. Provide air separator on suction side of system circulation pump and connect to expansion tank.
- H. All strainer blow-down connections shall be provided with a 3/4" drain valve with hose connection and brass cap.
- I. Relief Valves:
 - 1. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.
 - 2. Select system relief valve capacity greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
 - 3. Pipe relief valve outlet to nearest floor drain.
 - 4. If relief valve serves a glycol / water solution, pipe relief valve to glycol make-up tank.
 - 5. At the discharge of each relief valve, minimum pipe size shall be outlet connection size of drip pan elbow serving relief valve.

6. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

J. Air Vents:

1. Provide manual air vents at all system high points.
2. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
3. Where large air quantities accumulate, provide enlarged air collection standpipes.

K. Pumps:

1. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems.
2. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps.
3. Support pump fittings with floor mounted pipe and flange supports.

3.2 INSTALLATION - THERMOMETERS AND GAGES

- A. Install minimum one pressure gage for each pump, locate taps before strainers and on suction and discharge of pump; pipe to gage.
- B. Install gage taps in piping
- C. Install pressure gages with pulsation dampers. Provide needle valve to isolate each gage. Extend nipples to allow clearance from insulation.
- D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inches for installation of thermometer sockets. Allow clearance from insulation.
- E. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets.
- F. Coil and conceal excess capillary on remote element instruments.
- G. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- H. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- I. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.3 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements and 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

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BRANFORD, CONNECTICUT
State Project No.s: 014-0034 EA / 014-0035 BE-EA

3.4 PROTECTION OF INSTALLED CONSTRUCTION

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

END OF SECTION

SECTION 232123 - HYDRONIC PUMPS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. In-line pumps.
 - 2. Base mounted end suction pumps.
 - 3. Condensate pumps.

- B. Related Sections:
 - 1. Section 23 04 00 – General Conditions for Mechanical Trades
 - 2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
 - 3. Section 23 05 23 - General-Duty Valves for HVAC Piping: Product requirements for valves used in hydronic piping systems.
 - 4. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for vibrations isolators installed with pumps.
 - 5. Section 23 21 13 - Hydronic Piping: Execution requirements for connection to pumps specified by this section.
 - 6. Section 23 21 16 - Hydronic Piping Specialties: Product and execution requirements for piping specialties installed in hydronic systems adjacent to pumps.
 - 7. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electrical connections to pumps specified by this section.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- B. Underwriters Laboratories Inc.:
 - 1. UL 778 - Motor Operated Water Pumps.

1.5 PERFORMANCE REQUIREMENTS

- A. Provide pumps to operate at system fluid temperatures as indicated on Drawings 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.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements. Submit also, manufacturer model number, dimensions, service sizes, and finishes.
- C. Manufacturer's Installation Instructions: Submit application, selection, and hookup configuration with pipe and accessory elevations. Submit hanging and support requirements and recommendations.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- E. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.

3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.7 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit installation instructions, servicing requirements, assembly views, lubrication instructions, and replacement parts list.
- C. Maintain one copy of each document on site.

1.8 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.10 PRE-INSTALLATION MEETINGS

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

1.11 DELIVERY, STORAGE, AND HANDLING

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

1.12 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.13 WARRANTY

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

PART 2 PRODUCTS

2.1 IN-LINE PUMPS

- A. Manufacturers:
 - 1. Taco.
 - 2. B+G.
 - 3. Armstrong.
- B. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 175 psig maximum working pressure. Pumps shall be in-line type for installation in vertical or horizontal piping. Pump must be capable of being serviced without disturbing pipe connections.
- C. Casing: Cast iron, with flanged pump connections, gauge ports at nozzles, vent port and drain port.
- D. Impeller: Non-ferrous material, enclosed type, dynamically balanced, keyed to the shaft and secured by a locking cap screw or nut.
- E. Seal: Liquid cavity shall be sealed off at the motor shaft by an internally-flushed mechanical seal with ceramic seal seat, and seal ring, suitable for continuous operation at 225 deg. F. A non-ferrous shaft sleeve shall completely cover the wetted area under the seal.
- F. Pump bearing bracket shall have oil lubricated bronze journal and thrust bearings. Bracket shaft shall be alloy steel having ground and hardened thrust bearing faces. A flexible coupling to dampen starting torque and torsional vibrations shall be employed.
- G. Shaft: Alloy or stainless steel with copper or bronze sleeve, integral thrust collar.

- H. Drive: Flexible coupling.
 - 1. Motors: In accordance with Section 21 05 13; 1750 rpm unless specified otherwise.
 - 2. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.
 - 3. All pumps served by a VFD shall be provided with a shaft grounding ring.
- I. Each pump shall be factory tested. It shall then be thoroughly cleaned and painted with at least one coat of high-grade machinery enamel prior to shipment. The paint shall be free of ozone depleting substances

2.2 BASE MOUNTED END SUCTION PUMPS

- A. Manufacturers:
 - 1. Taco.
 - 2. B+G.
 - 3. Armstrong.
- B. Type: Horizontal shaft, single stage, direct connected, split casing, for 175 psig maximum working pressure. Pumps shall be end suction design with true back pull-out, capable of being serviced without disturbing piping connections
- C. Casing: Cast iron, with suction and discharge gage ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge, integrally-cast pedestal support.
- D. Impeller: Bronze, fully enclosed, dynamically balanced, keyed to the shaft and secured by a locking cap screw or nut.
- E. Seal: The liquid cavity shall be sealed off at the pump shaft by an internally-flushed mechanical seal with ceramic seal seat of at least 98% alumina oxide content, and carbon seal ring, suitable for continuous operation at 225 deg. A replaceable bronze shaft sleeve shall completely cover the wetted area under the seal
- F. Bearings: Heavy-duty regreaseable ball bearings; replaceable without disturbing piping connections.
- G. Baseplate: Cast iron or fabricated steel with integral drain rim , channel configuration fully enclosed at sides and ends, with securely welded cross members and fully open grouting area. . Contractor to level and grout each unit according to manufacturer's instructions
- H. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.
- I. Drive: Flexible coupling with coupling guard.
 - 1. Motors: In accordance with Section 21 05 13; 1750 rpm unless specified otherwise.

2. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.
 3. All pumps served by a VFD shall be provided with a shaft grounding ring.
- J. Each pump shall be factory tested. It shall then be thoroughly cleaned and painted with at least one coat of high-grade machinery enamel prior to shipment.
- K. Pump and motor shall be factory aligned, and shall be realigned by contractor after installation

2.3 CONDENSATE PUMPS

- A. Little Giant Model VCAM-20.
1. Other acceptable manufacturers offering equivalent products:
 - a. Dayton.
 - b. Aspen Pumps.
 - B. Pumps shall be UL listed, vertical type pump unit with ½ gallon ABS tank, stainless steel motor shaft, optional safety switch, thermal overload protection and glass filled polypropylene volute and impeller.
 - C. Capacity shall be 20 gallons per hour at 16 ft hd. Pump shall be rated for intermittent liquid temperature up to 120 F.
 - D. Pumps shall be 120, volt, single phase, 1/30 HP with minimum 6 foot long plug in power cord

2.4 ACCESSORIES

- A. Each pump served by a VFD shall be provided with an individual AEGIS grounding ring on the pump's shaft.

PART 3 EXECUTION

3.1 PREPARATION

- A. Coordinate that electric power is available and of the correct characteristics.
- B. Coordinate completion of bases and rails and layouts of concrete pads.
- C. Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.

3.2 INSTALLATION

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

- B. Install long radius reducing elbows or reducers between pump and piping. Support piping adjacent to pump so no weight is carried on pump casings. For close coupled or base mounted pumps, install supports under elbows on pump suction and discharge lines.
- C. Install pumps on vibration isolators. Refer to Section 23 05 48.
- D. Install floor mounted and base mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Refer to Section 23 05 48 and 03 30 00.
- E. Install flexible connectors at pump connections. Refer to Section 23 05 48 and 23 21 16.
- F. Provide line sized shut-off valve and strainer (or pump suction fitting with strainer), and line sized soft seat check valve, balancing valve, and shut-off valve (or combination pump discharge valve on pump discharge). Refer to Section 23 05 23 and Section 23 21 16.
- G. Provide air cock and drain connection on horizontal pump casings.
- H. Provide pressure gauges with shut-off valves at inlet and outlet of each pump.
- I. Provide drains for bases and seals; piped to and discharging into floor drains.
- J. Lubricate pumps before start-up.

3.3 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Check, align, and certify alignment of base mounted pumps prior to start-up.

END OF SECTION

SECTION 232300 - REFRIGERANT PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Refrigerant piping.
 - 2. Unions, flanges, and couplings.
 - 3. Pipe hangers and supports.
 - 4. Refrigerant moisture and liquid indicators.
 - 5. Valves.
 - 6. Expansion Loops.

- B. Related Sections:
 - 1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
 - 2. Section 23 05 00 – Common Work Results for HVAC: Product requirements for identification for placement by this section.
 - 3. Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment: Product requirements for hangers and supports for placement by this section
 - 4. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for Vibration Isolation for placement by this section.
 - 5. Section 23 07 00 - HVAC Insulation: Product requirements for Piping Insulation for placement by this section.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. Air-Conditioning and Refrigeration Institute:
 - 1. ARI 710 - Liquid-Line Driers.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- C. American Society of Mechanical Engineers:
 - 1. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - 2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
 - 3. ASME B31.5 - Refrigeration Piping.
- D. ASTM International:
 - 1. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
 - 2. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
 - 3. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
- E. American Welding Society:
 - 1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
 - 2. AWS D1.1 - Structural Welding Code - Steel.
- F. Manufacturers Standardization Society of the Valve and Fittings Industry:
 - 1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 - 2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
 - 3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.5 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.
- B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves or equipment.
- C. Provide pipe hangers and supports in accordance with ASME B31.5.

- D. Provide receivers on systems with piping runs exceeding 100 feet.
- E. Flexible Connectors: Use at or near compressors where piping configuration does not absorb vibration.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate layout of refrigeration piping system, including equipment, critical dimensions, and sizes.
- C. Product Data:
 - 1. Piping: Submit data on pipe materials, fittings, and accessories.
 - 2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
 - 3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
 - 4. Refrigerant Specialties: Submit manufacturers catalog information including capacity, component sizes, rough-in requirements, and service sizes for refrigerant moisture and liquid indicators.
- D. Design Data: Indicate pipe size. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- E. Test Reports: Required
- F. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.
- G. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.
- H. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.

3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.7 CLOSEOUT SUBMITTALS

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

1.8 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.5 code for installation of refrigerant piping systems.
- B. Maintain one copy of each document on site.
- C. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.9 QUALIFICATIONS

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

1.10 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Dehydrate and charge refrigeration components including piping and receivers, seal prior to shipment. Maintain seal until connected into system.
- C. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

1.12 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.13 COORDINATION

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

1.14 WARRANTY

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

1.15 MAINTENANCE MATERIALS

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

PART 2 PRODUCTS

2.1 REFRIGERANT PIPING

- A. Copper Tubing: ASTM B280, Type ACR hard drawn or annealed.
 - 1. Fittings: ASME B16.22 wrought copper.
 - 2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.

- B. Copper Tubing to 7/8 inch OD: ASTM B88, Type K, annealed.
 - 1. Fittings: ASME B16.26 cast copper.
 - 2. Joints: Flared.
- C. Flexible connections and expansion joints: Unisource Series 412; bronze hose and braid.

2.2 UNIONS, FLANGES, AND COUPLINGS

- A. 2 inches and Smaller:
 - 1. Ferrous Piping: 150 psig malleable iron, threaded.
 - 2. Copper Pipe: Bronze, brazed joints.
- B. 2-1/2 inches and Larger:
 - 1. Ferrous Piping: 150 psig forged steel, slip-on.
 - 2. Copper Piping: Bronze.
 - 3. Gaskets: 1/16 inch thick preformed neoprene.
- C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper brazed end, water impervious isolation barrier.

2.3 REFRIGERANT MOISTURE AND LIQUID INDICATORS

- A. Manufacturers:
 - 1. Henry Valve Co.
 - 2. Alco Controls Div, Emerson Electric Co.
 - 3. Parker Hannifin Corp., Refrig. & Air Cond. Div.
 - 4. Sporlan Valve Co.
- B. Indicators:
 - 1. Port: Single, UL listed.
 - 2. Body: Copper or brass, flared or brazed ends.
 - 3. Sight glass: Color-coded paper moisture indicator and plastic cap.
 - 4. Maximum working pressure: 500 psig
 - 5. Maximum working temperature: 200 degrees F.

2.4 VALVES

- A. Manufacturers:
 - 1. Henry Valve Co.
 - 2. Alco Controls Div, Emerson Electric Co.
 - 3. Parker Hannifin Corp., Refrig. & Air Cond. Div
 - 4. Sporlan Valve Co.
- B. Diaphragm Packless Valves:
 - 1. UL listed, globe or angle pattern, forged brass body and bonnet brazed or flared ends.
 - 2. Phosphor bronze and stainless steel diaphragms, rising stem and hand wheel.

3. Stainless steel spring, nylon seats, disc with positive back seating.
 4. Maximum working pressure: 500 psig.
 5. Maximum working temperature: 275 degrees F.
- C. Packed Angle Valves:
1. Forged brass, brazed or flared ends.
 2. Forged brass seal caps with copper gasket, rising stem and seat, molded stem packing.
 3. Maximum working pressure: 500 psig.
 4. Maximum working temperature: 275 degrees F.
- D. Ball Valves:
1. Two piece forged brass body with teflon ball seals and copper tube extensions, brass seal cap, chrome plated ball, stem with neoprene ring stem seals, brazed ends.
 2. Maximum working pressure: 500 psig.
 3. Maximum working temperature: 300 degrees F.
- E. Service Valves:
1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or brazed ends.
 2. Maximum working pressure: 500 psig.

2.5 REFRIGERANT FILTER-DRIERS

- A. Manufacturers:
1. Henry Valve Co.
 2. Alco Controls Div, Emerson Electric Co.
 3. Parker Hannifin Corp., Refrig. & Air Cond. Div.
 4. Sporlan Valve Co.
- B. Replaceable Cartridge Angle Type:
1. Shell: ARI 710, UL listed, brass, removable cap, for maximum working pressure of 500 psig.
 2. Filter Cartridge: Pleated media with integral end rings, stainless steel support.
 3. Filter/Dryer Cartridge: Pleated media with solid core sieve with activated alumina.
- C. Permanent Straight Through Type:
1. ARI 710, UL listed, steel shell with molded desiccant filter core, for maximum working pressure of 400 psig.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 INSTALLATION - INSERTS

- A. Provide inserts for placement in concrete forms.
- B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

3.4 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

- A. Route piping parallel to building structure and maintain gradient.
- B. Install piping to conserve building space, and not interfere with use of space.
- C. Group piping whenever practical at common elevations.
- D. Sleeve pipe passing through partitions, walls and floors. Refer to Section 23 05 29.
- E. Install pipe identification in accordance with Section 23 05 00.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 13.
- H. Arrange refrigerant piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
- I. Flood refrigerant piping system with nitrogen when brazing.
- J. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Section 09 90 00.
- K. Install valves with stems upright or horizontal, not inverted.

- L. Insulate piping and equipment; refer to Section 23 07 00.
- M. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
- N. Fully charge completed system with refrigerant after testing.
- O. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.
- P. Install refrigerant piping in accordance with ASME B31.5.

3.5 INSTALLATION - REFRIGERANT SPECIALTIES

- A. Refrigerant Moisture and Liquid Indicators:
 - 1. Install line size liquid indicators in main liquid line downstream of condenser.
 - 2. When receiver is provided, install line size liquid indicators in liquid line downstream of receiver.
 - 3. Install line size liquid indicators downstream of liquid solenoid valves.
- B. Refrigerant Valves:
 - 1. Install service valves on compressor suction and discharge.
 - 2. Install gage taps at compressor inlet and outlet.
 - 3. Install gage taps at hot gas bypass regulators, inlet and outlet.
 - 4. Install check valves on compressor discharge.
 - 5. Install check valves on condenser liquid lines on multiple condenser systems.
 - 6. Install refrigerant charging valve in liquid line between receiver shut-off valve and expansion valve.
- C. Filter-Dryers:
 - 1. Install permanent filter-dryers in low temperature systems.
 - 2. Install permanent filter-dryer in systems containing hermetic compressors.
 - 3. Install replaceable cartridge filter-dryer vertically in liquid line adjacent to receivers.
 - 4. Install replaceable cartridge filter-dryer upstream of each solenoid valve.

3.6 TESTING / FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Test refrigeration system in accordance with ASME B31.5.
- C. Pressure test refrigeration system with dry nitrogen to 200 psig for minimum two hours. Perform final tests at 27 inches vacuum and 200 psig using electronic leak detector.

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- D. Repair leaks.
- E. Retest until no leaks are detected.

END OF SECTION

SECTION 232500 - HVAC WATER TREATMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. System cleaner.
 - 2. Closed system treatment (water).
 - 3. Glycol makeup systems.
 - 4. Propylene glycol.
 - 5. Test equipment.
- B. Related Sections:
 - 1. Section 23 04 00 – General Conditions for Mechanical Trades.
 - 2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
 - 3. Section 23 21 13 – Hydronic Piping.
 - 4. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electrical connections specified by this section.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.
- C. Product Data: Submit chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Submit placement of equipment in systems, piping configuration, and connection requirements.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- F. Manufacturers Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.
- G. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout products.
- B. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical treatment system connections.
- C. Operation and Maintenance Data: Submit data on equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with State and local standards for addition of non-potable chemicals to building systems and for discharge to public sewers.
- B. Maintain one copy of each document on site.
- C. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum five years documented experience as approved by manufacturer. Company shall have local representatives, water analysis laboratories and full time service personnel within 150 miles of Project.

1.9 PRE-INSTALLATION MEETINGS

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

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.11 MAINTENANCE SERVICE

- A. Section 01 70 00 - Execution and Closeout Requirements: Maintenance service.
- B. Furnish quarterly technical service visits, for one year starting at Date of Substantial Completion, to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements and corrective actions needed. Submit two copies of field service report after each visit.
- C. Furnish laboratory and technical assistance services during this maintenance period.
- D. Furnish on site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

1.12 MAINTENANCE MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish chemicals for treatment and testing during warranty and maintenance period.

PART 2 PRODUCTS

2.1 WATER TREATMENT COMPANIES

- A. Water Treatment shall be provided by Nalco Co, Windsor Locks, CT. Other acceptable water treatment companies include:
 - 1. Jamestown Chemical Water Co, West Haven, CT
 - 2. Water Specialties LLC, West Suffield, CT
 - 3. Clearwater Industries, Shelton, CT

2.2 SYSTEM CLEANER

- A. System Cleaner shall be Nalco 2567 with antifoam Nalco 2508 Plus or approved equal.
- B. Product Description: Liquid alkaline compound with emulsifying agents and detergents to clean piping systems including removal of grease and petroleum products

2.3 CLOSED SYSTEM WATER TREATMENT

- A. Coupon racks shall have a minimum of 2 sampling ports and shall include a flow indicator (no dole valves) and an isolation valve on both ends of the rack.
- B. Closed System Water Treatment shall include the following features:
 - 1. Sequestering agent to reduce deposits and adjust pH polyphosphate.
 - 2. Corrosion inhibitors.
 - 3. Conductivity enhancers.

- C. Propylene Glycol:
 - 1. Dow Frost HD or approved equal.

2.4 TESTING EQUIPMENT

- A. Furnish basic water test equipment, including carrying case and spare reagents for maintaining control of the program standards. Provide reagents and apparatus for determination of corrosion inhibitor and oxidizing biocide levels in the re-circulating water systems.
- B. Provide reagents and apparatus for determination of TDS (umhos) in the system. The TDS meter should be a hand held with 4 selectable ranges (0-10, 0-100, 0-1000, and 0-10,000 umhos).
- C. Provide bacteria slides for measuring total bacteria counts in the system.

2.5 SHOT FEEDERS

- A. Provide individual shot feeders where shown on the drawings and noted below. Feeder shall be 12 gallon capacity, 150 psig working pressure, with tank, funnel, vent and drain valves: Mogul or approved equivalent.
- B. Install shot feeders adjacent to respective system circulating pumps. Connect shot feeder to one pump only, according to manufacturer's instructions.
- C. Provide tank supports, inlet valves, outlet valves, pipe and fittings.

2.6 AUTOMATIC MAKEUP / GLYCOL MAKEUP SYSTEMS

- A. Wessels Model GMP-15100. Other acceptable manufacturers offering equivalent products:
 - 1. Bell and Gossett.
 - 2. Armstrong.
 - 3. John Wood.
 - 4. Skidmore.
- B. The pumping assembly shall be mounted in a sturdy steel frame with legs to keep it off the floor. It shall include a 2.0 GPM at 75 psig pump, a ½ HP motor, a magnetic starter, a pressure tank with a pressure control, a priming valve, a PRV, shut-off valves, strainer and a pressure gauge. Pump shall be 110 volt, single phase.
- C. It shall feature a cut-off and alarm arrangement which will stop the pump in case of excessive pressure, or a low solution level, and activate an audible (which can be silenced) and a visual alarm. A 110 V signal shall also be available for a remote alarm.
- D. A translucent 100 gallon polyethylene solution container, complete with a lid, shall be mounted on the pumping assembly and shall include a strainer and a shut off valve.

PART 3 EXECUTION

3.1 PREPARATION

- A. Systems shall be operational, pressure tested, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place terminal control valves in open position during cleaning.

3.2 MANUFACTURER'S INSTRUCTIONS

- A. Install equipment in accordance with manufacturer's instructions.
- B. Handle and introduce chemicals in accordance with manufacturer's instructions.

3.3 PROCEDURES

- A. Contractor shall flush all systems with clean water including mud from drop legs. Remove, clean and replace all strainer screens.
- B. Enough cleaner shall be provided to clean all internal heat transfer surfaces, as a minimum a 2 % solution of total system volume for maximum effectiveness.
- C. Add recommended quantity of chemical directly into systems before the recirculating pumps to ensure rapid mixing and distribution throughout the system. . A small amount of antifoam (Nalco 2508 Plus or approved equal) may be added to prevent excessive foaming.
- D. Circulate the system for 48 - 72 hours. Open and drain mud legs and low points periodically during the cleaning process
- E. Drain system completely paying particular attention to mud from drop legs and all low points.
- F. Refill the system with clean, potable water; check all strainers, re-circulate and drain completely.
- G. Introduce chemicals per manufacturer's recommendations.
- H. Test and start-up all equipment
- I. Hot Water Heating Systems:
 - 1. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.
 - 2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.
 - 3. Circulate for 6 hours at design temperatures, then drain.
 - 4. Refill with clean water and repeat until system cleaner is removed.
 - 5. Drain and fill with PPG / water solution.

- J. Chilled Water Systems:
 - 1. Circulate for 48 hours, then drain systems as quickly as possible.
 - 2. Refill with clean water, circulate for 24 hours, then drain.
 - 3. Refill with clean water and repeat until system cleaner is removed.
 - 4. Drain and fill with PPG / water solution..

3.4 DEMONSTRATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Furnish two hour training course for operating personnel, instruction to include installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at start up of systems.

END OF SECTION

SECTION 233100 - HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Duct materials.
 - 2. Duct fabrication.
 - 3. Duct cleaning
 - 4. Ductwork leakage testing.
- B. Related Sections:
 - 1. Section 23 04 00 – General Conditions for Mechanical Trades
 - 2. Section 23 07 00 – HVAC Insulation
 - 3. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for hangers, supports and sleeves for placement by this section.
 - 4. Section 23 05 93- Testing, Adjusting, and Balancing for HVAC.
 - 5. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 PHASE 2 SUPPORT REQUIREMENTS

- A. All mechanical systems including equipment, ductwork, piping and accessories being hung from above shall not be supported from the existing “space truss” roof structure unless noted otherwise. Systems shall be supported from new framing only. Refer to structural drawings for locations of new framing. Provide supplemental framing as required.

1.5 REFERENCES

- A. ASTM International:
1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
 2. ASTM A90/A90M - Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
 3. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 4. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 5. ASTM A568/A568M - Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
 6. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 7. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
 8. A1011/A1011M-07 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
 9. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 10. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- B. National Fire Protection Association:
1. NFPA 70 - National Electrical Code.
 2. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
 3. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
 4. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- C. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - HVAC Air Duct Leakage Test Manual.
 2. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
 3. SMACNA - Rectangular or Round Industrial Duct Construction Standards.
 4. SMACNA - Thermoplastic Duct (PVC) Construction Manual.

- D. Underwriters Laboratories Inc.:
 - 1. UL 181 - Factory-Made Air Ducts and Connectors.

1.6 PERFORMANCE REQUIREMENTS

- A. Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.7 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Submit Ductwork Fabrication Drawings, drawn to scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as Contract Documents. Shop Drawings shall be submitted as colored hard copies and ACAD files and shall indicate:
 - 1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
 - 2. Duct layout, indicating sizes, pressure classifications and duct gages and in plan view. For exhaust duct systems, indicate classification of materials handled as defined in this section.
 - 3. Fittings.
 - 4. Reinforcing details and spacing.
 - 5. Seam and joint construction details.
 - 6. Penetrations through fire rated and other walls.
 - 7. Terminal unit, coil, and humidifier installations.
 - 8. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
- C. Product Data: Submit data for duct materials and methods of fabrication.
 - 1. Submit two samples of spiral ductwork.
- D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.
- E. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.

2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.8 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used. Record Documents shall be submitted as hard copies and ACAD files.

1.9 QUALITY ASSURANCE

- A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.
- B. Maintain one copy of each document on site.
- C. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.10 QUALIFICATIONS

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

1.11 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum four week2 prior to commencing work of this section.

1.12 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.
- B. Do not install duct sealant when temperatures are less than those recommended by sealant manufacturers.
- C. Maintain temperatures during and after installation of duct sealant.

1.13 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 1.
- B. Delivery:
 - 1. Open ends of ductwork shall be sealed during delivery and storage.
 - 2. At the time of delivery all materials shall be visually inspected for damage. Any damaged products, boxes, crates, , etc. shall be noted on the receiving ticket and immediately reported to the shipping company and the material manufacturer.
- C. Storage:
 - 1. Material may be stored either indoors or outdoors.
 - 2. If stored outdoors the material must be raised sufficiently off the ground to prevent it from being flooded.
 - 3. If stored outdoors the material must be covered with a weather proof flame resistant sheeting or tarpaulin.

1.14 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.15 WARRANTY

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

PART 2 PRODUCTS

2.1 DUCT MATERIALS

- A. Galvanized Steel Ducts: ASTM A653/A653M galvanized steel sheet, lock-forming quality, having G60 zinc coating of in conformance with ASTM A90/A90M; minimum 26 gage.

- B. Steel Ducts: ASTM A568/A568M. All connections shall be welded or flanged type.
- C. Fasteners: Rivets, bolts, or sheet metal screws.
- D. Hanger Rod: ASTM A36/A36M; steel; threaded both ends, threaded one end, or continuously threaded.
- E. Stainless Steel Ducts: ASTM A240/A240M or ASTM A666, Type 304.
- F. Aluminum Ducts: ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength. Support with aluminum threaded rod.
- G. Hanger Rod: ASTM A36/A36M; galvanized steel; stainless steel; threaded both ends, threaded one end, or continuously threaded.

2.2 METAL DUCTWORK FABRICATION

- A. Fabricate and support rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. Fabricate and support round ducts with longitudinal seams in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible (Round Duct Construction Standards). Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- C. Construct T's, bends, and elbows with minimum radius 1-1/2 times centerline duct width. Where not possible and where rectangular elbows are used, provide airfoil turning vanes. Where acoustical lining is indicated, furnish turning vanes of perforated metal with glass fiber insulation.
- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- E. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.
- F. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoff, use 90-degree conical tee connections.
- G. Seal joints between duct sections and duct seams with welds, gaskets, mastic adhesives, mastic plus embedded fabric systems, or tape.
 - 1. Sealants, Mastics and Tapes: Conform to UL 181A. Provide products bearing appropriate UL 181A markings.
 - 2. Sealants shall be low VOC, water resistant, fire resistive.

2.3 FLEXIBLE DUCTS

- A. Manufacturers:
 - 1. Thermaflex
 - 2. Technaflex
 - 3. Tuttle + Bailey
- B. Product Description: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helical-wound spring steel wire.
 - 1. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
 - 2. Maximum Velocity: 4000 fpm.
 - 3. Temperature Range: -20 degrees F to 210 degrees F.

2.4 INSULATED FLEXIBLE DUCTS

- A. Manufacturers:
 - 1. Thermaflex M-KE or approved equal by:
 - 2. Technaflex
 - 3. Tuttle + Bailey
- B. Product Description: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helical wound spring steel wire; fiberglass insulation; and outer jacket of fiberglass reinforced metalized film barrier.
 - 1. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
 - 2. Maximum Velocity: 5000 fpm.
 - 3. Temperature Range: -20 degrees F to 210 degrees F.
 - 4. Thermal Resistance: 4.2 square feet-hour-degree F per BTU.

2.5 KITCHEN HOOD EXHAUST DUCTWORK FABRICATION

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and NFPA 96.
- B. Exposed Kitchen Hood Exhaust Ducts: Construct of stainless steel ASTM A240/A240M OR ASTM 666, Type 304, minimum 18 gauge using continuous external welded joints.
- C. Concealed Kitchen Hood Exhaust Ducts: Construct of 16 gage carbon steel or 18 gage stainless steel ASTM A240/A240M OR ASTM 666, type 304 using continuous external welded joints.

2.6 PRE-FABRICATED GREASE DUCT

- A. Manufacturers:
 - 1. Van Packer DW Plus or approved equal by:
 - 2. Selkirk Metalbestos.
 - 3. Metal Fab.
- B. Grease duct shall be positive pressure, double wall metal duct system, tested to UL 103 and UL listed, for use with kitchen exhaust systems, in compliance with NFPA 96.

- C. Fabricate with 1 inch minimum air space between walls. Construct inner jacket of minimum .035" thick (0.9 mm) Type 304 stainless steel. Construct outer jacket of minimum .025" thick stainless steel.
- D. Accessories, UL labeled:
 - 1. Fan to Duct Transitions: Consists of roof penetration, flanged transition and spacers.
 - 2. Access Door Sections: Consisting of flanged, gasketed access doors.
 - 3. Grease Duct Drain Sections: Consisting of straight duct sections with grease drain fittings.
 - 4. Fittings: Elbows, wyes, expansion sections and accessories as required for a complete installation.
 - 5. Joints: Seal with sealant as recommended by manufacturer.

2.7 SINGLE WALL SPIRAL ROUND AND FLAT OVAL DUCTS

- A. Manufacturers:
 - 1. McGill AirFlow Corporation
 - 2. Semco Incorporated
 - 3. Spiral Mfg. Co., Inc
 - 4. Eastern Sheet Metal.
- B. Product Description: Machine made, UL 181, Class 1, round spiral lockseam duct constructed of ASTM A527 galvanized steel with G60 zinc coating in conformance with ASTM A90; rated for 10 inches wg pressure or ASTM B209; aluminum sheet, alloy 3003-H14 per schedules below.

2.8 DOUBLE WALL DUCTWORK

- A. Manufacturers:
 - 1. McGill AirFlow Corporation
 - 2. Semco Incorporated
 - 3. Spiral Mfg. Co., Inc.
 - 4. Eastern Sheet Metal.
- B. Double Wall Round and Oval Product Description: McGill AirFlow Acouti-k27 or approved equal, machine made, UL 181 round spiral lockseam or solid weld duct with light reinforcing corrugations, minimum 28 gauge galvanized steel outer wall, 1 inch thick glass fiber insulation, perforated galvanized steel inner wall; fittings of the same constructions. Rating shall be for 10 inches wg. Galvanized steel shall be ASTM A527 steel with G60 zinc coating in conformance with ASTM A90.
- C. Double Wall Rectangular Product Description: McGill AirFlow k-27 or approved equal, machine made, minimum 28 gauge galvanized steel outer wall, 1 inch thick glass fiber insulation, minimum 24 gauge perforated galvanized steel inner wall; fittings of the same constructions. Rating shall be for 10 inches wg. Galvanized steel shall be ASTM A527 steel with G60 zinc coating in conformance with ASTM A90. Duct connections shall be TDC transvers duct connection flanged ends.

- D. Duct Coatings: All double wall ductwork will be spray coated in the field; refer to Division 9. Ductwork shall be provided factory prepped for final field applied coatings.

2.9 CASINGS / PLENUMS

- A. Fabricate casings and plenums in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and construct for operating pressures indicated.
- B. Reinforce access door frames with steel angles tied to horizontal and vertical plenum supporting angles. Furnish hinged access doors where indicated or required for access to equipment for cleaning and inspection.

2.10 FABRIC DUCTWORK

- A. Manufacturers:
1. Fabric Air Comi 70 or approved equal as manufactured by:
 - a. Durkee Sox
 - b. ADC Custom Fabric
- B. Fabric Dispersion System
1. Color: Fabric system shall be 3000 - white.
 2. The fabric system shall be a woven fire retardant and permeable fabric complying with the following characteristics:
 - a. Fabric: 100% Flame Retardant Polyester
 - b. Weight: 8.5 oz./yd² per ASTM D3776
 - c. Shrinkage: Max. 0.5% per DIN EN 26 630
 - d. Temperature Range: -40°F to +284°F
 - e. Base Permeability @ 0.5" WG: 2.28 CFM/SQFT per ASTM D737, Shall be verified by the Frazier Permeability Test
 - f. Fire Retardancy: Shall meet the requirements of NFPA 90-A, ICC AC167 and UL 2518
 3. Fabrication Requirements
 - a. The system shall be made with sewn in but removable aluminum hoops. The hoops shall;
 - 1) Maintain the ducts' cylindrical shape at all times,
 - 2) Be made to a circular arc angle of 180° (8" - 48"), 120° (49" - 60"), 90° (61" - 68") or 60° (69" - 80") depending on duct diameter.
 - 3) Be centered at the 12:00 o'clock position of the duct,
 - 4) Be installed at the factory, on-site installation shall not be allowed.
 - b. Diameter and spacing of hoops shall be determined by the manufacturer based on duct diameter.
 - c. Elbows of 70° or more shall have at least two hoops.
 - d. Air dispersion shall be accomplished with linear arrays of laser cut "Sonic Flow Orifices" for ductwork installed at maximum 15' above finished floor. Orifices shall be from 0.12" to 0.55" diameter.

- e. Air dispersion shall be accomplished with linear arrays of laser cut “Ori Flow Orifices” for ductwork installed over 15’ above finished floor. Orifices shall be from 0.56” to 4.92” diameter.
 - f. Number and size of orifices shall be determined by manufacturer and as required to meet performance as shown on the contract documents.
 - g. The system shall be made of permeable fabric. Base permeability of fabric shall be reached based on a combination of weave construction and a thermo fixation process in order to prevent permeability degradation after wash. Fabric permeability based on a calendering process is not acceptable.
 - h. Fabric system shall include connectors to attach to suspension system.
 - i. Provide system in sections optimized for maintenance, connected by zippers. Zippers shall provide closure completely around the circumference to prevent leakage. Required number of zippers shall be specified by the manufacturer.
 - j. Each section to have a unique tag including information about manufacturer's order number, position, diameter of section, length of section, maintenance instruction, code compliance and contact details for spare parts.
- C. Design Parameters
- a. Use fabric air diffusers only for positive pressure air distribution.
 - b. Do not use fabric air diffusers in concealed locations.
 - c. Fabric diffusers shall be designed from minimum 0.25” water gage to 3” as the maximum – 0.5” being the standard.
 - d. Design temperatures between –40°F and 284°F
 - e. Manufacturer shall approve all technical design parameters.
 - f. Pool / Natatorium applications: Materials shall be compatible with chlorine environment.
- D. Hangers and Supports
- a. Type 8: One row H-rail/cable system located 2” above 12 o'clock of Fabric Ductwork System. Hardware to include H-rail joint, eye bolt, end cap H-rail, cable, tie down strap and H-rail as required. System shall be attached to hardware using one single row of plastic sliders located 12 o'clock spaced 20 inches.
 - b. Hardware: Anodized Aluminum H-Rails - With PVC coated Stainless Steel suspension cable. Suspension cable clamps, H-rail suspension eyebolts, and all other factory supplied metal components shall be Stainless Steel.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify sizes of equipment connections before fabricating transitions.

3.2 INSTALLATION

- A. Install, support and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. During construction, install temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- C. Duct sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- D. Use crimp joints with or without bead or beaded sleeve couplings for joining round duct sizes 8 inch and smaller.
- E. Use double nuts and lock washers on threaded rod supports.
- F. Set plenum doors 6 to 12 inches above floor. Arrange door swing so fan static pressure holds door in closed position.
- G. Plenums and Casings: Install floor mounted casings on 4 inch high concrete curbs. Refer to Section 03 30 00. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, furnish liner of 18 gage galvanized expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.
- H. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- I. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct usable space or block access for servicing building and its equipment
- J. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.
- K. Provide openings in ductwork where required to accommodate control devices. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring
- L. Provide duct access doors for inspection and cleaning before and/or after filters, coils, manual dampers, control dampers, control devices, fire dampers, combination fire and smoke dampers, and where shown on the drawings. Minimum door size shall be 10 x 12 inches except where limited by duct size. Minimum door size at intake or exhaust plenums shall be 18 x 24.
- M. Flexible Ductwork and Insulated Flexible Ductwork:
 - 1. Ductwork systems which cross rated walls of 1 hour or less shall be continuous, minimum 26 gauge ductwork systems. Flexible duct shall not be installed.

2. Connect terminal units such as VAV boxes to supply ducts with one foot maximum length of flexible duct. Do not use flexible duct to change direction.
 3. Connect diffusers to low pressure ducts with 8 feet maximum length of flexible duct held in place with strap or clamp
 4. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.
- N. Louvers and Roof Hoods: All unused sections shall be sealed off / “blanked-off” with double wall insulated panels. Panels shall encase 2” rigid insulation, Type D-2 per Specification Section 23 0700.
- O. Ductwork (non-insulated) installed at the exterior of the building shall be aluminum construction. Joins shall be made with flanged duct connections designed for weatherproof installation. Provide with gaskets for installation outside the building (temperature ranges and weather resistant).
- P. Exhaust Outlet Locations:
1. Minimum Distance from Property Lines: 3 feet.
 2. Minimum Distance from Building Openings: 3 feet.
 3. Minimum Distance from Outside Air Intakes: 25 feet.
- Q. For outdoor ductwork, protect ductwork, ductwork supports, linings and coverings from weather.
- R. Kitchen Hood Exhaust:
1. Install residue traps in kitchen hood exhaust ducts at base of vertical risers with provisions for clean out.
 2. Ductwork: Install ductwork without forming dips or traps. Maintain pitch to drain grease back to the hood.
 3. Ductwork Access Panels: Install access panels per mechanical codes and where shown on the drawings.

3.3 INSTALLATION OF FABRIC DUCT SYSTEM

- A. Examine area and conditions under which the Fabric Duct systems are to be installed. Do not continue any installation until unsatisfactory conditions have been corrected.
- B. Install chosen suspension system in accordance with the requirements of the manufacturer. Installation instructions shall be provided by the manufacturer with product.
- C. Coordinate layout with suspended ceiling, lighting layouts, and all other trades that may interfere with the installation.
- D. Clean air handling unit and other ductwork prior to the duct system as it is installed. Ensure that all construction debris, including dust, is removed from the air handling unit and other ductwork before connecting the duct system.
- E. If the duct system becomes soiled during the installation, it should be removed and cleaned following the manufacturers cleaning instructions.

3.4 DUCTWORK LEAKAGE TESTING

- A. The following ductwork systems shall be pressure/leakage tested:
1. All ductwork to be concealed in a sheetrock, concrete block or other permanent chase shall be pressure tested before ductwork is concealed.
 2. All ductwork systems listed below to be constructed and installed for 3" w.c. or more (positive or negative).
 3. All supply air ductwork from outlet of each AHU and DOAS to inlet of each VAV box.
 4. For AHU's without VAV boxes, all supply air ductwork mains.
 5. All exhaust air ductwork from inlet of each DOAS to outlet of each VAV box.
 6. All return air and exhaust air ductwork mains.
 7. All plenums.
 8. For ductwork leakage testing: "Ductwork main" shall be defined as all ductwork serving more than one grille or diffuser.
 9. All ductwork outside of the building insulation envelope.
- B. Testing shall conform to the following:
1. Test in accordance with SMACNA HVAC Air Duct Leakage Test Manual. Maximum Allowable Leakage shall be in accordance with Duct Pressure Class rating listed below and Leakage Class listed here-in.
 2. For Ductwork Pressure Class 3" w.c: Leakage Class shall be 8.
 3. For Ductwork Pressure Class 2" w.c: Leakage Class shall be 16.
 4. Testing shall occur after ductwork has been cleaned, but before duct insulation is applied or ductwork is concealed.
 5. During the ductwork leakage test, the pressure maintained in the ductwork shall be set for the Ductwork Pressure Class.
- C. Duct Leakage Test Report shall include:
1. Date of test.
 2. Name of company and person conducting the test.
 3. Name of company and person witnessing the test.
 4. Description of ductwork tested. Provide drawings to indicate section of ductwork being tested. Labeling on the drawings shall correspond to labeling in the report.
 5. Surface area (square feet) of section of ductwork being tested.
 6. Duct design operating pressure (inches w.c.)
 7. Duct design test static pressure (inches w.c.)
 8. Duct capacity, air flow
 9. Specified Leakage Class.
 10. Leakage factor (CFM / 100 sf of duct area)
 11. Maximum allowable leakage (CFM)
 12. Test apparatus
 - a. Blower
 - b. Orifice tube size
 - c. Orifice size
 - d. Calibrated
 13. Test orifice differential pressure (inches w.c.)

3.5 GREASE DUCT TESTING

- A. Prior to concealing, wrapping, or insulating grease ductwork, or placing grease duct in service, perform leakage test in accordance with ICC IMC, in presence of authority having jurisdiction.
- B. Perform light test by pulling minimum 100 W light through duct and observing for light leaks at duct joints.
- C. Test complete extent of duct installed, including joint at which duct connects to exhaust hood.

3.6 DUCTWORK CLEANING

- A. All interior surfaces of new ductwork and new air handling equipment shall be cleaned by a contractor certified by the National Air Duct Cleaners Association (NADCA). Duct cleaning shall be performed in accordance with the latest version of NADCA publication "Assessment, Cleaning and Restoration ACR 2005". The criteria for the cleanliness of the ductwork shall be NADCA Assessment, Cleaning & Restoration of HVAC Systems Method 1 – Visual Inspection, Method 2 – Surface Comparison Test and Method 3 – NADCA Vacuum Test.
- B. Contractor shall notify Engineer in a timely manner (minimum 48 hours notice) upon completion of cleaning of sections of ductwork such that Engineer, Owner and Owner's representatives can inspect the ductwork. After the ductwork has been cleaned the NADCA Certified Supervisor shall inspect the ductwork for cleanliness prior to inspection by the Owner and Owner's IAQ Specialist. The air handling units, diffusers and open ended ductwork shall be protected after cleaning so that dust does not resettle on the ductwork.
- C. Ductwork shall be re-cleaned at no cost to the Owner if it becomes contaminated due to the Contractor's activities.
- D. Provide duct access doors of adequate size and quantities to allow thorough cleaning and inspection. Access doors shall meet NADCA Standard 05 – Requirement for the Installation of Service Openings in HVAC Systems.

3.7 SCHEDULES

A. Ductwork Material Schedule:

AIR SYSTEM	MATERIAL
Supply Air and Return Air unless noted otherwise	Galvanized Steel
Relief Air unless noted otherwise	Galvanized Steel
Outside Air unless noted otherwise	Aluminum
General Exhaust unless noted otherwise	Galvanized Steel
All Exhaust Serving DOAS-4	Aluminum
Supply Air and Return Air Serving Rooms without ceilings (open to roof or floor structure above) including spaces like Band Room, General Music Rooms, and Choral Rooms	Double Wall
AHU-1: All Supply Air and Return Air Installed inside Auditorium and Auditorium Stage including duct mains and branches	Double Wall
Supply Air and Return Air Serving Open Areas including Gymnasiums	Double Wall and Fabric Duct
Return Air Under the Floor of the Stage	Aluminum
Supply Air, Return Air and Exhaust Serving Pool / Natatorium / Pool Equipment Rooms	Aluminum and Fabric Duct
Kitchen Hood Exhaust	Concealed Ductwork: Carbon Steel or Pre-fabricated Grease Duct system. Ductwork Exposed to View: Stainless Steel or Pre-fabricated Grease Duct System Ductwork at Exterior of the Building: Pre-fabricated Grease Duct System
Dishwasher Exhaust	Stainless Steel
Fume Hood Exhaust	Stainless Steel
All Non-Insulated Ductwork at the Exterior of the Building	Aluminum
Louvers and Roof Hoods: Double wall insulated panels serving "blank-offs"	Aluminum

Combustion Air Intakes	Galvanized Steel
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B. Ductwork Pressure Class Schedule:

AIR SYSTEM	PRESSURE CLASS
Supply Air Unless Noted Otherwise	2 inch w.c. regardless of velocity.
Return Air Unless Noted Otherwise	2 inch w.c. regardless of velocity.
Outside Air Unless Noted Otherwise	2 inch w.c. regardless of velocity.
Exhaust Unless Noted Otherwise	2 inch w.c. regardless of velocity.
Relief Air Unless Noted Otherwise	2 inch w.c. regardless of velocity.
AHU Supply Air from outlet of unit to inlet of each VAV	3 inch w.c. regardless of velocity.
AHU Supply Air Mains from unit to inlet of fabric duct.	3 inch w.c. regardless of velocity.
DOAS Supply Air from outlet of unit to inlet of each VAV	3 inch w.c. regardless of velocity.
DOAS Return Air from inlet of unit to outlet of each VAV	3 inch w.c. regardless of velocity.
Variable Air Volume Supply (downstream of VAV boxes)	1 inch w.c. regardless of velocity.
Combustion Air Intakes	1 inch w.c.
Dishwasher Exhaust	3 inch w.c.
Fume Hood Exhaust	3 inch w.c.

END OF SECTION

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Duct access doors.
 - 2. Dynamic fire dampers.
 - 3. Volume control dampers/balancing dampers.
 - 4. Remotely controlled volume dampers.
 - 5. Flexible duct connections.
 - 6. Duct test holes.
- B. Related Sections:
 - 1. Section 23 09 23 - Direct-Digital Control System for HVAC: Execution and Product requirements for connection and control of Combination Smoke and Fire Dampers for placement by this section.
 - 2. Section 23 31 00 - HVAC Ducts and Casings: Requirements for duct construction and pressure classifications.
 - 3. Division 26 - electrical: Execution requirements for connection of electrical Combination Smoke and Fire Dampers specified by this section.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. Air Movement and Control Association International, Inc.:
 - 1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
- B. ASTM International:
 - 1. ASTM E1 - Standard Specification for ASTM Thermometers.
- C. National Fire Protection Association:
 - 1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
 - 2. NFPA 92A - Recommended Practice for Smoke-Control Systems.
- D. Sheet Metal and Air Conditioning Contractors:
 - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
- E. Underwriters Laboratories Inc.:
 - 1. UL 555 - Standard for Safety for Fire Dampers.
 - 2. UL 555C - Standard for Safety for Ceiling Dampers.
 - 3. UL 555S - Standard for Safety for Smoke Dampers.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, duct access doors, and duct test holes.
- C. Product Data: Submit data for shop fabricated assemblies and hardware used.
- D. Materials of construction shall match ductwork materials. Refer to Section 23 3100.
- E. Product Data: Submit for the following. Include where applicable electrical characteristics and connection requirements.
 - 1. Fire dampers including locations and ratings.
 - 2. Smoke dampers including locations and ratings.
 - 3. Backdraft dampers.
 - 4. Flexible duct connections.
 - 5. Volume control dampers.
 - 6. Duct access doors.
 - 7. Duct test holes.
- F. Product Data: For fire dampers submit the following:
 - 1. Include UL ratings, dynamic ratings, leakage, pressure drop and maximum pressure data.
 - 2. Indicate materials, construction, dimensions, and installation details.
 - 3. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.

- G. Manufacturer's Installation Instructions: Submit for Fire and Combination Smoke and Fire Dampers.
- H. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- I. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of access doors.

1.7 QUALITY ASSURANCE

- A. Dampers tested, rated and labeled in accordance with the latest UL requirements.
- B. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.
- C. Maintain one copy of each document on site.
- D. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.

2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.9 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Protect dampers from damage to operating linkages and blades.
- C. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.
- D. Storage: Store materials in a dry area indoor, protected from damage.
- E. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.12 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate Work where appropriate with building control Work.

1.13 WARRANTY

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

1.14 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two of each size and type of fusible link.

PART 2 PRODUCTS

2.1 DUCT ACCESS DOORS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.
- B. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, furnish minimum 1 inch thick insulation with double wall, sheet metal cover.
 - 1. Less than 12 inches square, secure with sash locks.
 - 2. Up to 18 inches Square: Furnish two hinges and two sash locks.
 - 3. Up to 24 x 48 inches: Three hinges and two compression latches with outside and inside handles.
 - 4. Access doors with sheet metal screw fasteners are not acceptable.

2.2 DYNAMIC FIRE DAMPERS

- A. Manufacturers:
 - 1. Ruskin models noted below.
 - 2. Other acceptable manufacturers offering equivalent products include:
 - a. Air Balance.
 - b. Greenheck.
 - c. Prefco.
- B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
- C. Ceiling Dampers: Galvanized steel, minimum 22 gage frame and 22 gage insulated blades. Provide with adjustable air flow balancing device and thermal insulation blanket for diffusers. Dampers shall be Ruskin Model CFD.
- D. Curtain Type Dampers: Galvanized steel minimum 22 gage frame and interlocking blades normally set out of the air stream. Provide stainless steel closure springs and latches. Damper shall be Ruskin Model DIBD.
- E. Multiple Blade Dampers: 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock. Damper shall be Ruskin Model FD35.

- F. Fire dampers serving aluminum ductwork systems including pool supply air, pool return air, pool exhaust, chemical exhaust, etc, shall be all stainless steel construction.
- G. As required by ductwork fabrication shop drawings, Damper “Out-of-Wall” applications shall be Model FD/OW or approved equal and shall be provided with factory insulation between damper and wall.
- H. Fusible Links: UL 33, separate at 165 degrees F.
- I. Fire rating of dampers shall be 1 ½ hour unless noted otherwise on the drawings.
- J. Fire dampers shall be labeled according to UL 555 Type “B”, dynamically rated to close under maximum flow conditions. Static rated dampers are unacceptable.

2.3 VOLUME CONTROL DAMPERS / BALANCING DAMPERS

- A. Manufacturers:
 - 1. Ruskin models noted below.
 - 2. Other acceptable manufacturers offering equivalent products include:
 - a. Air Balance.
 - b. Greenheck.
- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
- C. Single Blade Dampers: For duct sizes up to 12 x 36 inch and 20 inch diameter with minimum 20 gage frame and blade and molded synthetic bearings. Damper shall be Ruskin Model MD25 and MDRS 25.
- D. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 48 inch. Provide with minimum 16 gage frame and blades and molded synthetic bearings. Dampers shall be Ruskin Model MD35.
- E. Quadrants:
 - 1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
 - 2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
 - 3. Where rod lengths exceed 30 inches provide regulator at both ends.
- F. Damper Marker Tape: Attach bright colored tape to each damper for ease of identifying dampers in the field. Tape shall hang down below bottom of duct the damper is serving.

2.4 REMOTELY OPERATED VOLUME DAMPERS

- A. Manufacturers
 - 1. Metro Air Tech
 - 2. Young Regulators

- B. Produce Description
1. Furnish cable operated remote controlled volume dampers in branch ducts located at inaccessible ceilings and where indicated on the Drawings. Reference architectural drawings for locations of gypsum board and spline etc. ceilings.
 2. Dampers are adjustable with standard tools at the ceiling line by one of the following methods:
 - a. Through face of the diffuser or grille.
 - b. Round or rectangular steel cup secured to the ceiling framing or wall mounted at locations approved by Architect and Owner.
 - c. in a self supporting 2" round cup.
 3. Powder painted steel box cover plate shall be fastened with standard countersunk (Option: tamperproof countersunk) screws providing a secure, unobtrusive appearance flush with the ceiling surface.
 4. Galvanized steel, square-shafted damper shall be worm gear actuated via a brass plated rotary cable meeting Mil-spec I-45208 and supported at the damper end by a self lubricating bearing integral to the worm gear assembly.
 5. Additional cable retainer supports shall be factory furnished as required by the cable length. Rotary cable shall have a minimum torque service factor of 200% when installed in accordance with manufacturer furnished instructions. Ceiling Cup, rotary cable, and worm gear shall be furnished as one piece for installation with no linkage adjustment required or small parts to get lost on site. Positive, direct, two-way damper control shall be provided with no sleeves, springs, or screw adjustments to come loose after ceiling closure.

2.5 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
- B. Connector: Fabric crimped into metal edging strip.
1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.
 2. Net Fabric Width: Approximately 3 inches wide.
 3. Metal: 3 inch wide, 24 gage galvanized steel.

2.6 DUCT TEST HOLES

- A. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Furnish extended neck fittings to clear insulation.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify rated walls are ready for fire damper installation.

- C. Verify ducts and equipment installation are ready for accessories.
- D. Check location of air outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.2 INSTALLATION.

- A. Install in accordance with NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 31 00 for duct construction and pressure class.
- B. Access Doors: Install access doors at the following locations and as indicated on Drawings:
 - 1. Spaced every 50 feet of straight duct or less spacing as required for cleaning of ductwork.
 - 2. Upstream of each elbow.
 - 3. Upstream of each reheat coil.
 - 4. Before and after each duct mounted filter.
 - 5. Before and after each duct mounted coil.
 - 6. Before and after each duct mounted fan.
 - 7. Before and after each automatic control damper.
 - 8. Before and after each fire damper, smoke damper, combination fire and smoke damper.
 - 9. Downstream of each VAV box.
 - 10. Install at locations for cleaning kitchen exhaust ductwork in accordance with NFPA 96 and 2012 IMC.
- C. Access Door Sizes: Install minimum 12 x 12 inch size for hand access, 18 x 18 inch size for shoulder access.
- D. Install fire dampers at locations as indicated on Drawings at all rated walls and partitions (refer to architectural drawings and code drawings); including 1 hour rated walls and partitions. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
 - 1. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A.
 - 2. Install dampers square and free from racking with blades running horizontally.
 - 3. Do not compress or stretch damper frame into duct or opening.
 - 4. Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jack shaft.
 - 5. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.
- E. Installation of Volume Control Dampers:
 - 1. Provide at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing and where shown on drawings. Install minimum 2 duct widths from duct take-off.

2. Provide volume control / balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.
 3. At each damper, attach Damper Marker Tape for ease of identifying dampers in the field. Tape shall hang down below bottom of duct.
- F. Remote controlled volume dampers shall be installed in branch ducts located at inaccessible ceilings and where indicated on the Drawings. Reference architectural drawings for locations of gypsum board and spline etc. ceilings.
- G. Install flexible duct connections immediately adjacent to equipment in ducts associated with fans and motorized equipment.
- H. Install temporary duct test holes and required for testing and balancing purposes. Cut or drill in ducts. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

3.3 DEMONSTRATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate re-setting of fire dampers to Owner's representative.

END OF SECTION

SECTION 233303 - SOUND ATTENUATORS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sound Attenuators.
- B. Related Sections:
 - 1. Section 23 04 00 – General Conditions for Mechanical Trades
 - 2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for hangers, supports and sleeves for placement by this section.
 - 3. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.
 - 4. Section 23 31 00 – HVAC Ducts and Casings.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. ANSI S12.60 – Acoustical Performance Criteria, Design Requirements and Guidelines for Schools

- B. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- C. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.
- D. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.5 PERFORMANCE REQUIREMENTS

- A. Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data:
 - 1. Published Literature: Indicate dimensions, weights, capacities, ratings, gages and finishes of materials.
 - 2. Select sound attenuators based on actual HVAC equipment that is being provided. Review shop drawings for Air Handling Units and Air Terminal Units and provide sound attenuator selections that match the equipment's sound data.
 - 3. Submit sound data at rated capacity.
- C. Manufacturer's Installations Instructions.
- D. Provide acoustical system calculations for all duct systems with silencers to demonstrate the silencers shall reduce noise levels from AHU-1, AHU-2 and DOAS-1 to NC and dBa values stated on contract documents (ANSI S12.60). Use sound power levels of actual equipment to be installed on project. Analysis shall include breakout noise calculations. In the absence of specified background sound level criteria, the guidelines as expressed in the "Sound and Vibration Control" Chapter of the ASHRAE Handbook - HVAC Applications, shall be used. Spaces shall be designed for:
 - 1. Music Room: Maximum dBa of 35.
 - 2. Classrooms and all Learning Environments: Maximum dBa of 35.
 - 3. Multi-Purpose: Maximum dBa of 35
 - 4. Offices: Maximum NC-35.
 - 5. Conference rooms: Maximum NC-35.
 - 6. Auditorium and Stage: Maximum NC-20.
- E. The manufacturer shall supply certified test data for each scheduled silencer. The data shall include dynamic insertion loss, generated noise and pressure drop for forward or reverse flow, matching the project's air distribution system requirement. All ratings shall be conducted in the same facility and shall utilize the same silencer.
- F. Test facilities and test reports shall be open to inspection upon request from the Engineer. Silencer performance shall be substantiated by laboratory testing according to ASTM E-477-99 and so certified when submitted for approval. The aero-acoustic laboratory shall

be NVLAP accredited for the ASTM E-477-99 test standard. A copy of the accreditation certificate shall be included with the submittals.

- G. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.7 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.8 QUALITY ASSURANCE

- A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.
- B. Construct ductwork to NFPA 90A standards.
- C. Maintain one copy of each document on site.
- D. Perform Work in accordance with SMACNA publication as scheduled in Part 3 - Execution.
- E. Silencer manufacturer shall operate its own duct-to-reverberant room test facility which provides for airflow in both directions through the test silencer in accordance with ASTM

E-477-99. The facility shall maintain NVLAP accreditation for the E477-99 test standard.

- F. High Performance Building Requirements:
1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.9 QUALIFICATIONS

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

1.10 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.
- B. Do not install duct sealant when temperatures are less than those recommended by sealant manufacturers.
- C. Maintain temperatures during and after installation of duct sealant.

1.12 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Vibro-Acoustics.
- B. Other manufacturers offering similar products.
1. Industrial Acoustics Company.
 2. McGill Airflow.

2.2 MATERIALS

- A. Rectangular Silencers: All rectangular silencers shall be constructed with a 22 gauge galvanized steel outer casing and 26 gauge galvanized perforated steel unless note otherwise.
- B. Elbow Silencers: All elbow silencers shall be constructed with an 18 gauge galvanized steel outer casing and 22 gauge galvanized perforated steel. All acoustical splitters shall be internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters are required as necessary to achieve the scheduled insertion loss. All elbow silencers with a turning cross-section dimension greater than 48" shall have at least two half splitters and one full splitter.
- C. Vibro-Acoustics Model RMB - Mold Block Acoustic Media: Media shall be MoldBlock Media™ containing 100% natural cotton fibers treated with an EPA registered, non-toxic borate solution, "flash dried" to actively inhibit the growth of mold, mildew, bacteria and fungi. Media shall not contain any formaldehydes, phenolic resins or Volatile Organic Compounds (VOC's) that can off-gas and/or cause health concerns. Media shall be 100% recyclable. Media shall comply with UL181 and NFPA 90A. MoldBlock Media™ shall be packed with a minimum of 15% compression during silencer assembly. Media shall not cause or accelerate corrosion of aluminum or steel. Glass fiber, fiberglass and rock wool will not be permitted as a substitute for MoldBlock Media™
1. An alternate acceptable material to Mold Block Acoustic Media is Fiberglass Acoustic Media as specified below with Film Lining.
- D. Vibro-Acoustics Model RD - Fiberglass Acoustic Media: Media shall be of acoustic quality, shot-free glass fiber` insulation with long, resilient fibers bonded with a thermosetting resin. Glass fiber density and compression shall be as required to insure conformance with laboratory test data. Glass fiber shall be packed with a minimum of 15% compression during silencer assembly. Media shall be resilient such that it will not crumble or break, and conform to irregular surfaces. Media shall not cause or accelerate corrosion of aluminum or steel. Mineral wool will not be permitted as a substitute for glass fiber.
- E. Combustion Ratings: Silencer materials, including acoustic media shall have maximum combustion ratings as noted below when tested in accordance with ASTM E84, NFPA 255 or UL 723.
- | | |
|-----------------------------|----|
| Flamespread Classification: | 15 |
| Smoke Development Rating: | 10 |

2.3 CONSTRUCTION

- A. Silencers shall be constructed in accordance with ASHRAE and SMACNA standards for the pressure and velocity classification specified for the air distribution system in which it is installed. Material gauges noted in "Section B Materials", are minimums. Material gauges shall be increased as required for the system pressure and velocity classification. The silencers shall not fail structurally when subjected to a differential air pressure of 8 inches water gauge.

- B. Casings shall be lockformed and sealed, except as noted in Section B Materials, to provide leakage-resistant construction. Airtight construction shall be achieved by use of a duct-sealing compound supplied and installed by the contractor at the jobsite.
- C. All perforated steel shall be adequately stiffened to insure flatness and form. All spot welds shall be painted.

2.4 ACOUSTIC PERFORMANCE

- A. Silencer dynamic insertion loss shall not be less than that listed in the schedule.
- B. Acoustic performance shall include dynamic insertion loss and generated noise for forward flow (air and noise in same direction) or reverse flow (air and noise in opposite direction) in accordance with the project's air distribution system requirements.
- C. All silencer ratings shall be determined in a duct-to-reverberant room test facility which provides for airflow in both directions through the test silencer in accordance with the ASTM E-477-99 test standard. The test set-up, procedure and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves and reverberation room absorption.

2.5 AERODYNAMIC PERFORMANCE

- A. Silencer pressure drops shall not exceed those listed in the schedule. Pressure drop measurements shall be made in accordance with the ASTM E-477-99 test standard. Tests shall be conducted and reported on the identical units for which acoustical data is presented.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify sizes of equipment connections before fabricating transitions.

3.2 INSTALLATION

- A. Use double nuts and lock washers on threaded rod supports.
- B. Install equipment in accordance with manufacturer's instructions, NFPA 90A, and SMACNA publications and guidelines.

3.3 MATERIAL STORAGE ON-SITE

- A. All attenuators stored on-site should be elevated from the ground and sealed or covered to protect from moisture and dirt accumulation.

3.4 PROTECTION OF FINISHED WORK

- A. Immediately after installation, seal all supply, return and exhaust openings not under immediate work (open ends in ductwork runs) with plastic.

PART 4 ACOUSTIC PERFORMANCE DATA

4.1 NOTES FOR ALL PERFORMANCE DATA

- A. Model Number shall be as manufactured by Vibro-Acoustics.
- B. Length of elbow silencers shall be centerline dimensions from face of inlet to the face of the outlet.
- C. HTL = 10 gauge casing (High Transmission Loss)
- D. Type RED shall be elbow type. Type RD shall be straight type. RED and RD Series shall be provided with fiberglass acoustic media as specified above.

4.2 DYNAMIC INSERTION LOSSES – VAV and CV BOXES

- A. Provide sound attenuators at all VAV and CV boxes.
- B. Minimum Dynamic Insertion Losses (dB) shall be as scheduled below.
- C. Pressure drop data is taken at standard 500 fpm.
- D. Insertion Loss Data for sound attenuators is taken at standard 50 fpm; forward flow where the noise and airflow move in same directions.

<u>VAV & CV Types</u>	<u>Model Number</u>	<u>Air Flow (cfm)</u>	<u>Face Dims (in.)</u>	<u>Length (inches)</u>	<u>Press Drop (in.)</u>	<u>HTL</u>	<u>63 Hz</u>	<u>125 Hz</u>	<u>250 Hz</u>	<u>500 Hz</u>	<u>1 kHz</u>	<u>2 kHz</u>	<u>4 kHz</u>	<u>8 kHz</u>
A & F	RD-LV-F9	400	12x10	36	.08	No	5	7	16	28	39	32	21	13
B & G	RD-LV-F9	700	14x14	36	.08	No	5	7	16	28	39	32	21	13
C & H	RD-LV-F7	1200	18x18	36	.07	No	6	8	19	28	31	25	17	12
D & I	RD-LV-F7	1600	22x22	36	.07	No	6	8	19	28	31	25	17	12
E & J	RD-LV-F7	2500	30x24	36	.07	No	6	8	19	28	31	25	17	12

4.3 DYNAMIC INSERTION LOSSES – AIR HANDLING EQUIPMENT (AHU’s, DOAS, etc.)

- A. Attenuators shall be Vibro-Acoustics Model RD or approved equal.
- B. Provide sound attenuators at all air handling equipment as scheduled on the drawings. Attenuators shall be provided with the units or field installed.
- C. Sizes of Attenuators and Minimum Dynamic Insertion Losses (dB) shall be per manufacturer’s recommendations; maximum face velocities as listed on schedule on the drawings.
- D. Refer to schedules on the drawings for airflows, face dimensions and lengths.

4.4 DYNAMIC INSERTION LOSSES – SPECIFIC ATTENUATORS

- A. Refer to floor plans for locations of attenuators below.
- B. Refer to floor plans for other attenuators listed on the drawings
- C. Sizes of Attenuators and Minimum Dynamic Insertion Losses (dB) shall be as scheduled below.

	<u>Model Number</u>	<u>Air Flow (cfm)</u>	<u>Face Dims (in.)</u>	<u>Length (inches)</u>	<u>Press Drop (in.)</u>	<u>HTL</u>	<u>63 Hz</u>	<u>125 Hz</u>	<u>250 Hz</u>	<u>500 Hz</u>	<u>1 kHz</u>	<u>2 kHz</u>	<u>4 kHz</u>	<u>8 kHz</u>
SA-1	RD-MLV-F2	13,500	84 x 24s	60”	0.2	No	7	12	22	27	31	24	18	14
SA-2	RD-MHV-F2	10,800	56 x 24	60”	0.2	No	5	11	18	24	23	18	14	11

4.5 DYNAMIC INSERTION LOSSES – SPECIFIC SOUND ATTENUATORS

- A. Minimum Dynamic Insertion Losses (dB) shall be as scheduled below.
- B. Pressure drop data is taken at standard 1250 fpm.
- C. Insertion Loss Data for sound attenuators is taken at standard 1250 fpm; reverse flow where the noise and airflow move in opposite directions.

<u>Symbol</u> <u>Type</u>	<u>Model</u> <u>Number</u>	<u>Air</u> <u>Flow</u> <u>(cfm)</u>	<u>Face</u> <u>Dims</u> <u>(in.)</u>	<u>Length</u> <u>(inches)</u>	<u>Press</u> <u>Drop</u> <u>(in.)</u>	<u>HTL</u>	<u>63</u> <u>Hz</u>	<u>125</u> <u>Hz</u>	<u>250</u> <u>Hz</u>	<u>500</u> <u>Hz</u>	<u>1</u> <u>kHz</u>	<u>2</u> <u>kHz</u>	<u>4</u> <u>kHz</u>	<u>8</u> <u>kHz</u>
SA- DOAS- 1	RD-MV- F1	5000	1200 fpm	36"	.21	No	4	8	12	14	17	15	13	11
SA- DOAS- 2	RD-MV- F1	9000	1200	60"	.28	No	6	11	19	22	26	20	16	13

4.6 SPECIFIC SOUND ATTENUATORS

- A. AHU-1, 2, 3 and 4: Supply air sound attenuators shall be elbow type, nominal 36" long; 400 fpm with maximum pressure drop of 0.25".
- B. DOAS-1, 2, 3 and 4: Supply air sound attenuators shall be straight and elbow type, nominal 60" long; 400 fpm with maximum pressure drop of 0.15"

END OF SECTION

SECTION 233400 - HVAC FANS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Roof mounted fans.
 2. In line fans / ceiling mounted fans.
 3. Lab exhaust fans / high plume fans.
 4. Roof hoods.
- B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
 2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
 3. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for resilient mountings and snubbers for fans for placement by this section.
 4. Section 23 09 23 - Direct-Digital Control System for HVAC: Controls remote from unit.
 5. Section 23 31 00 - HVAC Ducts and Casings: Product requirements for hangers for placement by this section.
 6. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.
 7. Section 26 05 03 - Equipment Wiring Connections: Execution and product requirements for connecting equipment specified by this section.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. American Bearing Manufacturers Association:
 - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
 - 2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- B. Air Movement and Control Association International, Inc.:
 - 1. AMCA 99 - Standards Handbook.
 - 2. AMCA 204 - Balance Quality and Vibration Levels for Fans.
 - 3. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 - 4. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
 - 5. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- C. American Refrigeration Institute:
 - 1. ARI 1060 - Air-to-Air Energy Recovery Ventilation Equipment Certification Equipment Program.
- D. ASTM International:
 - 1. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.
- E. National Electrical Manufacturers Association:
 - 1. NEMA MG 1 - Motors and Generators.
 - 2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- F. Underwriters Laboratories Inc.:
 - 1. UL 705 - Power Ventilators.

1.5 PERFORMANCE REQUIREMENTS

- A. Wind-Borne Debris Loads: Design louvers located within 30 feet of grade to withstand ASTM E1996; large missile impact test.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, ductwork and accessory connections.

- C. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Submit fan manufacturers instructions.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- F. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.7 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.8 QUALITY ASSURANCE

- A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
- C. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.

- D. Balance Quality: Conform to AMCA 204.
- E. Maintain one copy of each document on site.
- F. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.9 QUALIFICATIONS

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

1.10 PRE-INSTALLATION MEETINGS

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

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Protect motors, shafts, and bearings from weather and construction dust.

1.12 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.13 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish one year manufacturer's warranty for fans.

1.14 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two sets of belts for each fan.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers of HVAC fans and hoods shall be as specified in this list unless noted otherwise:
 - 1. Greenheck
 - 2. Loren Cook
 - 3. Twin City
- B. Custom External Finish / Painting (typical for all roof mounted fans and hoods:
 - 1. All external surfaces of the casing, support framing and accessories shall be prepared and painted. Paint shall be able to withstand a salt spray test in accordance with ASTM B117 for a minimum of 700 consecutive hours. Paint shall be custom off-white color as selected by architect.

2.2 UP-BLAST CENTRIFUGAL ROOF FANS

- A. Fan Unit: Up-blast lab type. V-belt drive, spun aluminum housing with grease tray; resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.
- B. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
- C. Motor: Totally enclosed fan cooled.
- D. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor NEMA 250 Type 3R enclosure.
- E. Accessories:
 - 1. Fan speed controller shall be provided for all direct drive fans and where shown on the drawings.

2.3 DOWNBLAST CENTRIFUGAL ROOF FANS

- A. Fan Unit: Spun aluminum housing; resilient mounted motor; aluminum wire bird screen; square base to suit roof curb with continuous curb gaskets.

- B. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
- C. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor NEMA 250 Type 3R enclosure.
- D. Accessories:
 - 1. Fan speed controller shall be provided for all direct drive fans and where shown on the drawings.

2.4 CENTRIFUGAL SQUARE INLINE FANS (AND CEILING FANS)

- A. Product Description: Direct drive or belt drive as scheduled with galvanized steel housing, integral inlet cone, removable access doors on 3 sides, inlet and outlet duct collar, gravity backdraft damper in discharge, horizontal hanging brackets.
- B. Fan Wheel: Backward inclined centrifugal type, aluminum construction.
- C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
- D. Motor and Drive Mounting: Out of air stream.
- E. Motor: Open drip proof.
- F. Bearings: ABMA 9 life at 200,000 hours.
- G. Accessories:
 - 1. Belt guard.
 - 2. Motor cover.
 - 3. Inlet safety screen where intake is not ducted.
 - 4. Flexible duct connector.
 - 5. Inlet and outlet ductwork companion flange.
 - 6. Disconnect Switch: NEMA 250 Type 1 enclosure.
 - 7. Fan speed controller shall be provided for all direct drive fans and where shown on the drawings
 - 8. Ceiling fans: Provide grille.

2.5 LAB EXHAUST FANS / HIGH PLUME DISCHARGE FANS

- A. Fan Housing and Construction
 - 1. Fan housing shall be a minimum 12 gauge steel construction.
 - 2. Adjustable motor plate, where applicable shall utilize threaded studs for positive belt tensioning.
 - 3. Fan shall be constructed with an integral housing drain to alleviate rainwater.

4. Fan shall contain a bolted and gasketed access door. Access door shall allow for the removal of wheel, shaft and bearings without the removal of the fan from the laboratory exhaust system.
 5. Belt driven fan shafts shall be stainless steel and accurately turned, ground and polished. Shafting shall be sized for a critical speed of at least 125% of maximum fan RPM.
 6. Unit fasteners exposed to corrosive airstream shall be of stainless steel construction.
 7. Unit components fabricated of steel shall be coated with an electrostatically applied, high performance, baked phenolic epoxy powder coating with an ultraviolet protective topcoat. Finish color shall be light gray. Coating thickness shall be 5.0 mils. Coating shall be salt spray tested per ASTM B117 for in excess of 1000 hours without failure, humidity resistance tested per ASTM D2247 for in excess of 1000 hours without failure, and impact resistance tested per ASTM D2794 and shall pass a minimum of 100 in-lbs.
 8. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM, static pressure, and maximum fan RPM.
 9. Units specified as Spark Resistant Construction shall be constructed to the AMCA Spark Resistant Construction level as dictated on the plans and specifications.
 10. Unit shall be shipped in ISTA Certified Transit Tested Packaging.
- B. High Plume Discharge Nozzle
1. Fans shall incorporate a conical discharge nozzle supplied by the fan manufacturer.
 2. Discharge nozzle shall be constructed and designed to efficiently handle up to 6000 feet per minute outlet velocity. Nozzle shall not utilize a stack cap nor hinged cover and shall be matched to project specific requirements as noted on the contract drawings.
- C. Centrifugal Fan Impeller
1. Fan impeller shall be non-overloading, steel centrifugal, backward inclined, flatblade type. Blades shall be continuously welded to the backplate and deep spun inlet wheel shroud.
 2. Fan impeller hub shall be keyed and securely attached to the fan shaft.
 3. Fan impeller shall be statically and dynamically balanced in accordance with AMCA Standard 204-96, "Balance Quality and Vibration Levels for Fans."
 4. Fan impeller shall be coated with a finish to match the fan housing.
 5. Fan impeller shall be balanced utilizing weights which are welded and coated with chemical resistant coating. Balancing by means of bolts and washers shall not be acceptable.
 6. Belt driven fan bearings shall be designed and tested specifically for use in air handling applications. Construction shall be heavy duty regreaseable ball or roller type in a cast iron pillow block housing utilizing concentric mounting locking collars. Belt driven fan bearings shall be selected for a minimum L50 life of not less than 200,000 hours.
 7. Belt driven fan units shall have stainless steel lube lines installed from the fan bearings with Zerk fittings to allow for easy lubrication.

- D. Bypass Air Plenum
1. Bypass air plenum shall be designed to support fan assembly (assemblies) and configuration(s) as shown on the contract drawings.
 2. Bypass air plenum shall introduce outside air above the roof level and shall have rain hood(s) and bird screen protection over the bypass air damper(s).
 3. Bypass air plenum shall be constructed of welded steel, minimum 14 gauge, with a finish to match the fan housing.
 4. Bypass dampers shall be opposed blade low leakage design. The dampers shall be aluminum construction and coated to match the fan housing.
 5. Provide with extended shafts and manual locking quadrant handles shall be provided for adjustment of the dampers. The extended shaft can be used for external connection to actuators by controls contractor.
- E. Fan Motors and Drives
1. Fan motors shall be premium efficiency, NEMA frame, nominal 1800 or 3600 RPM Totally Enclosed Fan Cooled, Inverter Duty Labeled with a 1.15 service factor.
 2. Belt driven fan drive belts shall be oil and heat resistant, non-static type. Fixed drives shall be sized for a minimum 1.5 service factor (150% of the motor horsepower) and shall be readily and easily accessible for service, if required.
 3. Belt driven fans shall utilize precision machined cast iron type sheaves, keyed and securely attached to the wheel and motor shafts.

2.6 CENTRIFUGAL UTILITY FAN

- A. Description: Fan shall be a single width, single inlet, backward inclined flat blade, belt driven centrifugal vent set.
- B. Certifications: Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL/cUL 705) for US and Canada. For restaurant applications, fan shall be listed by Underwriters Laboratories (UL/cUL 762) for US and Canada. For smoke control applications, fan shall be listed by Underwriters Laboratories (Power Ventilator for Smoke Control Systems) for US and Canada. Fan shall bear the AMCA Certified Ratings Seal for Sound and Air performance.
- C. Construction: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The scroll wrapper shall be a minimum 14 gauge steel and the scroll side panels shall be a minimum 12 gauge steel. The entire fan housing shall have continuously welded seams for leak-proof operation. A performance cut-off shall be furnished to prevent the recirculation of air in the fan housing. The fan housing shall be field rotatable to any one of eight discharge positions and shall have a minimum 1-1/2 inch outlet discharge flange. Bearing support shall be minimum 10 gauge welded steel. Side access inspection ports shall be provided with quick release latches for access to the motor compartment without removing the weather cover. Lifting lugs shall be provided for ease of installation. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM, static pressure, and maximum fan RPM. Unit shall be shipped in ISTA Certified Transit Tested Packaging.

- D. Coating: Steel fan components shall be Lorenized™ with an electrostatically applied, baked polyester powder coating. Each component shall be subject to a five stage environmentally friendly wash system, followed by a minimum 2 mil thick baked powder finish. Paint must exceed 1,000 hour salt spray under ASTM B117 test method.
- E. Wheel shall be steel centrifugal backward inclined, non-overloading flat blade type. Blades shall be continuously welded to the back plate and deep spun inlet shroud. Wheel hub shall be keyed and securely attached to the fan shaft. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-05, Balance Quality and Vibration Levels for Fans
- F. Motor shall be NEMA Design B with Class B insulation rated for continuous duty and furnished at the specified voltage, phase and enclosure.
- G. Bearing: shall be designed and tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball or roller type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
- H. Blower shaft shall be AISI C-1045 hot rolled and accurately turned, ground and polished. Shafting shall be sized for a critical speed of at least 125% of maximum RPM.
- I. Belts shall be oil and heat resistant, static conducting. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150% of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM

2.7 ROOF HOODS

- A. Product Description: (Loren Cook Type PR or GI or GR) Square, rectangular or round type as scheduled on the drawings; Aluminum housing bolted to aluminum structural frame. Provide with bird screen constructed of 1/2" galvanized mesh mounted in the hood. Hood shall bear an engraved aluminum nameplate.
- B. Roof Curb: 16 inch high self-flashing of aluminum construction with continuously welded seams, built-in cant strips, 1 inch insulation and curb bottom, and factory installed nailer strip.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify roof curbs are installed and dimensions are as instructed by manufacturer.

3.2 INSTALLATION

- A. Secure roof fans and hoods with cadmium plated steel lag screws to roof curb. Secure roof fans with cadmium plated steel lag screws to roof curb. For other requirements, refer to Specification 230548.
- B. Suspended Cabinet Fans: Install flexible connections specified in Section 23 33 00 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
- C. Provide backdraft dampers on outlet from ceiling fans.
- D. Install safety screen where inlet or outlet is exposed.
- E. Provide sheaves required for final air balance.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Section 01 40 00 - Quality Requirements: Requirements for manufacturer's field services.
- B. Furnish services of factory trained representative for minimum of one day to start-up, calibrate controls, and instruct Owner on operation and maintenance.

3.4 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Vacuum clean coils and inside of fan cabinet.

3.5 DEMONSTRATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate fan operation and maintenance procedures.

3.6 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Do not operate fans for until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION

SECTION 233600 - AIR TERMINAL UNITS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Constant volume terminal units.
 - 2. Variable air volume terminal units.
- B. Related Sections:
 - 1. Section 23 04 00 – General Conditions for Mechanical Trades
 - 2. Section 23 09 23 - Direct-Digital Control System for HVAC: Controls remote from unit.
 - 3. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation applying to units in this section.
 - 4. Section 23 33 03 - Sound Attenuators.
 - 5. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electrical connections to air terminal units specified by this section.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. American Refrigeration Institute:
 - 1. ARI 880 - Air Terminals.
 - 2. ARI 885 -Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.
- B. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- C. National Fire Protection Association:
 - 1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
- D. Underwriters Laboratories Inc.:
 - 1. UL 181 - Factory-Made Air Ducts and Connectors.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings indicating airflow, static pressure, and NC designation. Include electrical characteristics and connection requirements. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 inch to 4 inches wg.
- C. Manufacturer's Installation Instructions: Submit support and hanging details, and service clearances required.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- E. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.

4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of units.
- C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.

1.7 QUALITY ASSURANCE

- A. Test and rate air terminal units performance for air pressure drop, flow performance, and acoustical performance in accordance with ARI 880 and ARI 885. Attach ARI seal to each terminal unit.
- B. Maintain one copy of each document on site.
- C. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

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

1.9 PRE-INSTALLATION MEETINGS

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

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.11 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate Work with 15905 - HVAC Instrumentation and Controls.

1.12 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish one year manufacturer warranty for air terminal units.

PART 2 PRODUCTS

2.1 SINGLE DUCT, CONSTANT VOLUME AND VARIABLE VOLUME AIR TERMINAL UNITS

- A. Manufacturers:
 - 1. The Trane Co.
 - 2. Enviromental Technologies, Inc.
 - 3. Krueger
 - 4. Titus
- B. Product Description: Variable air volume terminal units for connection to central air systems, with electronic controls.
- C. Identification: Furnish each air terminal unit with identification label and airflow indicator. Include unit nominal airflow, maximum factory-set airflow and minimum factory-set airflow and coil type.
- D. Basic Assembly:
 - 1. Casings: Minimum 22 gage galvanized steel.
 - 2. Lining: Minimum 1 inch thick neoprene or vinyl coated glass fiber insulation, 1.5 lb./cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements.
 - 3. Plenum Air Inlets: Round stub connections for duct attachment.
 - 4. Plenum Air Outlets: S slip-and-drive connections.

- E. Basic Unit:
 - 1. Configuration: Air volume damper assembly inside unit casing. Locate control components inside protective metal shroud.
 - 2. Volume Damper: Construct of galvanized steel with peripheral gasket and self-lubricating bearings; maximum damper leakage: 2 percent of design air flow at 1 inches rated inlet static pressure.
 - 3. Mount damper operator to position damper normally open.
- F. Round Outlet: Discharge collar matching inlet size.
- G. Hot Water Heating Coil Construction: 1/2 inch copper tube mechanically expanded into aluminum plate fins, leak tested under water to 200 psig pressure, factory installed.
- H. Automatic Damper Operator:
 - 1. Electric Actuator: 24 volt with high limit.
- I. Sound Attenuators: Refer to Specification Section 23 33 03.
- J. Sequence of Operation: Refer to Section 23 09 93.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify ductwork is ready for air terminal installation.

3.2 INSTALLATION

- A. Connect to ductwork in accordance with Section 23 31 00.
- B. Install ceiling access doors or locate units above easily removable ceiling components.
- C. Support units individually from structure. Do not support from adjacent ductwork.
- D. Support air terminal units connected by flexible duct independently of flexible duct.
- E. Install transition piece to match flexible duct size to inlet or outlet of variable air volume terminal.
- F. Install 1 inch thick lined ductwork downstream of units. Refer to Section 23 31 00 and 23 07 00.

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BRANFORD, CONNECTICUT
State Project No.s: 014-0034 EA / 014-0035 BE-EA

3.3 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.
- B. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to 0 percent full flow.

END OF SECTION

SECTION 233603 – VARIABLE REFRIGERANT FLOW (VRF) UNITS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Variable Refrigerant Flow (VRF) Heat Pump Systems
 - 2. VRF Controls and Integration to BMS
- B. Related Sections:
 - 1. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for fan powered terminal units for placement by this section.
 - 2. Section 23 08 00 – Commissioning of HVAC.
 - 3. Section 23 09 23 - Direct-Digital Control System for HVAC: Controls remote from unit.
 - 4. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation applying to units in this section.
 - 5. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electrical connections to air terminal units specified by this section.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. American Refrigeration Institute:
 - 1. ARI 880 - Air Terminals.
 - 2. ARI 885 - Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.
- B. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- C. National Fire Protection Association:
 - 1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
- D. Underwriters Laboratories Inc.:
 - 1. UL 181 - Factory-Made Air Ducts and Connectors.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings indicating airflow, static pressure, heating coil capacity and NC designation. Include electrical characteristics and connection requirements. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 inch
- C. Manufacturer's Installation Instructions: Submit support and hanging details, and service clearances required.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- E. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.

4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.7 VRF SYSTEM DESIGN

- A. The design and layout of the multi-zone refrigerant piping systems on the drawings is diagrammatic; it does not include many of the components that are required for a complete system. All equipment, parts and accessories shall be included in this bid to provide the owner with a complete and operational system.
- B. The design and the installation of the system shall be approved by the manufacturer, and shall include at minimum the following.
 1. The system design shall be by a designer certified by the manufacturer.
 2. The system installation shall be by a Contractor certified by the manufacturer.
 3. A complete commissioning report submitted to and approved by the manufacturer.
- C. Where the drawings indicate a piping layout, piping sizes, or components that do not conform to the manufacturer's requirements, the design shall incorporate the modifications necessary for the system to operated as intended.
- D. Where the manufacturer is other than Daikin, the selected manufacturer shall provide a design via shop drawings to bidding contractors which shall incorporate all of the details necessary to conform to the layouts and capacities of the base design system. Where such redesign requires modifications to the structural support, roof flashing, roof openings, ceiling space, refrigerant piping, condensate piping, valve boxes, control wiring/sensors, electrical power system, wiring, accessories or any other base design features; these modifications shall be identified and included in the bid price. There shall be no change to the building and HVAC design features and there shall be no additional cost to the Owner for installation of a system other than Daikin.

- E. Sound Power Levels for indoor components including indoor fan units and BS boxes shall be less than 35 dBA.

1.8 COORDINATION DRAWINGS

- A. Prepare coordination drawings drawn in the latest AutoCAD version in accordance with Division 1 to a minimum scale of 1/4"=1'-0" detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
 - 1. The Contractor shall indicate the proposed locations of piping, conduit, ductwork, equipment, and materials. Include the following:
 - a. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
 - b. Equipment connections and support details.
- B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
- C. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.
- D. The Contractor and each subcontractor shall sign and date each coordination drawing prior to submission.
- E. Work shall not be performed until coordination drawings have been approved by the architect and engineer.
- F. The contractor shall provide final piping and wiring arrangements.

1.9 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of units, controls components.
- C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.

1.10 FACTORY QUALITY ASSURANCE

- A. Test and rate air terminal units performance for air pressure drop, flow performance, and acoustical performance in accordance with ARI 880 and ARI 885. Attach ARI seal to each terminal unit.

- B. Maintain one copy of each document on site.

1.11 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' experience.
- B. Selling Agent: The selling agent shall have qualified service technicians on staff to support startup and troubleshooting issues
- C. Manufacturer Authorized Installer: Company specializing in performing Work of this section with minimum three years' experience.

1.12 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

1.13 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.14 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate Work with HVAC Instrumentation and Controls.

1.15 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for compressor and one year full parts.
- C. Special Warranty: Manufacturer to include 1 year labor warranty, direct from factory

1.16 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for extra materials.

PART 2 PRODUCTS

2.1 MANUFACTURERS – VRF SYSTEMS

- A. Basis of Design: Daikin VRV.

- B. Other manufacturers offering similar products (considered substitutions):
 - 1. Mitsubishi
 - 2. Trane

2.2 GENERAL

- A. System Description
 - 1. The variable capacity, heat pump or heat recovery air conditioning system shall be based upon Daikin VRV. Other manufacturers must meet the qualifications of this specification and the high efficiency goals contained herein.
 - 2. The system shall consist of an outdoor unit, multiple indoor units and DDC (Direct Digital Controls) and BS (Branch Selector) Box for heat recovery. Each indoor unit or group of indoor units shall be independently controlled.
 - 3. VRF system shall provide simultaneous heating and cooling via a 3-pipe refrigeration pipe design to Branch Selector Boxes and a 2-pipe design.
- B. Quality Assurance
 - 1. The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label.
 - 2. All wiring shall be in accordance with the National Electrical Code (N.E.C.).
 - 3. A full charge of R-410A for the condensing unit only shall be provided in the condensing unit.
- C. Delivery, Storage and Handling
 - 1. Unit shall be stored and handled according to the manufacturer's recommendation.
- D. The VRF system shall be installed by a manufacturer authorized installer with training specific to the equipment being installed.

2.3 PRODUCTS

- A. Outdoor Unit
 - 1. General: The outdoor unit shall be used with compatible indoor components. The system shall consist of outdoor unit, Branch Selector (BS) Boxes, indoor units and D-III NET DDC (Direct Digital Controls). The outdoor units shall be equipped with multiple circuit boards that interface to the D-III NET controls system and shall perform all functions necessary for operation. The outdoor unit shall have a powder coated finish. The outdoor unit shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory.
 - a. The sum of connected capacity of all indoor air handlers shall range from 50% to 110% of outdoor rated capacity.
 - b. The sound pressure level standard shall be that value as listed in the manufacturer's engineering manual for the specified models at 3 feet from the front of the unit. The outdoor unit shall be capable of operating automatically at further reduced noise during night time.
 - c. All refrigerant lines from the outdoor unit to the BS (Branch Selector) Boxes shall be insulated.

- d. The outdoor unit shall have an accumulator with refrigerant level sensors and controls.
 - e. The outdoor unit shall have a high pressure safety switch, over-current protection and DC bus protection.
 - f. The system shall be capable of refrigerant piping up to distances as indicated by unit zoning on the drawing without any oil traps.
 - g. REFNET™ piping joints and headers shall be used to ensure proper refrigerant balance and flow for optimum system capacity and performance. T style joints shall not be acceptable.
 - h. The VRF outdoor unit shall be capable of operating in heating down to -4°F ambient temperature without additional low ambient controls.
 - i. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.
 - j. Each condensing unit module (6-12 ton) shall contain two compressors. Each set of condensing units 14-20 tons shall contain four compressors. Multiple compressors are required for reliability and redundancy in case of failure and reliability.
 - k. It is important that the VRF system provide heating to the indoor units in heating operation while in the defrost mode and during oil equalization mode.
 - l. Manufacturer must guarantee cooling operation to 110°F
2. Unit Cabinet:
- a. The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.
 - b. Custom External Finish / Painting: All external surfaces of the casing, support framing and accessories shall be prepared and painted. Paint shall be able to withstand a salt spray test in accordance with ASTM B117 for a minimum of 700 consecutive hours. Paint shall be custom off-white color as selected by architect.
3. Fan:
- a. The unit shall be furnished with one or more direct drive fan motor(s), that have multiple speed operation via a DC (digitally commutating) inverter.
 - b. The fan motor shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
 - c. The fan motor shall be mounted for quiet operation.
 - d. The fan shall be provided with a raised guard to prevent contact with moving parts.
 - e. The outdoor unit shall have vertical discharge airflow.
 - f. The fan motor shall be factory set as standard at 0.12 in. WG, but contain a field setting switch to a maximum 0.32 in. WG pressure.
 - g. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Operation sound level shall be selectable from 3 steps
4. Refrigerant
- a. R410A refrigerant shall be used.

5. Coil
 - a. The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film type E1.
 - b. The coil shall be protected with an integral metal guard.
 - c. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
 6. Compressor:
 - a. The compressor shall be a high performance, inverter driven, modulating capacity scroll compressor. Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. At complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
 - b. A crankcase heater shall be factory mounted on the compressor.
 - c. The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable down to as low as 6% of rated capacity.
 - d. The compressor will be equipped with an internal thermal overload.
 - e. The compressor shall be spring mounted to avoid the transmission of vibration.
 7. Electrical:
 - a. The outdoor unit shall be controlled by integral microprocessors.
 - b. The control circuit between the indoor units, BS Box and the outdoor unit shall be 16VDC completed using a 2-conductor, stranded, non-shielded cable to provide total integration of the system. Control wiring shall be provided by the BMS Contractor.
- B. Branch Selector (BS) Boxes
1. General:
 - a. The BS (Branch Selector) Boxes shall be provided and installed on this project in support of heat recovery. These units shall be equipped with a circuit board that interfaces to the D-III NET controls system and shall perform all functions necessary for operation. The unit shall have a galvanized steel finish. The BS Boxes shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory. This unit shall be mounted indoors.
 - b. Each indoor unit shall be served by a dedicated BS box.
 - c. Each BS Box is piped from the condensing unit with a 3-pipe design to maximize efficiency and reduce the need for condensate removal. The branch selector must not develop condensate or it will not be considered. From the BS Box to the indoor unit shall be a 2-pipe design.
 2. Cabinet:
 - a. The casing shall be fabricated of galvanized steel.
 - b. Each cabinet shall house a liquid-gas separator and multiple refrigeration control valves.
 - c. The unit shall house two tube-in-tube heat exchangers.
 - d. The unit shall have sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene.

3. Refrigerant
 - a. R410A refrigerant shall be required.
 4. Refrigerant valves:
 - a. The unit shall be furnished with electronic expansion valves to control the direction of refrigerant flow.
 5. Electrical:
 - a. The BS Boxes require 208/230 volts, 1 phase, 60 hertz. power connections.
 - b. The control circuit between the indoor units and the outdoor unit shall be 16VDC completed using a 2-conductor, stranded, non-shielded cable to provide total integration of the system. Controls shall be provided by the BMS Contractor.
- C. 4 Way Ceiling Cassette (FXZQ)
1. General: Daikin indoor unit model FXZQ shall be a ceiling cassette fan coil unit, operable with R-410A refrigerant, equipped with an electronic expansion valve, for installation into the ceiling cavity equipped with an air panel grill. It shall be a four-way air distribution type, white, impact resistant with a washable decoration panel. The supply air is distributed via motorized louvers which can be horizontally and vertically adjusted from 0° to 90°. Computerized PID control shall be used to control superheat to deliver a comfortable room temperature condition. The unit shall be equipped with a programmed drying mechanism that dehumidifies while limiting changes in room temperature. The indoor units sound pressure shall range shall not exceed Daikin's performance at a minimum.
 2. Indoor Unit:
 - a. Indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
 - b. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
 - c. Both refrigerant lines shall be insulated from the outdoor unit.
 - d. The 4-way supply air flow can be field modified to 3-way and 2-way airflow to accommodate various installation configurations including corner installations.
 - e. Return air shall be through the concentric panel, which includes a resin net mold resistant filter.
 - f. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 21" of lift and has a built in safety shutoff and alarm.
 - g. The indoor units shall be equipped with a return air thermistor.
 - h. All electrical components are reached through the decoration panel, which reduces the required side service access.
 - i. The indoor unit will be separately powered with 208~230V/1-phase/60Hz.
 - j. The voltage range will be 253 volts maximum and 187 volts minimum.

3. Unit Cabinet:
 - a. The cabinet shall be space saving and shall be located into the ceiling.
 - b. Three auto-swing positions shall be available to choose, which include standard, draft prevention and ceiling stain prevention.
 - c. The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation.
 - d. Fresh air intake shall be possible by way of direct duct installation to the side of the indoor unit cabinet.
 - e. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
 4. Fan:
 - a. The fan shall be direct-drive turbo fan type with statically and dynamically balanced impeller with high and low fan speeds available.
 - b. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output range from 0.06 to 0.12 HP.
 - c. The airflow rate shall be available in high and low settings.
 - d. The fan motor shall be thermally protected.
 5. Filter:
 - a. The return air shall be filtered by means of a washable long-life filter with mildew proof resin.
 6. Coil:
 - a. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
 - b. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
 - c. The coil shall be a 2-row cross fin copper evaporator coil with 17 FPI design completely factory tested.
 - d. The refrigerant connections shall be flare connections and the condensate will be 1 -1/32 inch outside diameter PVC.
 - e. A condensate pan shall be located under the coil.
 - f. A condensate pump with a 21 inch lift shall be located below the coil in the condensate pan with a built in safety alarm.
 - g. A thermistor will be located on the liquid and gas line.
- D. Ceiling Concealed Ducted Indoor Unit (FXMQ)
1. General:
 - a. The unit shall be a ceiling concealed ducted indoor fan coil design that mounts above the ceiling with a 2-position, field adjustable return and a fixed horizontal discharge supply and shall have a modulating linear expansion device. The unit shall support individual control using D-III NET DDC controllers.
 2. Indoor Unit:
 - a. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory. The unit shall contain a factory installed condensate drain pan

- and condensate drain pump with float switch. Pump and float switch shall be factory wired.
3. Unit Cabinet:
 - a. The cabinet panel shall have provisions for a field installed filtered/mixing box. Provide low pressure drop filter (field installed) at the inlet to each indoor unit.
 4. Fan:
 - a. The fan shall be direct-drive DC (ECM) type fan, statically and dynamically balanced impeller with three fan speeds.
 - b. The indoor fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.
 - c. The indoor fan shall consist of three (3) speeds, High, Low, and Low-Low of which are selectable on the room controller and by the BS Box.
 - d. The indoor unit shall have a ducted air outlet system and ducted return air system.
 5. Return Air Duct Connection:
 - a. Return air duct connections shall be rear duct connections unless noted or shown otherwise.
 - b. The units come standard as bottom return and shall require the bottom to be blanked off by the contractor.
 6. Coil:
 - a. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
 - b. The tubing shall have inner grooves for high efficiency heat exchange.
 - c. All tube joints shall be brazed with phos-copper or silver alloy.
 - d. The coils shall be pressure tested at the factory.
 - e. A condensate pan and drain shall be provided under the coil.
 - f. A factory mounted condensate pump with a 9-13/16" lift shall be located below the coil in the condensate pan with a built in safety alarm and internal float switch.
 - g. Both refrigerant lines to the indoor units shall be insulated.
 7. Controls:
 - a. This unit shall use controls provided by manufacturer to perform functions necessary to operate the system. Please refer to this specification for details on controllers and other control options.

2.4 CONTROLS

- A. Physical characteristics:
 1. General: Refer to Spec Sections 23 0923 and 23 0993
- B. Electrical Characteristics
 1. General:
 - a. The electrical voltage from each circuit board to the controls shall be 16 volts DC. The voltage may fluctuate up or down depending on communication packets being sent and received. Control wiring to be provided by Contractor.

2. Wiring:
 - a. Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit then to the Branch Selector Box and outdoor unit. Control wiring shall run from the indoor unit terminal block to the controller associated with that unit. Control wiring to be provided by BMS Contractor.
 - b. Wiring shall be 2-conductor 16 AWG or 18 AWG stranded wire non-shielded.

- C. Controls Network
 1. The Controls Network consists of remote controllers, timers, centralized controllers, and integrated system software communicating over a high-speed communication bus with optional interconnection and control via a network PC. The Controls Network shall support operation monitoring, scheduling, error e-mail distribution, personal browsers, maintenance support, and integration with Building Management Systems (BMS) using either LON or BACnet interfaces. All of which unite to provide the best in comfort conditioning control.
 2. Specifically the VRF manufacturer shall furnish a communications Gateway supporting BACNet or LonWorks® to seamlessly integrate with the existing DDC Building Management System. Also, a central control panel (DAIKIN I-Touch) shall be furnished for local control, viewing and troubleshooting remotely. Simple wired thermostats shall be furnished for the fan coil units with all the features and options shown above (DAIKIN NAVIGATOR Thermostat). Software that requires licensing restrictions or future license purchase shall not be considered.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify ductwork is ready for air terminal installation.

3.2 INSTALLATION

- A. Connect to ductwork in accordance with Section 23 31 00.
- B. Install ceiling access doors or locate units above easily removable ceiling components.
- C. Support units individually from structure. Do not support from adjacent ductwork.
- D. Support air terminal units connected by flexible duct independently of flexible duct.
- E. Coordinate installation and clearances for maintenance with ductwork fabrication and coordination drawings

- F. At each indoor unit, provide isolation valves at each of the refrigerant lines serving each unit.
- G. At each indoor unit: Units come standard as bottom return and shall require the bottom to be blanked off by the contractor.

3.3 VRF STARTUP

- A. System startup will be supported locally by a certified factory approved technicians. All wiring, piping, evacuation and an initial charge of R-410A shall be completed prior to having a certified technician called out to witness and assist with startup. The certified technician shall provide technical support and assist with startup; the refrigeration, charging and evacuation shall be by the mechanical contractor.
- B. Provide written report confirming each part of the VRF system is installed and operating correctly.

END OF SECTION

SECTION 233700 - AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Diffusers.
 - 2. Registers
 - 3. Grilles.
- B. Related Sections:
 - 1. Section 09 90 00 - Painting and Coating: Execution and product requirements for Painting of ductwork visible behind outlets and inlets specified by this section.
 - 2. Section 23 33 00 - Air Duct Accessories: Volume dampers for inlets and outlets.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. Air Movement and Control Association International, Inc.:
 - 1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets.
- C. Sheet Metal and Air Conditioning Contractors:
 - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit sizes, finish, and type of mounting. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- C. Test Reports: Rating of air outlet and inlet performance.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- E. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of air outlets and inlets.

1.7 QUALITY ASSURANCE

- A. Test and rate diffuser, register, and grille performance in accordance with ASHRAE 70.
- B. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 WARRANTY

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

PART 2 PRODUCTS

2.1 GRILLES, REGISTERS, AND DIFFUSERS

- A. For all diffusers, grilles and registers, Noise Criteria (NC) shall not exceed 30 unless noted otherwise on drawings. NC rating shall be for diffuser/neck assembly.
- B. Refer to schedule on the drawings for manufacturer, materials, etc.
- C. Manufacturers:
 - 1. Titus.
 - 2. Metal Aire.
 - 3. Krueger.
 - 4. Price.
- D. Refer to schedule on drawings for diffuser type, materials, arrangements, etc.
- E. Refer to floor plans for quantity, neck size and flow rates.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify inlet and outlet locations.
- C. Verify ceiling systems are ready for installation.

3.2 INSTALLATION

- A. Install diffusers to ductwork with airtight connection.
- B. Install balancing dampers on duct take-off to diffusers, grilles, and registers, whether or not dampers are furnished as part of diffuser, grille, and register assembly. Refer to Section 23 33 00.
- C. Paint visible portion of ductwork behind air outlets and inlets matte black. Refer to Section 09 90 00.

3.3 MATERIAL STORAGE ON-SITE

- A. All ductwork stored on-site should be elevated from the ground and sealed or covered to protect from moisture and dirt accumulation.

3.4 PROTECTION OF FINISHED WORK

- A. Immediately after installation, seal all supply, return and exhaust openings as well as all temporary ductwork openings not under immediate work (open ends in ductwork runs) with plastic.

3.5 INTERFACE WITH OTHER PRODUCTS

- A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

END OF SECTION

SECTION 235100 - BREECHINGS, CHIMNEYS, AND STACKS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Breeching and vents.
 - 2. Combustion air intake.
 - 3. Breeching and vents for boilers and water heaters.
 - 4. Combustion air intake piping for boilers and water heaters.
- B. Related Sections:
 - 1. Section 23 04 00 – General Conditions for Mechanical Trades
 - 2. Section 22 34 00 - Fuel-Fired Domestic Water Heaters: Water heaters using breeching, chimneys, and stacks.
 - 3. Section 23 52 32 – Condensing Boilers.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. American National Standards Institute:
1. ANSI Z21.66 - Automatic Vent Damper Devices for Use with Gas-Fired Appliances.
 2. ANSI Z21.67 - Mechanically Actuated Automatic Vent Damper Device.
 3. ANSI Z21.68 - Thermatically Actuated Automatic Vent Damper Devices.
 4. ANSI Z95.1 - Oil Burning Equipment, Installation.
- B. ASTM International:
1. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 2. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 3. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 4. A1011/A1011M-07 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
 5. ASTM C401 - Standard Classification of Alumina and Alumina-Silicate Castable Refractories.
- C. National Fire Protection Association:
1. NFPA 31 - Standard for the Installation of Oil-Burning Equipment.
 2. NFPA 54 - National Fuel Gas Code.
 3. NFPA 82 - Standard on Incinerators and Waste and Linen Handling Systems and Equipment.
 4. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel Burning Appliances.
- D. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - Guide for Steel Stack Construction.
 2. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
- E. Underwriters Laboratories Inc.:
1. UL 103 - Factory-Built Chimneys for Residential Type and Building Heating Appliances.
 2. UL 127 - Factory-Built Fireplaces.
 3. UL 378 - Draft Equipment.
 4. UL 441 - Gas Vents.
 5. UL 641 - Type L Low-Temperature Venting Systems.
 6. UL 959 - Medium Heat Appliance Factory Built Chimneys.

1.5 DEFINITIONS

- A. Breeching: Vent Connector.
- B. Chimney: Primarily vertical shaft enclosing at least one vent for conducting flue gases outdoors.
- C. Smoke Pipe: Round, single wall vent connector.
- D. Vent: Portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.
- E. Vent Connector: Part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.

1.6 DESIGN REQUIREMENTS

- A. Design stacks above the roof for per local wind loading velocities.

1.7 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittals procedures.
- B. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breeching. Submit layout drawings indicating plan view and elevations
- C. Product Data: Submit data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.
- D. Calculations: Submit flue vent calculations based upon submitted product data and shop drawings.
- E. Manufacturer's Installation Instructions: Submit assembly, support details, and connection requirements.
- F. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.

2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.8 QUALITY ASSURANCE

- A. Provide factory built vents and chimneys used for venting natural draft appliances complying with NFPA 54 for gas fired and UL listed and labeled.
- B. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.10 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum two weeks prior to commencing work of this section.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.
- B. Maintain water integrity of roof during and after installation of chimney or vent.

1.12 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.13 WARRANTY

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

PART 2 PRODUCTS

2.1 FLUE VENTS FOR BOILERS, WATER HEATERS AND POOL HEATER

- A. Manufacturers:
 - 1. Metal-Fab Inc. Model Corr/Guard
 - 2. Other acceptable manufacturers offering equivalent products.
 - a. Metalbestos
 - b. CB Exhaust Solutions.
 - c. Security Chimneys International.
- B. Flue shall be positive pressure, double wall metal stack, UL 1738 listed for a high efficiency, condensing, Category IV boiler.
- C. Fabricate with 1 inch (25 mm) annular space. Inner wall shall be constructed of AL29-4C, minimum.015" thickness. Outer wall shall be constructed of Type 304 stainless steel, minimum.018" thickness
- D. Accessories, UL labeled:
 - 1. Ventilated Wall Thimble: Consists of wall penetration, vent flashing with spacers and storm collar.
 - 2. Stack Cap: Consists of conical rainshield with inverted cone for partial rain protection with low flow resistance.
 - 3. Fittings: Elbows, wyes, expansion sections, barometric dampers, and accessories as required for a complete installation.
 - 4. Joints: Seal with sealant as recommended by manufacturer.

2.2 FLUE VENT FOR DU-1

- A. Manufacturers:
 - 1. Metal-Fab Inc. Model I PIC
 - 2. Other acceptable manufacturers offering equivalent products.
 - a. Metalbestos
 - b. CB Exhaust Solutions <Blake Equipment>.
 - c. Cheminee.
 - d. Security Chimneys International.
- B. Flue shall be positive pressure, double wall metal stack, tested to UL 103 and UL listed for use with building heating equipment, in compliance with NFPA.

- C. Fabricate with 1 inch minimum mineral wool insulation between walls. Construct inner jacket of minimum .035" thick Type 304 stainless steel. Construct outer jacket of minimum .025" thick aluminized steel.
- D. Accessories, UL labeled:
 - 1. Ventilated Roof Thimble: Consists of roof penetration, vent flashing with spacers and storm collar.
 - 2. Stack Cap: Consists of conical rainshield with inverted cone for partial rain protection with low flow resistance.
 - 3. Fittings: Elbows, wyes, expansion sections, barometric dampers, and accessories as required for a complete installation.
 - 4. Joints: Seal with sealant as recommended by manufacturer.

2.3 COMBUSTION AIR INTAKE PIPING FOR CONDENSING BOILERS AND WATER HEATERS

- A. Galvanized steel: Refer to Spec Section 23 3100.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with NFPA AND SMACNA Guide for Steel Stack Construction.
- B. Install breeching with minimum of joints. Align accurately at connections, with internal surfaces smooth.
- C. Support breeching from building structure, rigidly with suitable ties, braces, hangers and anchors to hold to shape and prevent buckling. Support vertical breeching, chimneys, and stacks at 12 foot spacing, to adjacent structural surfaces, or at floor penetrations. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible for equivalent duct support configuration and size.
- D. Pitch breeching with positive slope up from fuel-fired equipment to chimney or stack.
- E. Maximum Vent Horizontal Distance: 75 percent of vent vertical distance.
- F. Install vent dampers, locating close to draft hood collar, and secured to breeching.
- G. Level and plumb chimney and stacks.
- H. Clean breeching, chimneys, and stacks during installation, removing dust and debris.
- I. Install slip joints allowing removal of appliances without removal or dismantling of breeching, breeching insulation, chimneys, or stacks.
- J. At appliances, provide slip joints permitting removal of appliances without removal or dismantling of breeching, breeching insulation, chimneys, or stacks

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State Project No.s: 014-0034 EA / 014-0035 BE-EA

- K. Provide minimum length of breeching to connect appliance to chimney.
- L. Extend vent above roof in accordance with applicable code.

END OF SECTION

SECTION 235232 - CONDENSING BOILERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Condensing water-boilers.
 - 2. Boiler mounted controls.
 - 3. Boiler trim and accessories.
 - 4. Boiler control panel and accessories.

- B. Related Sections:
 - 1. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for concrete housekeeping pads specified by this section.
 - 2. Section 23 04 00 – General Conditions for Mechanical Trades
 - 3. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this section.
 - 4. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for Vibration Isolators for placement by this section.
 - 5. Section 23 11 23 - Facility Natural-Gas Piping: Execution requirements for natural gas piping connections to boilers specified in this section.
 - 6. Section 23 21 13 - Hydronic Piping: Execution requirements for hot water piping for piping connections to boilers specified in this section.
 - 7. Section 23 51 00 - Breechings, Chimneys, and Stacks: Execution requirements for breeching, chimney, and stack connections to boilers specified in this section.
 - 8. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to boilers specified in this section.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of

School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI Z21.13 - Gas-fired Low Pressure Steam and Hot Water Boilers.
- B. American National Standards Institute:
 - 1. ANSI Z21.13 - Gas-fired Low Pressure Steam and Hot Water Boilers.
- C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- D. American Society of Mechanical Engineers:
 - 1. ASME Section IV - Boiler and Pressure Vessel Code - Heating Boilers.
 - 2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
- E. Hydronics Institute:
 - 1. H.I. Heating Boiler Standard - Testing and Rating Standard for Heating Boilers.
- F. International Fuel Gas Code - 2012
- G. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit capacities and accessories included with boiler. Include general layout, dimensions, size and location of water, fuel, electric and vent connections, electrical characteristics, weight and mounting loads.
- C. Test Reports: Indicate boilers meet or exceed specified performance and efficiency. Submit results of combustion test.
- D. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

- F. Manufacturers Field Reports: Indicate condition of equipment after start-up including control settings and performance chart of control system.
- G. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

1.7 QUALITY ASSURANCE

- A. Conform to ASME Section IV and ANSI Z21.13 Code for construction of boilers. Provide boilers registered with National Board of Boiler and Pressure Vessel Inspectors.
- B. Boiler Performance Requirements: Conform to minimum efficiency prescribed by ASHRAE 90.1 when tested in accordance with H.I. Heating Boiler Standard.
- C. Gas Train and Safety Controls: Conform to requirements of Factory Mutual (FM) and Industrial Risk Insurers (IRI).
- D. Unit Certification: AGA and ETL or UL certified.
- E. Conform to applicable code for internal wiring of factory wired equipment.

- F. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc., as suitable for purpose specified and indicated.
- G. Perform Work in accordance with State and Municipality standard.
- H. Maintain one copy of each document on site.
- I. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.9 PRE-INSTALLATION MEETINGS

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

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Accept boilers and accessories on site in factory shipping packaging. Inspect for damage.
- C. Protect boilers from damage by leaving packing in place until installation.

1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.12 WARRANTY

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

- B. The pressure vessel shall be guaranteed against thermal shock for 20 years when utilized in a closed loop hydronic heating system with a temperature differential of 170 °F or less. The boiler pressure vessel shall be guaranteed accordingly without a minimum flow rate or return water temperature requirement. The boiler shall not require the use of flow switches or other devices to ensure minimum flow.
- C. The pressure vessel, tubes and tube sheets (heat exchanger) shall be guaranteed against flue gas corrosion and materials/workmanship for a period of 10 years. The condensate collection box shall be guaranteed for 20 years.
- D. All parts not covered by the above warranties shall carry a 1 year warranty from substantial completion including all electrical components and burner components.

PART 2 PRODUCTS

2.1 CONDENSING WATER-TUBE BOILERS

- A. Manufacturers:
 - 1. Cleaver Brooks Model CFLC
 - 2. Viessmann
 - 3. Buderus
- B. Furnish materials in accordance with State and Municipality standards.
- C. Product Description: Hot water condensing, finned tube heat exchanger, gas burning system, refractory combustion chamber, controls, and boiler trim including pump/circulator and neutralization tank.
- D. Height Restrictions: Boiler height including stand shall not exceed 96". Flue connections shall be low or at back side of the boiler. Top flue connections shall not be provided.
- E. Each unit shall be a Down-fired Firetube type complete with boiler fittings and automatic controls. The boiler, with all piping and wiring, shall be factory packaged. Each boiler shall be neatly finished, thoroughly tested and properly packaged for shipping. Boiler design and construction shall be in accordance with Section IV of the ASME Code for hot water heating boilers with a maximum working pressure of 60 PSIG. The boiler shall be CSA (formerly AGA/CGA) certified as an indirect or direct vent boiler and comply with ASME CSD-1 Code requirements.
- F. Boiler Fabrication: Boiler shall be a compact, single-pass, vertical down-fired Firetube type, with stainless steel tubes and tube sheets. The boiler pressure vessel shall be completely insulated with a minimum of 2" of insulation and shall be encased in an 18 gauge metal cabinet with powder coated finish. To prevent installation damage, the casing shall be packaged separately and shall ship loose for field installation by the manufacturer's service representative.

1. The tubes shall be 316Ti Stainless Steel and shall be fitted with Aluminum internal heat transfer fins creating no less than 10 square feet of fireside heating surface per boiler horsepower.
2. The Vessel shall be mounted on a structural steel stand with exhaust gasses collected in a polymer drain collection box complete with drain fitting for draining condensation from the products of combustion. Provide condensate drain tank and condensate neutralizing tank complete with limestone granules (shipped loose for field installation).
3. The top tubesheet shall be fully accessible by lifting the burner assembly which shall come complete with lifting hinges and pneumatic lifters. The boiler shall have a built in hinged platform allowing the operator to access the tubesheet, burner, ignition assembly and flame rod without the use of a ladder.
4. The vessel shall be fully insulated with a minimum of 2" of insulation, guaranteeing external convection and radiation heat losses to the boiler room from the boiler shall be less than 0.5% of the rated input.
5. The condensing capability shall allow the boiler to be operated without the use of a 3-way valve for the boiler supply water temperature reset. No minimum boiler return water temperature or secondary pump or minimum flow rate shall be required.
6. Each boiler shall be constructed in accordance with the A.S.M.E. Section IV Code and bear the "H" stamp and shall be manufactured within an ISO 9001 Certified facility to ensure high quality standards.

G. Hot Water Boiler Trim:

1. ASME rated pressure relief valve set at 60 psi.
2. Low water cut-off to automatically prevent burner operation when water falls below safe level.
3. Inlet flow switch to automatically prevent burner operation when low flow through boiler.
4. Temperature gage to indicate outlet water temperature.
5. Pressure gage with scale graduated from 1-1/2 to 3 times safety relief valve set pressure.
6. Control transformer.
7. On-off switch with indicator lights.
8. Alarm bell.

H. Boiler Fuel Burning System:

1. General: Forced draft burner mounted in and integral with the boiler hinged top door so when the door is opened the burner head, furnace, tubesheet, and tubes are exposed. The burner door shall utilize easy removable threaded handles, and the burner shall swing upward on hydraulic piston arms, one on each side to provide open support of the burner assembly.
2. A drop down hinged service platform shall be furnished to provide service personnel an easy means of accessing the burner and controls for service and maintenance. When out of use, this platform shall fold up beneath the front service boiler panel.
3. The burner shall be of the Unitized Venturi, Gas Valve, Blower, and burner head design. This pre-mix design shall utilize a variable speed fan connected to a venturi to simultaneously modulate fuel and air for a minimum a 5:1 turndown

ratio. The venturi design shall also act as a method for compensating for changes in barometric pressure, temperature and humidity so the excess air levels are not adversely affected by changes in atmospheric conditions. External linkages, damper motor drives and single speed fans shall not be acceptable.

4. Burner head shall be constructed of a Fecralloy-metal fiber for solid body radiation of the burner flame. Combustion shall take place on the surface of the burner mantle, which shall be constructed of a woven fecralloy material creating a 360 degree low temperature radiant flame.
5. Emissions: The boiler(s) burner shall be guaranteed to limit NOx emissions to 20 PPM or less, as certified by an independent testing lab. NOx emissions shall be at full operating conditions. Proof of such certification shall be made available to the engineer and purchaser. External flue gas recirculation shall not be accepted for emission control.
6. Gas Train - As a minimum, the gas train shall meet the requirements of CSA and ASME CSD-1 and shall include:
 - a. Boiler shall be capable of operating at minimum gas pressure as scheduled on the drawings and maximum gas pressure of 14" w.c.
 - b. Low Gas Pressure Interlock, manual reset.
 - c. High Gas Pressure Interlock, manual reset.
 - d. Upstream and downstream manual test cocks.
 - e. Ball Type manual shutoff valve upstream of the main gas valve.
 - f. Unibody double safety gas valve assembly.
 - g. Gas Pressure Regulator
 - h. Union connection to permit burner servicing.
 - i. Combustion Air Proving Switch shall be furnished to ensure sufficient combustion airflow is present for burner firing.
7. To ensure that proper draft is not blocked in the stack, the burner shall include a High Air Pressure Switch sensing the outlet pressure connection relative to stack back draft.

I. Boiler Trim

1. Safety valve(s) shall be ASME Section IV approved side outlet type mounted on the boiler water outlet. Size shall be in accordance with code requirements and set to open at 60 psig.
2. Temperature and pressure gauge shall be mounted on the water outlet.
3. Solid State Low water cut-off probe with manual reset and test switch.
4. Outlet water supply sensing probe for operating water limit setpoint.
5. Return water-sensing probe for operating water limit setpoint.
6. Neutralization tank with "chips".

J. Boiler Controls:

1. Operating Controls: Factory wired, factory assembled electric control including pilot safety and thermocouple transformer, 24-volt gas valve, manual main and pilot valves, and junction box.
2. Electronic operating temperature controller:
 - a. NEMA 250 Type 1 enclosure with full cover for wall mounting.
 - b. Ambient temperature range of -30 to 150 degrees F.
 - c. Adjustable reset ratio of outside air temperature change to discharge control point change 1: 2 to 100: 1.

- d. Integral set point adjustment 80 to 230 degrees F.
 - e. Electronic primary and outdoor sensors.
 - f. Suitable for on-off switching of pilot duty single-throw double-pole relays.
3. High limit temperature controller with manual reset for burner to prevent boiler water temperature from exceeding safe system temperature.
 4. Pump controller.
 5. Pump delay relay.
 6. Boiler sequencing control.
 7. The Boiler shall include a Computerized Boiler Burner control which shall be an integrated, solid state digital micro-processing modulating device, complete with sequence indication, fault reset, mode selection, and parameter set-point switches. It shall be mounted at the front of the boiler panel for easy access and viewing.
 8. Controller shall provide for both flame safeguard and boiler control and shall perform the following functions:
 - a. Burner sequencing with safe start check, pre-purge, Electronic direct spark ignition, and post purge. Flame rod to prove combustion.
 - b. Flame Supervision - the control shall provide pre-purge and post-purge and shall maintain a running history of operating hours, number of cycles, and the most recent faults. The control shall be connected to a touchscreen display module that will retrieve this information.
 - c. Safety Shutdown with display of error.
 - d. Modulating control of the variable speed fan for fuel/air input relative to load requirements.
 - e. High Limit temperature control.
 - f. Gas pressure supervision, high and low.
 - g. Combustion Air Proving Supervision.
 - h. High Air Pressure (back draft too high) Supervision.
 - i. Display of supply temperature and set-point temperature shall be accessible via touchscreen. Output shall be continuous PID via 4 -20 mA current.
 - j. Controller shall have an option for communication device to a laptop computer interface service and troubleshooting.
 - k. Include the programming of system circulating pump and provide the programming of 2 heating loops.
 9. All parameter input control set-points shall be factory downloaded with jobsite conditions programmed at the time of initial jobsite operation.
 10. All controls to be panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls and also located to prevent possible damage by water according to CSA requirements.
 11. When multiple boilers are utilized for a single installation, the boiler manufacturer or its authorized representative shall provide a UL listed sequencing control for up to 4 boilers. The control shall include automatic rotation of lead boiler, and adjustable outdoor reset schedule, 4-20 mA output to the boilers, digital display of settings, and interface capabilities to an Energy Management System. The control shall be provided with a NEMA 1 enclosure.

12. Controls shall be capable of interfacing directly with the Building Management System (BMS) which shall be a Delta Controls System. Provide Bacnet interface to share all operating data.

2.2 BOILER CONTROL & LEAD LAG

- A. The Boiler package shall each include an integrated, microprocessor-based Falcon touch screen display controller. Boiler control shall perform the following functions and shall be 120 volt, 1 phase power.
 1. Temperature sensors and flow meter (all field installed) as shown on the floor plans.
 2. Control valve (field installed)
 3. Electronic ignition.
 4. Burner sequencing and flame supervision with safe start check, pre-purge, electronic direct spark ignition, and post purge. Flame rod to prove combustion.
 5. Modulating combustion fan and burner modulation over a 5:1 turndown ratio.
 6. Safety shutdown with display of error.
 7. Low gas pressure, air proving, high limit, and frost protection.
 8. The supply temperature and set point temperature shall be displayed at all times by an LED readout. Output shall be a continuous PID via 4-20 mA current. (The control shall have the ability to reset the boiler water temperature based on outside air temperature or an input signal from a building management system).
- B. Controller shall have an option for communication device to computer interface for commissioning and advanced diagnostics.
- C. All controls to be panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls and also located to prevent possible damage by water according to CSA requirements. Electrical power supply for the controls shall be 120 volts, 60 cycle, single phase.
- D. A control circuit transformer shall be provided to allow single point power connection.
- E. LEAD-LAG (FALCON) In addition to each individual boiler having an integral Falcon controller then one of the two boilers shall be provided with a master touch screen display control system to control the lead lag of the two boilers. The Falcon Lead Lag control shall provide sequencing and staging for up to 8 boilers (this case shall be 2 boilers) using a daisy chain manor using Falcon controllers linked over the Falcon Lead Lag Modbus network. Falcon controllers connected in a lead lag network use the Modbus communication bus to communicate in a 'Master-Slave' configuration. The 'Master' is a software management service and is 'hosted' by one of the Falcon units in the network. The lead lag Master is not a separate controller and no additional control panels or devices are required to configure and operate a Falcon lead lag network. The Master is responsible for all high-level system functions including boiler sequencing and staging, pump/valve control, and system PID setpoint control, etc... as below;
 1. PID setpoint control - The lead lag Master uses a proportional-integral-derivative algorithm to maintain system header temperature at a setpoint. Individual boilers are turned on and off as necessary according to the configured sequence and add/drop-stage methods. PID gain settings are user-configurable.
 2. Outdoor reset (hot water systems) - Adjusts the setpoint according to outdoor temperature. Uses an outdoor temperature sensor wired to one of the lead lag slaves' sensor inputs.
 3. Time of day setpoint (night setback).
 4. Remote enable - system can be enabled from a separate boiler room controller or building energy management system (EMS).

5. Remote setpoint (hot water)
6. Warm weather shutdown (hot water) - uses the outdoor temperature and shuts down the lead lag system at a setpoint (plus a 4 deg F hysteresis). Can be programmed to shut down immediately or when current demand for central heat ends.
7. Frost Protection (hot water) - when an individual slave requires frost protection it notifies the lead lag Master, which will then activate a pump or if necessary fire a burner.
8. Pump control (hot water) - 3 configurable relays on each Falcon controller can be controlled in conjunction with the lead lag Master.
9. Lead-Lag Kit - This lead lag kit shall include a system header temperature sensor with thermowell, outdoor air temperature sensor, and Falcon Program Module for copying parameter settings from one Falcon to another supplied by the boiler manufacturer.
10. Modbus network connecting all Falcon boiler controllers in the system. The Falcon's Modbus communication capabilities shall allow the transfer of information between the lead lag network and a building EMS for purposes of remote system monitoring or data acquisition. In Lieu Of Hard wired contacts a remote enable/remote setpoint operation shall be available.
11. Master Control System shall be capable of enabling and modulating boiler primary circulating pumps in order to match flow rate through the boiler to its firing rate. This method best matches the system load demands while maximizing condensing boiler operational efficiency, especially when the system secondary pump(s) also incorporate variable flow control. This variable flow control standard option shall incorporate "Wave #4" modules for each of the systems boilers to be controlled.
12. A lead-lag supply "header" temperature sensor shall be connected to the lead lag Master to perform PID set point control to maintain desired system temperature set point. An outdoor temperature sensor shall perform outdoor reset temperature set point control. The lead lag Master shall coordinate the sequencing and firing rate of the Slave boilers, as well as connected pumps, to meet the desired system set point.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Assemble boiler after transporting into boiler room. Perform pressure test on boiler after assembly in accordance with the following:
 1. Pressure test before connecting gas piping, electrical connections, and controls.
 2. Install boiler drain and pressure gage.
 3. Plug remaining openings.
 4. Fill boiler with water and vent air.
 5. Pressure test to manufacturer's recommendations.
 6. Repair leaks and retest.
 7. After successful test, drain and remove plugs from openings to be used for piping connections and controls.
- B. Install boilers plumb and level, to plus or minus 1/16 inch over boiler base.
- C. Connect hot water piping to supply and return boiler connections.
- D. Maintain manufacturer's recommended clearances around and over boilers.
- E. Install boiler on concrete housekeeping pad, minimum 3-1/2 inches high and 6 inches larger than boiler base on each side. Refer to Section 03 30 00.

- F. Install boiler on vibration isolators in accordance with Section 23 05 48.
- G. Connect natural gas piping in accordance with latest edition of the International Fuel Gas Code - 2012.
- H. Connect natural gas piping to boiler, full size of boiler gas train inlet. Arrange piping with clearances for burner removal and service.
- I. Install the following piping accessories. Refer to Section 23 21 16.
 - 1. On supply:
 - a. Wells for pipe mounted temperature sensors as shown on the drawings.
 - b. Thermometer well and thermometer.
 - c. Strainer.
 - d. Pressure gage.
 - e. Shutoff valve.
 - 2. On return:
 - a. Wells for pipe mounted temperature sensors as shown on the drawings.
 - b. Thermometer well and thermometer.
 - c. Pressure gage.
 - d. Shutoff valve.
 - e. Balancing valve.
- J. Install the following piping accessories on natural gas piping connections. Refer to Section 23 11 23.
 - 1. Strainer.
 - 2. Pressure gage.
 - 3. Shutoff valve.
 - 4. Check valve.
 - 5. Pressure reducing valve.
- K. Install discharge piping from relief valves and drain valves to nearest floor drain.
- L. Install boiler trim and accessories furnished loose for field mounting.
- M. Install electrical devices furnished loose for field mounting.
- N. Install control wiring between boiler control panel and field mounted control devices.
- O. Connect flue to boiler outlet, full size of outlet.

3.2 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements and 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Perform combustion test including boiler firing rate, over fire draft, gas flow rate, heat input, burner manifold gas pressure, percent carbon monoxide, percent oxygen, percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature,

percent stack loss, percent combustion efficiency, and heat output. Perform test at minimum, mid-range, and high fire.

- C. Arrange with local authorities having jurisdiction for inspection of boiler, piping, and for certificate of operation.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Section 01 40 00 - Quality Requirements: Requirements for manufacturer's field services.
- B. Start-up boilers according to manufacturer's start-up instructions and in presence of boiler manufacturer's representative. Test controls and demonstrate compliance with requirements. Adjust burner for maximum burning efficiency. Replace damaged or malfunctioning controls and equipment.

3.4 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.
- B. Adjust all parameters in accord with manufacturer recommendations.

3.5 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Flush and clean boilers upon completion of installation, in accordance with manufacturer's start-up instructions.

3.6 DEMONSTRATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate operation and maintenance procedures.
- C. Furnish services for manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of boilers. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

END OF SECTION

SECTION 236416 - AIR COOLED CHILLERS – SPLIT SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes chiller package, charge of refrigerant and oil, controls and control connections, chilled water connections, remote condenser, refrigerant connections, auxiliary water connections, starters.
- B. Related Sections:
 - 1. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for concrete housekeeping pads specified by this section.
 - 2. Section 23 04 00 – General Conditions for Mechanical Trades
 - 3. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this section.
 - 4. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for vibration isolators for placement by this section.
 - 5. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation for chillers specified in this section.
 - 6. Section 23 21 13 - Hydronic Piping: Product requirements for chilled water and condenser water piping for placement by this section.
 - 7. Section 23 21 16 - Hydronic Piping Specialties: Product requirements for piping specialties for placement by this section.
 - 8. Section 23 23 00 - Refrigerant Piping: Product requirements for refrigerant piping for placement by this section.
 - 9. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for connection to chillers specified by this section.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project’s environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of

School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. Air-Conditioning and Refrigeration Institute:
 - 1. ARI 550/590 - Water Chilling Packages Using the Vapor Compression Cycle.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. American Society of Mechanical Engineers:
 - 1. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
- D. 2012 International Energy Conservation Code.
- E. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.5 DEFINITIONS

- A. Coefficient of Performance (COP) - cooling: The ratio of the rate of heat removal to the rate of energy input, in consistent units, for a complete refrigerating system or some specific portion of that system under designated operating conditions.
- B. Integrated Part-Load Value (IPLV): A single-number figure of merit based on part-load EER, COP, or kW/ton expressing part-load efficiency for air-conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the equipment.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate components, assembly, dimensions, weights and loads, required clearances, and location and size of field connections. Indicate valves, strainers, and thermostatic valves required for complete system.
- C. Product Data: Submit rated capacities, weights, specialties and accessories, electrical requirements, wiring diagrams, and control diagrams.

- D. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include startup instructions.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements including those furnished but not produced by manufacturer.
- F. Manufacturer's Field Reports: Submit start-up report for each unit. Indicate results of leak test and refrigerant pressure test.
- G. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.7 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit start-up instructions, maintenance data, parts lists, controls, and accessories. Include trouble-shooting guide.

1.8 QUALITY ASSURANCE

- A. Conform to ARI 550/590 code for testing and ratings.
- B. Performance Ratings: Coefficient of Performance (COP) and Integrated Part-Load Value (IPLV) not less than prescribed by ASHRAE 90.1-2010 and 2012 IECC.
- C. High Performance Building Requirements:

1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience and with service facilities within 100.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.10 PRE-INSTALLATION MEETINGS

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

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Accept chillers on site in factory packaging. Inspect for damage.
- C. Protect indoor chillers from weather by storing under roof.

1.12 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty to include coverage for compressor; materials and labor.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. The Trane Company
- B. Other manufacturers offering similar product:
 1. Daikin

2. JCI

2.2 EVAPORATOR

- A. The evaporator shall be built in accordance with ANSI/ASHRAE 15- Safety Code for Mechanical Refrigeration. Design, test, and stamp evaporator refrigerant side for 200 psig (1379 kPa) working pressure in accordance with ANSI/ASME SEC 8.
- B. Evaporator tubes shall be copper, internally enhanced and externally finned to achieve maximum efficiency. The nominal tube wall thickness shall be 0.025 inches.
- C. Water boxes shall be designed for 150 psig maximum waterside working pressure and shall be flanged and gasketed for easy removal and access to the tubes. The water boxes shall have grooved-type water connections for easy field chilled water and condenser water connections and have proper orientation as referenced in the scheduled drawings.
- D. Units with multi-stage compressors shall incorporate an interstage flash vessel economizer in the refrigerant cycle.
- E. Factory insulation will be 3/4" insulation Armaflex II or equal ($k=0.28$) and cover the evaporator, water boxes and motor housing. Factory installed foam insulation will be used on the suction line, liquid level sensor and oil return system assembly.

2.3 AIR-COOLED CONDENSER AND FANS

- A. Construct condenser coils with mill galvanized steel fan sections and coil side baffles. Legs shall be heavy gauge mill galvanized steel. Copper tubes shall be mechanically expanded into aluminum fins. Coils shall be helium leak and pressure tested with 400 psig dry air, shipped and pressurized with dry nitrogen.
- B. Provide quiet, direct-drive, multi-bladed propeller fans. Fans shall provide uniform air distribution through the coil and venturi fan orifices to optimize efficiency. Entire fan assembly shall be statically and dynamically balanced and fan assembly shall be either painted or zinc-coated steel. Fan guard shall be either PVC, chrome, or zinc coated.
- C. Condenser fans shall have weather resist DPAO fan motors designed with ball bearings inherent overheat protection in each phase; shaft slingers; enclosure hardware and lubrication for all weather conditions.
- D. Custom External Finish / Painting: All external surfaces of the casing, support framing and accessories shall be prepared and painted. Paint shall be able to withstand a salt spray test in accordance with ASTM B117 for a minimum of 700 consecutive hours. Paint shall be custom off-white color as selected by architect.

2.4 REFRIGERANT CIRCUIT

- A. All units shall have 2 independent refrigerant circuits, each with a separate single compressor. If manifolded compressors are provided on a circuit, then individual compressor warranties must be provided for each compressor on the circuit.

- B. Chiller shall be able to unload to 20% of capacity with AHRI relief.
- C. Provide for each refrigerant circuit
 - 1. Suction service valve
 - 2. Discharge service valve
 - 3. Liquid line shutoff valve
 - 4. Filter drier

2.5 CONTROLS

- A. The chiller(s) shall be controlled by a microprocessor-based, proportional and integral controller to show water and refrigerant temperatures, refrigerant pressures and diagnostics. A dedicated chiller control panel with a non-coded display is to be supplied with each chiller by the chiller manufacturer. The controller shall provide chiller capacity control in response to the leaving chilled water temperature.
- B. The chiller control panel shall utilize the following components to automatically take action to prevent unit shutdown due to abnormal operating conditions which will perform as follows:
 - 1. High pressure limit that is set 10% lower than factory pressure switch that will automatically unload the compressor to help prevent a high pressure condenser control trip. One switch is required for each compressor and indicating light shall also be provided.
 - 2. Current limit setpoint that is set to 120% of compressor RLA that will automatically unload the compressor to help prevent an overcurrent trip. One protector is required for each compressor and indicating light shall also be provided.
 - 3. Low refrigerant temperature limit that will automatically unload the compressor to help prevent a low evaporator temperature trip.
- C. If the chiller runs in any of the abnormal operating conditions, the chiller will continue to run, in an unloaded state, and will continue to produce chilled water in an attempt to meet the cooling load. However, if the chiller reaches the trip-out limits, the chiller controls will take the chiller off line for protection, and a manual reset is required. Once the "near trip" condition is corrected, the chiller will return to normal operation and can then produce full load cooling.
- D. The chiller control panel shall provide control of chiller operation and monitoring of chiller sensors, actuators, relays, and switches. The panel shall be a complete system for stand-alone chiller control and include controls to safely and efficiently operate the chiller.
- E. Manufacturer shall provide a compressor that is capable of unloading to an infinite amount of positions in order to provide water temperature accuracy of +/- 0.5F. In the event that the compressor unloads to finite steps, the manufacturer shall provide eight (8) or more steps of unloading on each compressor or provide HGBP.
- F. The chiller control panel is to be provided with the following digital type pressure readouts:

1. Evaporator refrigerant pressure
 2. Condenser refrigerant pressure
- G. The front of the chiller control panel shall be capable of displaying the following clear language as standard:
1. Entering and leaving evaporator water temperature
 2. Entering and leaving condenser water temperature
 3. Chilled water setpoint
 4. Electrical 3 phase current limit and percent RLA setpoint
 5. Electrical 3 phase amp draw
 6. Chiller operating mode
 7. Condenser refrigerant temperature
 8. Elapsed time and number-of-starts counter
 9. Chiller compressor run status relay
 10. Diagnostics with time and date stamp
 11. The control panel display shall identify the fault, indicate date, time, and operating mode at time of occurrence, and provide type of reset required and a help message. The historic diagnostic report shall display the last 20 diagnostics with their times and dates of occurrence
- H. Digital communication to the building management system shall consist of a BacNet certified interface.
- I. The chiller shall provide the following points for system control and monitoring:
1. A relay output that shall energize whenever a fault requiring manual reset is detected by the panel.
 2. A relay output that shall energize whenever the unit is operating in a limit mode for an extended time period.
 3. An analog input to control leaving chilled water temperature setpoint based upon a 4-20ma or 0-10 VDC signal from a building automation system.
- J. The chiller control panel shall provide a programmable soft load to prevent the chiller from achieving full capacity during the pulldown period by imposing a ramped current limit, or a temperature pulldown rate. Either can be adjusted to limit how fast the chiller can load after an initial startup.
- K. The chiller control panel shall provide leaving chilled water temperature reset based upon return water temperature.
- L. The chiller control panel shall provide an RS-232 for printer interface to a printer.

2.6 STARTERS

- A. The motor starters shall be Wye-Delta. Motor starters shall have a NEMA 1 gasketed enclosure. Enclosure shall be constructed of 12 gauge steel minimum with the exception of doors which shall be 14 gauge steel minimum.
- B. Starters shall be unit mounted with ventilating louvers.

- C. Motor starters shall include incoming line provisions for the number and size cables shown on the drawings. Incoming line lugs shall be aluminum mechanical type. Connection directly to the contactors is not permissible.
- D. Contactors shall be sized properly to the chiller full load and locked rotor currents. Contactors shall have double break main contacts with weld resistant silver cadmium faces. Auxiliary interlocks that interface with the control panel shall be low resistance having palladium silver contacts.
- E. Each starter shall include an advanced motor protection system incorporating electronic three phase overloads and current transformers. This electronic motor protection system shall monitor and protect against the following conditions:
 - 1. Three phase overload protection
 - 2. Overload protection during start-up
 - 3. Phase imbalance
 - 4. Phase loss
 - 5. Phase reversal
 - 6. Low voltage
- F. Alternately the advanced motor protection system can be furnished in the chiller control panel.
- G. Each starter/control shall be designed and able to operate in temperatures up to 104 F.
- H. All field supplied wires, bus bars, and fittings shall be copper only.
- I. Provide in the starter panel:
 - 1. Circuit Breaker - The disconnect handles, both internal and external, shall be capable of being padlocked in the off position.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install indoor chiller on concrete housekeeping pad minimum 3-1/2 inches high and 6 inches wider than equipment base on each side. Refer to Section 03 30 00.
- B. Install units on vibration isolation. Refer to Section 23 05 48.
- C. Install the following piping accessories on evaporator chilled water piping connections.
 - 1. On inlet:
 - a. Thermometer well for temperature controller.
 - b. Thermometer.
 - c. Strainer.
 - d. Flow switch.
 - e. Flexible pipe connection.
 - f. Pressure gage.
 - g. Shut-off valve.

2. On outlet:
 - a. Thermometer.
 - b. Flexible pipe connection.
 - c. Pressure gage.
 - d. Shut-off valve.
- D. Arrange piping for easy dismantling to permit tube cleaning.
- E. Install refrigerant piping connections to air-cooled condensing units. Refer to Section 23 23 00.
- F. Install piping from chiller safety relief valve up through roof. Size as recommended by manufacturer.
- G. Install chiller accessories furnished loose for field mounting.
- H. Install electrical devices furnished loose for field mounting.
- I. Install control wiring between chiller control panel and field mounted control devices.
- J. Provide connection to electrical service. Refer to Section 26 05 03.

3.2 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Furnish cooling season start-up, winter season shutdown service, for first year of operation. When initial start-up and testing takes place in winter and machines are to remain inoperative, repeat start-up and testing operation at beginning of first cooling season.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Section 01 40 00 - Quality Requirements: Manufacturers' field services.
- B. Furnish services of factory trained representative for minimum of one day to leak test, refrigerant pressure test, evacuate, dehydrate, charge, start-up, calibrate controls, and instruct Owner on operation and maintenance.
- C. Furnish initial charge of refrigerant and oil.

3.4 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.

3.5 DEMONSTRATION AND TRAINING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate system operations and verify specified performance. Demonstrate low ambient operation during winter testing for air-cooled condensers.

END OF SECTION

SECTION 237415 - CUSTOM AIR HANDLING UNITS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes
 - 1. Air Handling Units.
 - 2. Dedicated Outside Air Systems.

- B. Related Sections:
 - 1. Section 23 04 00 – General Conditions for Mechanical Trades
 - 2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this section.
 - 3. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for vibration isolators for placement by this section.
 - 4. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation for chillers specified in this section.
 - 5. Section 23 21 13 - Hydronic Piping: Product requirements for chilled water and condenser water piping for placement by this section.
 - 6. Section 23 21 16 - Hydronic Piping Specialties: Product requirements for piping specialties for placement by this section.
 - 7. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for connection to chillers specified by this section.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES:

- A. Material standards shall be as specified or detailed hereinafter and as follows:
1. AMCA Publication 99 – Standards Handbook
 2. AMCA Publication 311 – Certified Ratings Program - Product Rating Manual For Fan Sound Performance.
 3. AMCA Standard 300 – Reverberant Method for Sound Testing of Fans.
 4. AMCA Standard 301 – Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
 5. AMCA Standard 500-D – Laboratory Methods of Testing Dampers for Rating.
 6. AMCA Standard 500-L – Laboratory Methods of Testing Louvers for Rating.
 7. ANSI/ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
 8. ANSI/ABMA 11 – Load Ratings and Fatigue Life for Roller Bearings.
 9. ANSI/AMCA Standard 204 – Balance Quality and Vibration Levels for Fans.
 10. ANSI/AMCA Standard 210 – Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 11. ANSI/AHRI Standard 1060 – Rating Air-to-Air Energy Recovery Ventilation Equipment.
 12. ANSI/ASHRAE 52.2 – Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
 13. ANSI/NEMA MG 1 – Motors and Generators.
 14. AHRI Standard 260 – Sound Rating of Ducted Air Moving and Conditioning Equipment.
 15. AHRI Standard 410 – Forced-Circulation Air-Cooling and Air-Heating Coils.
 16. ASHRAE 52.1 – Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
 17. ASHRAE 84 – Method of Testing Air-to-air Heat Exchangers.
 18. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
 19. ASTM E477 – Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
 20. NFPA 70 – National Electrical Code®.
 21. NFPA 90A – Standard for the Installation of Air-Conditioning and Ventilation Systems.
 22. UL 555S – Standard for Safety Smoke Dampers.
 23. UL 900 – Standard for Safety Air Filter Units.
 24. UL 1812 – Standard for Safety Ducted Heat Recovery Ventilators.
 25. UL 1995 – Standard for Safety Heating and Cooling Equipment.

1.5 ABBREVIATIONS

- A. The following abbreviations pertain to this section:

1. ABMA – American Bearing Manufacturers Association.
2. AC – Alternating current.
3. AF – Air foil.
4. AI – Analog input.
5. AMCA – Air Movement and Control Association International, Inc.
6. ANSI – American National Standards Institute.
7. AO – Analog output.
8. AHRI – Air-Conditioning, Heating, and Refrigeration Institute.
9. ASHRAE – American Society of Heating, Refrigerating and Air-Conditioning Engineers.
10. ASTM – American Society for Testing and Materials.
11. dB – Decibels.
12. DDC – Direct digital controls.
13. DOP – Dioctyl phthalate aerosol.
14. DWDI – Double width, double inlet.
15. EATR – Exhaust air transfer rate.
16. EMT – Electrical metal tubing.
17. EAct – Energy Policy Act.
18. ETL – Electrical Testing Laboratories.
19. FC – Forward curved.
20. FLA – Full load amps.
21. FM – Factory Mutual.
22. FMC – Flexible metal conduit
23. FOB – Freight on board.
24. fpm – Feet per minute.
25. GFCI – Ground fault circuit interrupter.
26. IRI – Industrial Risk Insurers.
27. ISO – International Organization for Standardization.
28. MERV – Minimum efficiency report value.
29. MOP – Maximum overcurrent protection.
30. MPT – Male pipe thread.
31. NEC – National Electric Code.
32. NEMA – National Electrical Manufacturers Association.
33. NFPA – National Fire Protection Association.
34. NIST – National Institute of Standards and Technology.
35. ODP – Open drip proof.
36. OSHA – Occupational Safety and Health Administration.
37. psig – Pounds per square in gage.
38. SMACNA – Sheet Metal and Air-Conditioning Contractors’ National Association.
39. SWSI – Single width, single inlet.
40. TEFC – Totally enclosed, fan cooled.
41. UL – Underwriters Laboratory.
42. VFD – Variable frequency drive.

1.6 DEFINITIONS

- A. Class "A" thermal break shall be defined as a thermal break that ensures no member on the exterior of the unit, including fasteners, has through metal contact with any member on the interior of the unit, including fasteners.
- B. Wall assemblies shall include all unit wall panels around the air tunnel perimeter, all channels exposed to both the interior and exterior of the unit, and all removable wall access panels.
- C. Door assemblies shall include interior and exterior unit door panels, door frames, and door channels.
- D. Roof assemblies shall include exterior unit roof panels, interior unit ceiling panels, and all roof channels exposed to both the interior and exterior of the unit.
- E. External pipe cabinet assemblies shall include all cabinet wall panels, exterior cabinet roof panels, interior cabinet ceiling panels, all channels exposed to both the interior and the exterior of the unit, and interior and exterior cabinet door panels, door frames, and door channels.

1.7 SCOPE OF WORK

- A. The AHU Manufacturer's work shall include, but is not necessarily limited to the following:
 - 1. Furnish a complete set of submittals as described hereinafter.
 - 2. Provide AHUs fully factory assembled with the exception of unit splits as required for shipping or installation requirements as indicated on the schedule and drawings. Disassembled AHU components provided to the Mechanical Contractor for field assembly as built-up AHUs shall not be acceptable. As shipped from the AHU Manufacturer, AHUs shall meet the performance requirements shown on the equipment schedule. Units shall be for indoor or outdoor application and shall have all components and options as indicated on the schedule or drawings. Furthermore, units shall be constructed as detailed hereinafter. Field-provide components and options shall be unacceptable unless otherwise noted.
 - 3. Provide all labor, materials, and equipment necessary for the complete engineering, production, factory assembly, factory testing, packaging, and delivery of the custom AHUs and their related equipment. Provide high voltage components, factory engineered, mounted and wired.
 - 4. Permit the Owner and Engineer to inspect as herein described and to witness performance tests to ensure good product quality and compliance with these specifications.
 - 5. Factory test all AHUs as detailed herein and on the schedule.
 - 6. Provide a factory-authorized service representative employed by the AHU Manufacturer to supervise installation and start-up of the units as herein described. Installation shall be performed by the Mechanical Contractor employed by the Owner.

7. Provide Owner's Manual, complete operating instructions.
- B. Contractor Shall:
1. Coordinate all work associated with the AHU installation. Schedule with the AHU Manufacturer for a factory-authorized service person employed by the AHU Manufacturer to supervise unit installation. Clear area where unit is to be set of any construction materials or debris. Ensure equipment curbs or support platforms are level prior to setting the units. Hoist and set units in their proper position. Use spreader bars to hoist the unit (sections) to avoid damaging units. If units ship in multiple sections, provide all labor and equipment for placing and field joining sections.
 2. Provide all final chilled water, hot water, glycol water, and drain piping connections. Release the fan spring isolator shipping restraints.
 3. Remove all foreign objects and thoroughly clean the interior and exterior surfaces of the units with a mild detergent (soap and water). Do not use any abrasives or solvents without first consulting the AHU Manufacturer.
 4. Install filter media in filter frames. Operating units without filter media is strictly prohibited.
 5. Perform unit start up as detailed herein under the guidance and supervision of a factory-authorized service person employed by the AHU Manufacturer.

1.8 SUBMITTALS

- A. No equipment shall be fabricated or delivered until the receipt of approved shop drawings from the Owner or Owner's approved representative.
- B. AHU Manufacturer shall provide the following information with each shop drawing/product data submission:
 1. Dimensioned arrangement drawings for each AHU including a plan and elevation view of the assembled unit with overall dimensions, support locations, and weights. Drawings shall also indicate all electrical, piping, and ductwork requirements, including sizes, connection locations, and connection method recommendations. Each component of the unit shall be identified and shall include physical dimensions and material of construction.
 2. Panel-to-panel joint and corner details and panel-to-roof details, all showing Class "A" thermal breaks.
 3. All performance data, including capacities and airside and waterside pressure drops, for components. AMCA-certified fan curves shall be provided with specified operating point clearly plotted. AMCA-certified sound power level data for fan inlet and outlet at fan rated capacity shall be provided. EATR and the amount of outside air transferred to the exhaust air shall be provided for each energy wheel. Fan curves shall be provided for fans with the design operating points indicated. Data shall be corrected to actual operating conditions, temperatures, and altitudes. Unit discharge, inlet, and radiated sound power levels in dB shall be provided for 63, 125, 250, 500, 1000, 2000, and 4000 Hz based on AHRI 260 fan in unit testing.

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4. Brand and model of fans, fan motors, coils, air filters, dampers, silencers, total energy recovery wheels, variable frequency drives, and unit DDC controllers being furnished.
- C. The AHU Manufacturer shall provide appropriate sets of submittals as referenced in the General Conditions and shall submit to the Owner electronic copies of the IOM.

- D. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.9 QUALITY ASSURANCE

- A. High Performance Building Requirements:
1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.10 WARRANTY AND SERVICE

- A. The AHU Manufacturer shall have a service department located within 100 miles of the job site.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Trane Performance Climate Changer or Trane Custom.
- B. Other manufacturers offering similar product:
 - 1. Ventrol
 - 2. Buffalo Air Handler
 - 3. TMI.

2.2 AGENCY LISTING

- A. AHUs shall be agency listed to UL 1995 by UL or ETL.

2.3 UNIT NAMEPLATES AND LABELS

- A. Metal nameplates shall be provided on the units. All information contained on the nameplate shall be etched or burned into the surface to prevent fading. Information shall include:
 - 1. Job name, sales order number, unit tagging, and service model number.
 - 2. MCA, MOP, and maximum fuse/HACR circuit breaker size.
 - 3. Voltage, frequency, phase, Hp, FLA, and inverter input current for all motors.
- B. Labels for AHRI Standard 410, AHRI Standard 1060, and the listing agency, either UL or ETL, shall be provided on the units.
- C. Labels shall be provided on the units for unit rigging and coil piping and connection instructions. Labels shall be provided on fans indicating direction of rotation. Warning labels shall be provided on appropriate components indicating hazardous voltage. For each section which must be assembled to another, matching steel identification tags shall be welded at each mating joint to ensure correct assembly order.

2.4 UNIT CONSTRUCTION

- A. Casing Performance
 - 1. Unit air leakage shall not exceed 0.5% of design cfm at +12.0" w.g. in all positive-pressure sections and -12.0" w.g. in all negative-pressure sections. Leakage shall be calculated by totaling all leakage either in to or out of the unit.
 - 2. Casing deflection shall not exceed L/250 at +12.0" w.g. in all positive-pressure sections and -12.0" w.g. in all negative-pressure sections, where L is defined as the panel span.
 - 3. Under scheduled supply air temperature and design conditions on the exterior of the unit of 91°F dry bulb and 76°F wet bulb, condensation shall not form on the casing exterior. The AHU Manufacturer shall provide tested casing thermal performance for the scheduled supply air temperature plotted on a psychrometric chart. The design condition on the exterior of the unit shall also be plotted on the chart. If tested casing thermal data is not available, AHU Manufacturer shall

provide, in writing, a guarantee against condensation forming on the unit exterior under the scheduled supply air temperature and design conditions on the exterior of the unit of 91°F dry bulb and 76°F wet bulb. The guarantee shall note that the AHU Manufacturer will cover all expenses associated with modifying units in the field should external condensate form on them. Copies of the guarantee shall be provided to the Engineer and the Owner.

B. Bases & Floors

1. Base shall be constructed from welded structural steel channels around the perimeter and welded structural steel cross members. Formed steel channels are not acceptable. The structural steel base shall be shot blasted, fully welded and then painted. The maximum cross-member spacing shall be 24" on center with members located adequately to support fan, coils, and other large components. The height of each base channel shall be no less than the height indicated in the drawings. Each shipping section shall be provided with removable lifting lugs. Structural framework shall fully support the unit casing and all components during installation such that no section deflects more than L/1000 during rigging of that section, where L is defined as the distance between lifting lugs.
2. Floor shall be constructed from 1/8" aluminum safety tread plate surface. The floor surface shall be continuously welded with 2" turned up lip around the base perimeter and all floor penetrations. Caulk is not an acceptable sealing method for the floor. Floor drains shall be located in the floor to drain all sections. Floor drains shall be a minimum of 1.5" in diameter and shall be piped to the exterior of the unit base. Floor deflection shall not exceed L/200 under a point load of 200 pounds, where L is defined as the floor span. A galvanized steel liner shall be attached to the underside of the unit base and cross members, ensuring that the floor insulation is completely encapsulated.
3. Insulation that meets a minimum R-value of 25.0 shall be provided underneath the entire unit floor. Insulation shall be closed-cell foam to prevent wicking of moisture. If fiberglass insulation is provided, it shall be completely wrapped with long-strand fiberglass cloth to limit the entrainment of moisture into the insulation. The long-strand fiberglass cloth shall also incorporate an anti-microbial coating to suppress microbial growth. Insulation shall completely fill the panel cavity in all directions so that no voids exist. Base assemblies shall comply with NFPA 90 A.
4. Safety grates that provide a walking surface shall be provided across all bottom air openings. Safety grates shall support a minimum 300-pound load. Safety grates shall be made of Type IWA welded rod with a cross flow pattern of 1.1875" x 4". Grating shall be galvanized steel construction for units with galvanized or painted steel floors and shall be aluminum construction for units with aluminum floors. Safety grates shall be removable to ensure adequate access to the ductwork below.

C. Walls

1. Wall assemblies shall be double-wall construction with galvanized steel solid exterior and galvanized steel interior. The entire unit shall have a solid wall liner on the interior. All spaces and joints of wall assemblies shall be completely sealed. Wall shall meet the casing deflection limits contained herein.

2. A Class "A" thermal break shall be provided throughout the entire wall assembly.
 3. Insulation that meets a minimum R-value of 25.0 shall be provided throughout all unit wall assemblies. Insulation shall be injected foam. Foam shall be closed cell to prevent wicking of moisture. If fiberglass insulation is provided, it shall be completely wrapped with long-strand fiberglass cloth to limit the entrainment of moisture into the insulation. The long-strand fiberglass cloth shall also incorporate an anti-microbial coating to suppress microbial growth. Insulation shall completely fill the panel cavity in all directions so that no voids exist and settling of insulation is prevented. Wall assemblies shall comply with NFPA 90 A.
 4. Removable wall access panels shall be provided in coil sections for service removal of components. A Class "A" thermal break shall be provided throughout all removal wall access panels.
- D. Access Doors
1. Access doors shall be provided throughout units at all plenums sections, fan sections, access sections, ERV sections, economizer sections and pipe enclosures. Access doors shall be double wall construction. Interior and exterior door panels shall be of the same construction as the interior and exterior wall panels, respectively.
 2. A Class "A" thermal break shall be provided on all door assemblies downstream of the cooling coil.
 3. Insulation that meets a minimum R-value of 25.0 shall be provided throughout all door assemblies. Insulation shall be injected foam. Foam shall be closed cell to prevent wicking of moisture. If fiberglass insulation is provided, it shall be completely wrapped with long-strand fiberglass cloth to limit the entrainment of moisture into the insulation. The long-strand fiberglass cloth shall also incorporate an anti-microbial coating to suppress microbial growth. Insulation shall completely fill the panel cavity in all directions so that no voids exist and settling of insulation is prevented. Door assemblies shall comply with NFPA 90 A.
 4. All doors shall be a minimum of 60" high if sufficient height is available, or the maximum height allowed by the unit height. Access doors at pipe enclosures shall be full height. All doors shall open against pressure to ensure an airtight seal and to prevent a safety hazard.
 5. Door hinges shall be stainless steel type. Door handles shall be Allegis design for minimized leakage and to provide a Class "A" thermal break. Handles shall fasten against the door frame with a roller cam to eliminate wear of the door frame. On indoor units, if Allegis handles are not provided, Ventlok 310 handles shall be provided on all doors to ensure positive seal of the door and to avoid wear of the door frame. All door handles shall be operable from both the unit exterior and interior.
 6. Windows shall be provided in doors as indicated on the schedule and drawings. Windows shall be mounted in a metal frame and shall be a minimum of 8" x 8", with safety glass. For any instance where a window cannot fit in a door, a

narrower window 8” tall may be provided. Windows in doors with a thermal break shall be thermal, double-pane type.

E. Roofs

1. Roof assemblies shall be double wall construction. Exterior roof panels and interior ceiling panels shall be of the same construction as the exterior and interior wall panels, respectively. Sections in units with perforated interior wall liners shall have perforated interior ceiling liners. For perforated liners, a triple-wall panel shall be provided. This triple-wall panel shall be constructed such that two layers of the panel are solid, with the afore-mentioned class of thermal break between them to isolate the supply air from contact with the outside panel. The third, inner liner shall be perforated. All spaces and joints of roof assemblies shall be completely sealed. In addition to meeting the casing deflection limits contained herein, roof deflection shall not exceed $L/200$ under a point load of 200 pounds, where L is defined as the roof panel span.
2. A Class “A” thermal break shall be provided throughout the entire roof assembly.
3. Insulation that meets a minimum R-value of 25.0 shall be provided throughout all roof assemblies. Insulation shall be injected foam. Foam shall be closed cell to prevent wicking of moisture. If fiberglass insulation is provided, it shall be completely wrapped with long-strand fiberglass cloth to limit the entrainment of moisture into the insulation. The long-strand fiberglass cloth shall also incorporate an anti-microbial coating to suppress microbial growth. Insulation shall completely fill the panel cavity in all directions so that no voids exist. Roof assemblies shall comply with NFPA 90 A.
4. Outdoor unit roofs shall incorporate a standing seam on the exterior to ensure a rigid roof construction. Outdoor roofs shall be sloped, not less than 1/8” per foot for water drainage. Where outdoor units are shipped in multiple sections, provide standing-seam joiners at each split with adhesive, hardware, and cover strips for field joining by the installing contractor. On outdoor units, rain gutters shall be provided over all doors to direct rain away from the door assembly.

F. Pipe Cabinets

1. External Pipe Cabinets
 - a. The AHU Manufacturer shall provide external pipe cabinet assemblies as indicated on the schedule and drawings. External pipe cabinets shall be factory assembled and shipped with the units for field mounting. Pipe cabinet walls shall be double wall construction. Cabinet interior and exterior walls panels shall be of the same construction as the unit interior and exterior wall panels, respectively. Cabinet interior ceiling and exterior roof panels shall be of the same construction as the unit interior ceiling and exterior roof panels, respectively. Cabinet roofs shall be sloped away from the unit for water drainage.
 - b. External pipe cabinets shall be provided with doors as indicated on the schedule and drawings. Doors shall be double wall construction. Interior and exterior cabinet door panels shall be of the same construction as the unit interior and exterior door panels, respectively.

- c. Insulation that meets a minimum R-value of 25.0 shall be provided throughout all external pipe cabinet assemblies, including pipe cabinet doors. Insulation shall be injected foam. Foam shall be closed cell to prevent wicking of moisture. If fiberglass insulation is provided, it shall be completely wrapped with long-strand fiberglass cloth to limit the entrainment of moisture into the insulation. The long-strand fiberglass cloth shall also incorporate an anti-microbial coating to suppress microbial growth. Insulation shall completely fill the wall, ceiling, and door cavities in all directions so that no voids exist and settling of insulation is prevented. Pipe cabinet assemblies shall comply with NFPA 90 A.

G. Shipping Splits

1. Shipping splits shall be provided as indicated on the schedule and drawings. Heavy-gage gussets shall be provided in the corners of each split on the unit interior to minimize the opportunity for racking of the section during shipping and rigging. Structural members shall be provided at the base of the unit exterior to enable pull together of each shipping split.

H. Custom External Finish / Painting

1. All external surfaces of the casing, support framing and accessories shall be prepared and painted. Paint shall be able to withstand a salt spray test in accordance with ASTM B117 for a minimum of 700 consecutive hours. Paint shall be custom off-white color as selected by architect.

2.5 UNIT COMPONENTS

A. Weather Hoods

1. Outside and exhaust air weather hoods shall be fabricated from the same material as the unit exterior. Hoods shall extend past the perimeter of the unit casing opening to ensure the hood does not obstruct the airflow path. Hoods shall be furnished with drain gutters and wire mesh bird screen. Hoods shall be painted with the same paint requirements identified for the external casing herein.
2. Inlet hoods shall be sized for less than 750 fpm inlet velocity. Inlet hoods shall be provided with a moisture eliminator that ensures no entrainment of water into the unit for the velocity at which the hood is selected.

B. Dampers

1. Approved manufacturers: TAMCO 9000 BF, Ruskin CDTI-50BF or approved equal.
2. Ultra low-leak, modulating, insulated dampers with thermal breaks at the blades and frame.

C. Air Filters

1. Manufacturers level of quality: AAF, Airguard, Farr, Dynamic, and StrionAir.

2. All filters shall be 12" x 24", 24" x 24", or 24" x 12" nominal sizes to minimize the number of sizes required to be stocked by the Owner. Filters of other nominal sizes will not be acceptable.
 3. Medium Efficiency Pleated Media Filters
 - a. Pleated media filters 2" deep shall be provided as indicated on the schedule and drawings. The MERV rating shall be 8 when tested in accordance with ANSI/ASHRAE 52.2. Filter media shall be of non-woven fibers with metal grid support. set(s) of extra filters shall be provided with each unit.
 - b. Filters shall be UL Class 2 when tested in accordance with UL Standard 900.
 - c. Filters shall be provided with front-loading frames. Filter holding frames shall be constructed of galvanized steel and equipped with foam gaskets to seal filters against filter frames. Frame seams shall be sealed to eliminate air bypass. Front-loading frames shall be equipped with filter fasteners of the same material as the filter frame. Filter fasteners shall be capable of being installed without the use of special tools, bolts or nuts. Filter holding frames shall be of a universal type to accommodate standard filters of the same nominal size as well as appropriate fasteners. Filter access shall be as indicated on the schedule and drawings.
 4. High Efficiency Cartridge Filters
 - a. Rigid cartridge filters 12" deep shall be provided as indicated on the schedule and drawings. The MERV rating shall be 12 when tested in accordance with ANSI/ASHRAE 52.2. Filters shall consist of high density glass fiber media enclosed in galvanized steel frames with diagonal supports on both the entering and leaving sides. set(s) of extra filters shall be provided with each unit.
 - b. Filters shall be UL Class 2 when tested in accordance with UL Standard 900.
 - c. Filters shall be provided with front-loading frames. Filter holding frames shall be constructed of galvanized steel and equipped with foam gaskets to seal filters against filter frames. Frame seams shall be sealed to eliminate air bypass. Front-loading frames shall be equipped with filter fasteners of the same material as the filter frame. Filter fasteners shall be capable of being installed without the use of special tools, bolts or nuts. Filter holding frames shall be of a universal type to accommodate standard filters of the same nominal size as well as appropriate fasteners. Filter access shall be as indicated on the schedule and drawings.
 5. As a minimum, filters shall be provided at the inlet to coils and inlet side of energy recovery devices.
- D. Cooling and Heating Coils
1. Manufacturers level of quality: Aerofin, Heatcraft, and Trane.
 2. Coil performance shall be provided as indicated on the schedule and drawings. Coil capacities, pressure drops and selection procedures shall be certified to AHRI Standard 410.

3. Coils shall have same-end header connections. Water coils shall have non-ferrous headers. Water coils shall have vent and drain taps and MPT connections. Connection locations (handing) shall be as indicated on the drawings. Grommets shall be provided at coil casing penetrations around the coil piping. Grommets shall be designed to seal the opening under positive and negative pressure.
4. Hot Water Coils
 - a. Hot water coils shall be provided as indicated on the schedule and drawings.
 - b. Hot water coils shall have 0.0075" thick aluminum fins. Fins shall be mechanically bonded to 5/8" OD seamless copper tubes with 0.020" thick walls. Fins shall have collars drawn, belled and firmly bonded to the tubes by means of mechanical expansion. Coils shall be circuited for counter-flow heat transfer. Coil casings shall be constructed of galvanized steel.
 - c. Hot water coils shall be proof and leak tested under water. Proof test shall be at 300 psig and leak test shall be at 200 psig.
5. Chilled Water Coils
 - a. Chilled water coils shall be provided as indicated on the schedule and drawings.
 - b. Chilled water coils shall have 0.0075" thick aluminum fins. Fins shall be mechanically bonded to 5/8" OD seamless copper tubes with 0.020" thick walls. Fins shall have collars drawn, belled and firmly bonded to the tubes by means of mechanical expansion. Coils shall be circuited for counter-flow heat transfer. Coil casings shall be constructed of stainless steel.
 - c. Chilled water coils shall be proof and leak tested under water. Proof test shall be at 300 psig and leak test shall be at 200 psig.
6. Coil Racks
 - a. For all stacked coils, coil racks shall be provided to allow independent removal of any coil within the stack without the removal of another coil. Coil racks shall be constructed of the same material as the coil casing.
7. Primary Drain Pans
 - a. Primary condensate drain pans shall be provided in cooling coil sections as detailed in the drawings. Drain pans in cooling coil sections shall be stainless steel. Primary drain pans shall extend under each entire coil bank, including headers and return bends. Primary drain pans shall extend downstream of the coil bank for a minimum distance as indicated in the drawings. Primary drain pans shall be sloped a minimum of 1/8" per foot, shall be a minimum of 2" deep, and shall be double-sloped (sloped in 2 planes) to positively drain. Drain connections shall be of the same material as the primary drain pan and shall extend a minimum of 1-1/2" beyond the base to ensure adequate room for field piping of condensate drain traps. Drain connection locations (handing) shall be as indicated on the schedule and drawings. Any coil support member located inside a primary drain pan shall be of the same material as the drain pan.

8. Intermediate Drain Pans

- a. For cooling coil sections requiring stacked coils, sloped intermediate drain pans constructed of stainless steel shall be provided under each upper-level coil in the coil bank and shall extend under the entire coil, including headers and return bends. Intermediate drain pans shall extend downstream of the leaving face of the coil bank for a minimum of 4". Non-corrosive pipe with a minimum diameter of 1" shall be connected to each end of all intermediate drain pans, and shall be piped to the primary drain pan of the coil section. Any coil support member located inside an intermediate drain pan shall be of the same material as the drain pan.

- E. Fans
1. Manufacturers level of quality: Trane and Twin Cities.
 2. All fans shall be tested, rated and certified in accordance with ANSI/AMCA Standard 210 for air delivery and in accordance with AMCA Standard 300 for sound power levels and shall bear the AMCA seal. The fan balancing process, including vibration limits and documentation, shall be performed in accordance with ANSI/AMCA Standard 204. Fan and motor performance requirements shall be as shown on the schedule and drawings. Maximum rated speed of the fans shall not exceed 75% of the first critical speed.
 3. Housed Centrifugal Fans
 - a. Fan shall be DWDI or SWSI with BC or high-efficient AF blades as indicated on the schedule and drawings. The Hp characteristic of all fans shall be non overloading.
 - b. Fan bearings shall be heavy duty, grease lubricated, self-aligning, antifriction pillow block type. Fan bearings shall be rated for a minimum average life (L-50) per ANSI/ABMA of 200,000 hours at design operating conditions. For easy accessibility, lubrication lines for fan bearings shall extend to the drive side of the fan, on the unit interior.
 4. Unhoused Plenum Fans – Direct Drive
 - a. Fans shall be unhoused, SWSI plenum type with high efficient AF blades as indicated on the schedule and drawings. Fans shall be direct driven. Fan wheels shall be aluminum. The Hp characteristic of the fans shall be non-overloading. Fans shall be furnished with protective enclosures around the fan wheels. Fans shall be furnished with inlet collars. Fans shall be furnished with inlet screens.
 - b. For dual plenum fans, actuator-operated isolation dampers shall be factory mounted to prevent reverse airflow through any fan that fails. Dampers shall be sized and positioned to minimize impact on fan performance. All losses associated with the dampers shall be considered when making fan selections.
 5. Fan Motors
 - a. Approved manufacturers: A. O. Smith, Baldor, and Toshiba.
 - b. Locations of motors shall be as indicated on the schedule and drawings.
 - c. All motors shall conform to ANSI/NEMA MG 1 as well as all applicable requirements of NEC and shall be UL Listed. Motors shall be inverter ready, ODP and of the voltage, phase, frequency, and Hp indicated on the schedule and drawings. Motors shall be premium efficient, exceeding the EPA efficiency requirements. Motors for belt-driven fans shall be 1800 rpm, except where noted. The motor shall be provided with a heavy duty, adjustable, steel base.
 - d. Nameplate motor horsepower for all fans, including dual fans, shall be at least 10% greater than design brake horsepower of each fan.
 - e. Motors shall be NEMA Design B, with Class B insulation.
 6. Fan Motor Removal Rails
 - a. Fan section shall be provided with a structural steel I beam for mounting a trolley to assist in fan motor removal. Trolley assembly shall be

provided by others. The beam system shall be mounted overhead of the fan and motor. The beam system shall be supported and mounted to the unit's base support system.

7. V-Belt Drives (Sheaves)
 - a. Sheaves for motors and fans shall be fixed pitch and shall be selected at a minimum service factor of 1.2. Sheaves shall have multiple grooves, requiring a minimum of two belts for operation.
 8. Silencers (Sound Attenuators)
 - a. Approved manufacturers: Refer to Section 23 3303.
 - b. Silencers shall be of the size, configuration, specification and acoustical performance as scheduled in Section 23 3303.
- F. Energy Recovery Ventilation (ERV) Wheels
1. Manufacturers level of quality: Novel Air and DRI.
 2. Total energy recovery wheels shall be provided as indicated on the schedule and drawings. Wheels shall be integral parts of the AHUs and shall be sized per the ventilation requirement of the units. Additional outside air units, or other field assembled and ducted energy recovery devices, are not acceptable. Mixed air units with economizing shall be constructed with internal bypass dampers such that the pressure drop across the wheel does not increase during economizing. External bypass and multiple duct connections are not acceptable.
 3. The energy recovery wheel shall be certified to ANSI/AHRI Standard 1060 and bear the AHRI 1060 label. Performance characteristics of the energy wheel shall be provided as defined by AHRI 1060 definitions. The energy wheel shall be a total energy wheel, with the sensible and latent effectiveness reported and within 5% of each other. The calculated total net effectiveness of the recovery wheel shall not be less than 70% when the specified ventilation flow rate equals the exhaust flow rate. The energy wheel's EATR shall be less than the value indicated in the schedule and drawings. The amount of outside air transferred to the exhaust air shall also be reported to ensure proper fan and damper sizing. Wheel face velocity shall not exceed 900 fpm and pressure drops shall be less than 1.25" w.g.
 4. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belts. The energy wheel media shall be constructed of synthetic fiber or polymer media. The media shall not be subject to corrosion in marine or coastal environments. The adsorbent shall be integrally bound into the media or impregnated into the media without the use of binders or adhesives. The adsorbent shall not be applied as a glued on surface coating and not susceptible to erosion, abrasion, or delamination. The adsorbent shall be selected for its high affinity for water vapor and shall not dissolve or deliquesce in the presence of water or high humidity. Energy recovery cassettes shall be UL-recognized components certified for mechanical, electrical and fire safety in accordance with UL Standard 1812.
 5. All diameter and perimeter seals shall be provided as part of the cassette assembly. Perimeter seals shall be self-adjusting and diameter seals shall be adjustable. Seals shall be factory set.

6. Wheel drive motor shall be provided mounted in the cassette frame. Motor locations shall be as indicated on the schedule and drawings. Wheel drive motor shall be thermally protected and UL Component Recognized. Drive belts shall not require belt tensioners. Wheel motors shall be of the voltage, phase, frequency, and Hp indicated on the schedule and drawings. Wheels shall have flanged or pillow block bearings which support the rotating shaft of the wheel. Outboard bearings shall be provided with grease fittings for periodic lubrication. L-10 bearing life shall be greater than 400,000 hours at design conditions.
7. Access doors shall be provided for the removal of wheel segments. Doors shall be located to allow access to the entire upstream and downstream face of each wheel. Adequate space and access shall be provided for energy wheel motor, bearing and belt removal.
8. Energy recovery wheels shall be designed with variable effectiveness control, to vary the wheel's recovery capacity. Variable effective control shall be done by an internal bypass damper provided by the AHU Manufacturer. The wheel's variable effectiveness control shall have the ability to modulate the total energy recovery ability down to at least 40% of the initial recovery capacity. Variable frequency speed control is not an acceptable method for controlling variable effectiveness.
9. Frost prevention shall be achieved by outside air bypass, return air preheat, or outside air preheat, depending upon design conditions. Frost set point temperatures based on the scheduled design air conditions shall be provided by the AHU Manufacturer. Variable frequency speed control is not an acceptable method of frost control. Winter design supply and exhaust air conditions leaving the energy wheel shall be provided by the AHU Manufacturer and shall include any de-rate in performance due to frost prevention measures.

2.6 VIBRATION ISOLATION

- A. All fan and motor assemblies shall be mounted on vibration isolators which have a 2" deflection to isolate the assembly from the unit housing. The discharge of housed fan assemblies and the inlet of plenum fan assemblies shall be connected to the pressure-bulkhead panel (wall, floor, or roof) with flexible duct to prevent transmission of vibration to the unit casing. No metal-to-metal contact will be permitted between fixed and floating parts. Thrust restraints shall be provided as required to limit horizontal movement of fan assembly at design conditions. Fan bases shall be rigidly tied to the unit base during shipment to prevent damage from shipping vibrations. Shipping restraints shall be field removable with a common tool.
- B. Each fan assembly shall be vibration tested prior to shipment. Measurements shall include both radial and axial displacement at each bearing using magnetic accelerometers connected to a vibration analyzer. Vibration shall not exceed limits specified herein.

2.7 ELECTRICAL

- A. Marine Lights

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State Project No.s: 014-0034 EA / 014-0035 BE-EA

1. Marine lights shall be provided at each section with an access door. Lights shall be 50,000 hour LED service lights; 120V. Lights shall be constructed of safety glass. Lights shall be suitable for wet locations.

- B. Marine Light Switches
1. All lights on a unit shall be wired in the factory to a single on-off switch. The light switch shall be labeled and mounted on the casings exterior in a NEMA 3R enclosure next to the fan access door. Switch shall be provided with pilot light. Lighting circuit(s) shall be wired by the AHU Manufacturer to a common junction box separate from the VFD or starter so the lights can remain on when the main disconnect to the unit is off.
- C. Convenience Outlets
1. A 15 amp, 115V GFCI convenience outlet shall be provided by the AHU Manufacturer. On outdoor units, the outlet shall be mounted inside the unit at the fan access door. The outlet shall be wired by the AHU Manufacturer to the same circuit as the lights.
- D. Variable Frequency Drives (VFDs)
1. Manufacturers: Refer to Specification Section 23 09 23.
 2. VFD's shall be the same manufacturer and model being submitted under Specification Section 23 09 23 – Direct Digital Control System for HVAC. VFD manufacturer and specification requirements shall be in accordance with Section 23 09 23. All VFD's provided under Division 23 shall be the same manufacturer.
 3. Each fan motor shall be provided with a dedicated VFD. Provide factory wiring from fan motor to the VFD. Unit will be served by multiple branch circuits; one per VFD.
- E. Motors shall meet the criteria outlined in Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
- F. Factory Wiring of Lights, VFDs and Disconnect Switches
1. VFDs shall be wired per NEC, UL, and NFPA 90 A requirements. Units with factory-mounted controls shall also include power wiring from the VFD or starter/disconnect control transformer to the control system transformers. Units with VFDs and factory-mounted controls shall have a binary start-stop signal and an analog speed signal wired from the direct digital controller to the VFD.
 2. All power wiring for voltages greater than 24V shall be contained in an enclosed, metal, power-wiring raceway or EMT. When a power-wiring raceway is used, access panels shall be provided in the raceway at each shipping split to enable access to the wiring during installation.
 3. The AHU Manufacturer shall provide individual, single-point power connections for each VFD.
- G. Factory Commissioning of VFDs and Combination Starter/Disconnects
1. After mounting and wiring of VFDs, on the AHUs, trained factory personnel shall ensure proper operation of each VFD, through a thorough factory test. Testing shall include a Hypot test of unit wiring to ensure that no weaknesses exist in wiring or motor.

PART 3 EXECUTION

3.1 FACTORY INSPECTIONS

- A. All work shall be subject to the Owner's inspection and approval at all times, but such approval does not relieve the AHU Manufacturer of responsibility for proper functioning of material and work. Notification shall be given to the AHU Manufacturer by the Owner, in writing, a minimum of 10 business days in advance of the visit.

3.2 FACTORY TESTING

- A. Factory testing shall be conducted at the AHU Manufacturer's facility prior to shipment of the units being tested.
 - 1. One AHU out of the lot shall be tested.
 - 2. One DOAS out of the lot shall be tested.
- B. The Owner or his designated representative may witness the tests. The AHU Manufacturer shall notify the Owner, in writing, a minimum of 10 business days in advance of the testing to provide time to coordinate travel arrangements. The AHU Manufacturer shall provide all equipment and trained personnel to conduct each test. Results shall be recorded and provided to the Owner and Engineer.
- C. Costs for travel and lodging for the Owner or his designated representative shall be covered by the Owner.
- D. Air Leakage Tests: The AHU Manufacturer shall conduct factory air leakage tests on units as indicated in the schedule and drawings. Positive-pressure sections of units shall be tested under positive pressure and negative-pressure sections of units shall be tested under negative pressure. Unit air leakage shall not exceed 0.5% of design cfm at +12.0" w.g. in all positive-pressure sections and -12.0" w.g. in all negative-pressure sections. Leakage shall be calculated by totaling all leakage either in to or out of the unit.
- E. Panel Deflection Test: The AHU Manufacturer shall conduct factory panel deflection tests on units as indicated in the schedule and drawings. Positive-pressure sections of units shall be tested under positive pressure and negative-pressure sections of units shall be tested under negative pressure. Casing deflection shall not exceed L/250 at +12.0" w.g. in all positive-pressure sections and -12.0" w.g. in all negative-pressure sections, where L is defined as the panel span.
- F. The AHU Manufacturer shall repair/replace at his own expense any items that fail or are damaged during testing. For any unit that fails testing, the AHU Manufacturer shall retest the unit until all items are in compliance with limits specified herein. In addition a second unit out of the lot shall be tested.
- G. After factory assembly, inspection and testing of units, the AHU Manufacturer shall disassemble each unit (where required) only to the extent necessary for shipment, unless otherwise detailed herein.

- H. The AHU Manufacturer shall legibly mark the parts of work to be erected or field-assembled to enable the Mechanical Contractor to identify the various parts and erect the work without delay.

3.3 SHIPPING

- A. Paper copies of the IOM shall also be shipped with each AHU.
- B. The AHU Manufacturer shall identify all shipments with the order number. Enough information shall be provided with each shipment to enable the Mechanical Contractor to confirm the receipt of units when they are received. For parts too small to mark individually, the AHU Manufacturer shall place them in containers.
- C. To protect equipment during shipment and delivery, all indoor and outdoor units shall be completely shrink wrapped. Wrap shall be a minimum of 7 mil plastic. Pipe ends and pipe connection holes in the casing shall be capped or plugged prior to shipment.
- D. After loading the equipment for shipment, the AHU Manufacturer shall contact the shipping contact on the order and provide the name of the carrier, description of equipment, order number, shipping point, and date of shipment.

3.4 ON-SITE STORAGE

- A. If equipment is to be stored for a period of time prior to installation, the Mechanical Contractor shall remove all stretch or shrink wrap from units upon receipt to prevent unit corrosion and shall either place the units in a controlled indoor environment or shall cover the units with canvas tarps and place them in a well-drained area. Covering units with plastic tarps shall not be acceptable.

3.5 LEVELING

- A. Contractor shall laser level all unit mounting surfaces, including housekeeping pads, roof curbs, and/or structural steel prior to rigging and installation of the AHU units. Should the AHU units be installed on an unlevel surface, Contractor shall rework the installation at his/her own expense and to the satisfaction of the Owner and Engineer and to ensure proper installation.

3.6 FIELD EXAMINATION

- A. Contractor shall verify that the mechanical room and/or roof are ready to receive work and the opening dimensions are as indicated on the shop drawings and contract documents.
- B. Contractor shall verify that the proper power supply is available prior to starting of the fans.

3.7 INSTALLATION

- A. Contractor shall be responsible to coordinate ALL of his installation requirements to ensure that a complete installation for each unit is being provided. Coordination efforts shall include such items as unloading and hoisting requirements, field wiring requirements, field piping requirements, field ductwork requirements, requirements for assembly of field-bolted or -welded joints, and all other installation and assembly requirements.
- B. The AHU Manufacturer shall provide all screws and gaskets for joining of sections in the field.
- C. The AHU Manufacturer shall provide a factory-authorized service representative employed by the AHU Manufacturer to conduct a pre-installation inspection, provide rigging oversight, and supervise the AHU installation Contractor shall obtain site readiness approval from the AHU Manufacturer prior to proceeding with rigging and installation of AHU units.
- D. Contractor shall verify that the following items have been completed prior to scheduling the AHU Manufacturer's final inspection and start-up:
 - 1. All spring-isolated components have had their shipping restraints removed and the components have been leveled.
 - 2. On all field-joined units, that all interconnections have been completed, i.e., electrical and control wiring, piping, casing joints, bolting, welding, etc.
 - 3. All water piping connections have been completed and hydrostatically tested and all waterflow rates have been set in accordance with the capacities scheduled on the Drawings.
 - 4. All ductwork connections have been completed and all ductwork has been pressure tested for its intended service.
 - 5. All power wiring, including motor starters and disconnects, serving the unit has been completed.
 - 6. All automatic temperature and safety controls have been completed.
 - 7. All dampers are fully operational.
 - 8. All shipping materials have been removed.
 - 9. All (clean) filter media has been installed in the units.

3.8 DEMONSTRATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate unit operation and maintenance.
- C. Furnish services of manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

3.9 FINAL INSPECTION AND START-UP SERVICE

- A. Factory-authorized service representative employed by the AHU Manufacturer shall inspect the installation. Contractor shall perform startup of the equipment.
- B. The Building Management System (BMS) Contractor shall be scheduled to be at the job site at the time of the equipment start-up.
- C. Under the guidance and supervision of the factory-authorized service representative Contractor, shall perform the following tests and services and submit a report outlining the results:
 - 1. Record date, time, and person(s) performing service.
 - 2. Lubricate all moving parts.
 - 3. Check all motor and starter power lugs and tighten as required.
 - 4. Verify all electrical power connections.
 - 5. Conduct a start-up inspection per the AHU Manufacturer's recommendations.
 - 6. Record fan motor voltage and amperage readings.
 - 7. Check fan rotation and spin wheel to verify that rotation is free and does not rub or bind.
 - 8. Check fan for excessive vibration.
 - 9. Check V-belt drive or coupling for proper alignment.
 - 10. Check V-belt drive for proper tension. Tighten the belts in accordance with the AHU Manufacturer's directions. Check belt tension during the second and seventh day's operation and re-adjust belts, as may be required, to maintain proper tension as directed by the AHU Manufacturer.
 - 11. Remove all foreign loose material in ductwork leading to and from the fan and in the fan itself.
 - 12. Disengage all shipping fasteners on vibration isolation equipment.
 - 13. Check safety guards to ensure they are properly secured.
 - 14. Secure all access doors to the fan, the unit and the ductwork.
 - 15. Switch electrical supply "on" and allow fan to reach full speed.
 - 16. Physically check each fan at start-up and shut-down to ensure no abnormal or problem conditions exist.
 - 17. Check entering and leaving air temperatures (dry bulb and wet bulb) and simultaneously record entering and leaving chilled water temperatures and flow, steam pressures and flow, and outside air temperature.
 - 18. Check all control sequences.

END OF SECTION

SECTION 238112 - NATATORIUM PACKAGED UNITS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Packaged unit for mounting at grade.
- B. Related Sections:
 - 1. Section 23 04 00 – General Conditions for Mechanical Trades
 - 2. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Vibration isolators.
 - 3. Section 23 09 23 - Direct-Digital Control System for HVAC: Controls remote from unit.
 - 4. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation applying to units in this section.
 - 5. Section 23 33 00 - Air Duct Accessories: Flexible connections.
 - 6. Section 26 05 03 - Equipment Wiring Connections: Electrical connection to units.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. Air-Conditioning and Refrigeration Institute:
 - 1. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
 - 2. ARI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
- B. Air Movement and Control Association International, Inc.:
 - 1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
- C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 15 - Safety Standard for Mechanical Refrigeration.
 - 2. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
 - 3. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- D. ASTM International:
 - 1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
- E. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 2. NEMA MG 1 - Motors and Generators.
- F. 2012 International Fuel Gas Code

1.5 DEFINITIONS

- A. Energy Efficiency Ratio (EER) - Ratio of net cooling capacity in Btuh to total rate of electric input in watts under designated operating conditions.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit data indicating:
 - 1. Cooling and heating capacities.
 - 2. Dimensions.
 - 3. Weights.
 - 4. Rough-in connections and connection requirements.
 - 5. Duct connections.
 - 6. Electrical requirements with electrical characteristics and connection requirements.
 - 7. Controls.
 - 8. Accessories.
- C. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- E. Manufacturer's Field Reports: Submit start-up report for each unit.
- F. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.7 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of units and controls installed remotely from units.
- C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.8 QUALITY ASSURANCE

- A. Cooling Capacity: Rate in accordance with ARI 340/360.
- B. Sound Rating: Measure in accordance with ARI 270.
- C. Performance Requirements: Conform to minimum EER as scheduled on the Drawings and as prescribed by ASHRAE 90.1 when tested in accordance with ARI 340/360.
- D. Unit and refrigeration system shall comply with ASHRAE 15.

- E. Unit and gas fired heating system shall comply with 2012 IFGC.
- F. Outside Air Damper Leakage: Test in accordance with AMCA 500.
- G. Maintain one copy of each document on site.
- H. Entire unit shall be ETL listed and/or CSA certified and shall comply with BOCA code M-401.1 and M-402.1. Units with listed components only shall not be acceptable.
- I. Coils shall be UL listed and/or CSA certified.
- J. Blower motor(s) and compressor(s) shall be UL listed and/or CSA certified.
- K. Pool Water heater(s) shall be UL listed and/or CSA certified and comply with BOCA Piping in accordance with BOCA code M-702.0 for joints and connections. All refrigerant pipes shall be copper type "L".
- L. Units shall be completely factory assembled, wired, piped and tested. All controls shall be factory adjusted and pre-set to the design conditions. Test report shall be available on request. Engineer reserves the right to witness factory performance testing.
- M. Manufacturer of the packaged system for natatorium environmental control shall have a minimum of 25 years experience in the production of these systems and have at least 5 similar or larger units in operation.
- N. The system shall have a limited warranty for twenty-five months from shipment.
- O. The entire cabinet shall be painted internally and externally.
- P. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum ten years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum ten years documented experience as approved by manufacturer.

1.10 PRE-INSTALLATION MEETINGS

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

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Accept units on site. Inspect for damage.
- C. Protect units from damage by storing off roof until roof mounting curbs are in place.

1.12 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Coordinate installation of roof curbs with roof structure, roof deck and roof membrane installation.

1.13 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer's warranty for compressors.
- C. Furnish five year manufacturer's warranty for gas fired heat exchangers.

1.14 MAINTENANCE SERVICE

- A. Section 01 70 00 - Execution and Closeout Requirements: Maintenance service.
- B. Furnish service and maintenance of equipment for one year from Date of Substantial Completion. Include maintenance items as shown in manufacturer's operating and maintenance data, including filter replacements, fan belt replacement, and controls checkout, adjustments and recalibration.
- C. Maximum time period between maintenance calls shall be 3months.
- D. Furnish 24-hour emergency service on breakdowns and malfunctions for this maintenance period.
- E. Submit copy of service call work order or report, and include description of work performed.

1.15 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish one complete set of all types of filters for each unit. Extra set of filters shall be provided loose in manufacturers packaging to the Owner at Substantial Completion. Place extra set of filters in building at owner's discretion.

PART 2 PRODUCTS

2.1 MANUFACTURERS – DEHUMIDIFICATION UNIT DU-1

- A. Dectron Models as scheduled on the Drawings. Other manufacturers offering similar products:
 - 1. Munters
 - 2. Seresco
 - 3. Desert Aire

2.2 GENERAL DESCRIPTION

- A. The dehumidifiers shall be single package units. Each unit shall include compressor(s), evaporator (dehumidifying coil), condenser (air reheat coil), gas heater(s), supply air blower(s), blower motor(s), motor starters and controls in one complete enclosure. All controls shall be via fully programmable and fully self-diagnostic microprocessor.
- B. Entire unit shall be ETL listed and/or CSA certified. Units with listed components only shall not be acceptable.
- C. The unit shall be double walled construction and designed for outdoor, rooftop installation.
- D. All exhaust fan(s) shall be unit mounted and sized to maintain the facility at negative pressure as prescribed by ASHRAE.
- E. Unit shall be supplied with integral space heating coil sized to meet the skin losses and outdoor air heating loads.
- F. Unit shall be supplied with integral, factory wired condensate pump.
- G. Unit shall be supplied with Smart Saver Heat Recovery coils to preheat the outdoor air with energy reclaimed from the exhaust air.

2.3 CABINET

- A. The perimeter base frame shall be constructed of 10-gauge formed C channel (8" on units up to 228" long, 10" on 232" to 320" long units, 12" on units over 324" long) which extend 6" beyond the unit to provide an integral lifting lug. Two additional intermediate

lifting lugs are provided on units over 228" long. Four additional intermediate lifting lugs are provided on units over 380" long. The base shall be constructed of 12-gauge hot dipped zinc coated sheet metal. The zinc coating shall be smoothed to a paint-ready satin coat finish. Cold rolled steel shall not be acceptable. The base plates shall be formed for maximum structural strength. The entire base shall be phosphate degreased and painted with 2 coats of self-priming enamel paint, providing a chlorine and pool chemistry resistant finish.

- B. The cabinet shall be constructed of 14-gauge hot dipped zinc coated sheet metal. The zinc coating shall be smoothed to a paint-ready satin coat finish. Entire cabinet shall be painted internally and externally. All metal to be phosphate degreased and then painted with a 3 mils sprayed polyester powder paint, providing a 1000 hr + salt spray resistant finish, color Grey. Partitions and walls shall have minimum 2-inch deep corner bends for structural rigidity.
- C. All doors and service panels to be hinged to provide access to all internal parts from both sides and in both sections. Slide-in doors shall not be acceptable. Hinges to be 11-gauge stainless steel with 1/4" permanent pins bolted to the unit and doors. The fasteners shall be compression type that secure the door tightly to the enclosure.
- D. Each unit shall have a built-in electrical control panel in a separate compartment in order not to disturb the air flow within the dehumidifier during electrical servicing. All electrical components shall be mounted on a 14-gauge painted sub-panel. Direct mounting of components to the partition wall shall not be acceptable. Control panel shall be under negative pressure to not allow any pool air from entering during blower operation.
- E. The unit shall have a built-in air filter rack with separate hinged access door with compression fasteners. The filter rack shall be minimum 18" deep.
- F. The unit shall be equipped with an opening suitable for connection of a duct to admit outdoor air to comply with ASHRAE Ventilation Standard 62-1999. Outdoor air intake assembly shall be welded to become an integral part of the enclosure. The section shall be painted internally and externally. It shall have a built-in air filter rack with separate hinged access door and (motorized damper controlled by seven-day time clock). Outdoor air shall be admitted between the evaporator and condenser coils.
 - 1. Outdoor Cabinet
 - a. Unit shall have a built-in electrical control panel with separate double-door compartment (single door shall not be acceptable).
 - b. Entire cabinet and access doors shall be double walled construction with 2" insulation and fitted with a minimum of 24-gauge solid metal inner liner. The inner liner shall be constructed of painted hot dipped zinc coated sheet metal. The inner metal liner is to be installed with a continuous thermal break to prevent condensation and full silicone caulk seal at all sections of contact to the enclosure. The metal liner shall be installed to act as a vapor barrier. Units without a metal inner liner as a vapor barrier shall not be acceptable.
 - c. All access doors shall have welded edges that are ground smooth and be equipped with flush mounted, adjustable tension cam latch mechanisms

- and safety door stops and holders. The latches shall be secured to the unit frame and shall prevent entrance to the unit without tools.
- d. All access doors shall be sealed against the unit frame with a continuous raised weatherproof vinyl compression gasket. The compression gasket shall be fastened to the enclosure in a special freezeproof seam. Foam gasketing and glued gasketing shall not be acceptable.
 - e. Rain guards shall be installed over all access doors.
 - f. Roof panel has 1-½-inch standing seams with two 90° bends to form an inverted 'snap U' channel. Each 90° bend shall be fully gasketed to eliminate thermal bridging.
 - g. A 100-watt light, NEMA 4 type, switch operated shall be provided. The light shall be available for use with and without main power disconnect on.
 - h. All outdoor hardware shall be stainless steel. Plated or coated hardware shall not be acceptable. All components not requiring welding shall use ¼-inch stainless steel bolts fastened to permanently enclosure mounted nuts. Loose bolts and sheet metal screws shall not be acceptable.
 - i. The unit shall be equipped with a rainhood and birdscreen for the outdoor air intake and exhaust. The rainhood shall not reduce the face area of the damper. The rainhood and birdscreen construction and paint shall be the same as the units' casing. The rainhood shall be shipped loose from the unit for field installation.

2.4 INSULATION

- A. Rooftop units shall be insulated with 2-inch thick, fiberglass duct liner insulation, approved for 250°F operating temperature and up to 5,000-fpm air velocity. Surface to be protected against perforation with a reinforcing mesh. Sound attenuation coefficient shall be not less than 1.06 at a frequency of 1000 Hz as per ASTM Standard C423. Thermal conductivity shall be not more than 0.232 Btu·in./h·sq. ft.·F at 75°F. Insulation shall be securely fastened by spot welding to become an integral component of the enclosure and held on by mechanical fasteners. Adhesives shall not be acceptable.

2.5 EVAPORATOR (DEHUMIDIFIER COIL)

- A. Shall not be less than eight rows deep for maximum moisture removal capacity with air velocity not to exceed 500 fpm, with ¾ inch OD seamless copper tubing mechanically expanded to assure high heat transfer with maximum ten aluminum fins per inch. Coils over 45-inches high shall have an intermediate one piece drain pan constructed of 20-gauge hot dipped zinc coated corrosion resistant sheet and painted after fabrication with a USDA-approved converted epoxy resin providing a chlorine and pool chemistry resistant finish.
- B. Shall be HyPoxy® coated fins for maximum corrosion resistance. Untreated fin material shall not be acceptable. Coating shall comply with ASTM B117/D1654 and ASTM D2126 for corrosion resistance.
- C. Coil shall have a 16-gauge galvanized casing and end plates.

- D. An adjustable damper shall be installed above the evaporator coil for apparatus dew point control during cold water start-up. Capacity reduction methods shall absolutely not be used for dew point control. Systems with variable outdoor and return air flows shall have automatic air flow correction via motorized bypass dampers. Coils without bypass air shall not be acceptable.
- E. Coil shall be factory tested at air pressures not less than 400 psig in a water bath.

2.6 CONDENSER (AIR REHEAT COIL)

- A. Shall be sized to transfer 100% of the compressor heat of rejection into the air if necessary with 3/4 inch OD seamless copper tubing mechanically expanded to assure high heat transfer with maximum twelve aluminum fins per inch.
- B. Shall be HyPoxy® coated fins for maximum corrosion resistance. Untreated fin material shall not be acceptable. Coating shall comply with ASTM B117/D1654 and ASTM D2126 for corrosion resistance.
- C. Coil shall have a 16-gauge galvanized casing and end plates. The end plates shall be phosphate degreased and painted with 2 coats of self-priming enamel paint, providing a chlorine and pool chemistry resistant finish.
- D. Coil shall be factory tested at air pressures not less than 600 psig in a water bath.

2.7 DRAIN PAN

- A. Each unit shall be equipped with a sloped non-trapping drain pan under the entire evaporator coil and prevent condensate carryover. Flat drain pans susceptible to water pooling and subsequent bacteria growth shall not be acceptable.
- B. The drain pan shall be double walled with insulation and constructed of 16-gauge hot dipped zinc-coated corrosion resistant sheet metal and painted after fabrication with a USDA-approved converted epoxy resin providing a chlorine and pool chemistry resistant finish.
- C. The unit shall be configured with a side drain connection.

2.8 SUPPLY BLOWER #1

- A. Blower(s)
 - 1. Shall be high performance direct drive radial fan with centrifugal backward-curved impeller. The fan unit shall be epoxy coated.
 - 2. The inlet cone shall be made of epoxy coated steel. The inlet cone is optimized to give the best possible aerodynamic performance and high efficiency.
 - 3. The single inlet impeller shall have backward curved airfoil blades made of epoxy coated steel. The impeller is statically and dynamically balanced according to quality level of G2.5 (ATE G=6.3) and in accordance with DIN ISO 1940-1. The impeller is secured to the shaft through a hub.

- B. Blower Motor(s)
 - 1. Shall have inverter-rated insulation system and be open drip-proof, Class F insulation, induction type and pre-lubricated ball bearings. Motors shall have a service factor rating of 1.15 or higher and must be marked premium efficiency.
- C. Blower Direct Drive Assembly
 - 1. All impellers are statically and dynamically balanced to a grade of G= 2,5 in accordance with DIN ISO 1940-1. The impellers are secured to the shaft through a steel hub.

2.9 SUPPLY BLOWER #2

- A. Blower(s)
 - 1. Shall be high performance direct drive radial fan with centrifugal backward-curved impeller. The fan unit shall be epoxy coated.
 - 2. The inlet cone shall be made of epoxy coated steel. The inlet cone is optimized to give the best possible aerodynamic performance and high efficiency.
 - 3. The single inlet impeller shall have backward curved airfoil blades made of epoxy coated steel. The impeller is statically and dynamically balanced according to quality level of G2.5 (ATE G=6.3) and in accordance with DIN ISO 1940-1. The impeller is secured to the shaft through a hub.
- B. Blower Motor(s)
 - 1. Shall have inverter-rated insulation system and be open drip-proof, Class F insulation, induction type and pre-lubricated ball bearings. Motors shall have a service factor rating of 1.15 or higher and must be marked premium efficiency.
- C. Blower Direct Drive Assembly
 - 1. All impellers are statically and dynamically balanced to a grade of G= 2,5 in accordance with DIN ISO 1940-1. The impellers are secured to the shaft through a steel hub.

2.10 EF1 BLOWER #1

- A. Blower(s)
 - 1. Shall be double width, double inlet, multi-blade forward curved centrifugal type blower wheel, dynamically and statically balanced and tested, mounted on a solid steel coated shaft.
 - 2. Shall have a galvanized steel wheel and galvanized steel casing painted with a baked epoxy finish.
 - 3. Sealed Bearings shall be grease-lubricated, self-aligning for 200,000 hours average L-50 life.
 - 4. The unit mounted exhaust blower shall be supplied with a power open, spring return back draft shut off damper.
- B. Blower Motor(s)
 - 1. Shall have inverter-rated insulation system and be open drip-proof, Class F insulation, induction type, pre-lubricated ball bearings mounted on an adjustable

base. Motors shall have a service factor rating of 1.15 or higher and must be marked premium efficiency.

- C. Blower Belt Drive Assembly
 - 1. Shall be double V-belt with a safety factor not less than 1.5 based on nominal motor horsepower, dynamically balanced cast iron fixed pitch blower sheave and dynamically balanced cast iron variable pitch motor sheave.

2.11 WATER HEATER(S)

- A. Shall be sized specifically for the water heating requirements. Systems requiring more water flow must submit the larger pipe, pump and increased annual operating cost requirements. Oversized water heaters that result in cold supply air temperature when in pool water heating mode shall not be acceptable.
- B. Shall be coaxial, for maximum heat transfer from refrigerant to potable water. Pool heater(s) shall be corrosion resistant, cupronickel water circuit, self-purging and self-draining counter flow design.
- C. Water circuit(s) shall be supplied with PVC pipe stub outs for easy connection. The internal water circuit of the unit shall be smooth, valveless, and designed for constant water flow.
- D. Water heaters shall be located in the warm air stream as a form of freeze protection during power failures. Systems with water heaters in a service vestibule shall not be acceptable. Water circuit shall include a water pressure switch and an automatic air vent. The water pressure switch shall have a visible, calibrated, adjustable range scale with a snap-acting switch in a dust protected enclosure. The air vent body, cover and float assembly shall be made of thermoplastic with a

2.12 COMPRESSOR(S)

- A. Shall be heavy duty reciprocating compressors, serviceable type, suction gas cooled, suitable for refrigerant, equipped with stainless steel disc valves, internal solid state thermal protection sensor, service valves, vibration isolators, easily removable crankcase heater for liquid migration protection, spring mounted, muffler plate on the discharge valve, oil pump for forced lubrication, oil level sight glass, pump down cycle protection and oil failure protection.
- B. Compressor manufacturer must have a wholesale outlet for replacement parts in the nearest major city.
- C. Compressor(s) shall have a 3-year extended warranty underwritten by the manufacturer. Third party coverage shall not be acceptable.

2.13 REFRIGERATION CIRCUIT

- A. Shall have a replaceable core type liquid line filter drier with liquid and moisture indicator visible from outside the unit without removal of the access panel. Unit shall

have a thermostatic expansion valve, a pump down solenoid valve and one manual valve to isolate filter drier for fast drier core replacement.

- B. Tamper proof, hermetically sealed non-adjustable high and low pressure controls and refrigeration service valves shall be installed using Schraeder type valves.
- C. Refrigeration service valves shall be located outside of the air stream.
- D. Suction line shall be fully insulated with not less than ½-inch closed cell insulation.

2.14 CONTROL PANEL

- A. Shall be built-in within a separate compartment in order not to disturb the air flow during servicing.
- B. All electrical components shall be mounted on a 14-gauge painted sub-panel. Direct mounting of components to the partition wall shall not be acceptable.
- C. Blower motor(s) and compressor(s) shall be controlled by contactors.
- D. Blower motor(s) and compressor(s) shall be thermally protected.
- E. Voltage monitor shall be provided to shut down electrical system to prevent damage in the event of temporary voltage fluctuation, phase loss, or phase-sequence reversal. Voltage monitor shall be auto reset.
- F. Unit shall be provided with single point power connection. Provide with disconnect switch. Dual power connections shall not be acceptable.
- G. Dry contacts shall be provided for alarm and blower interlock.
- H. Color coding and wire numbering shall be provided for easy troubleshooting. All wires shall be in a wire duct.
- I. Compressor(s) shall have a time delay start to prevent short cycling.
- J. All wiring shall be installed in accordance with UL and/or CSA safety electrical standards, and shall be in accordance with NFPA 70 - National Electrical Code in the USA and/or CEC - Canadian Electrical Code in Canada. All components used shall be UL Listed or Recognized and/or CSA Certified.
- K. A grounded 115 V AC 15Amp, convenience outlet shall be provided in the compressor compartment; factory wired.
- L. Programmable seven-day time clock with dry contacts for mode status reporting.

2.15 MICROPROCESSOR CONTROL

- A. Unit shall be monitored and controlled with a solid state microprocessor system complete with control panel equipped with an integrated 4-line by 20 character backlit LCD display and keypad.
- B. Outdoor units shall have remote operator panel mounted up to a maximum of 3280 feet away from the controller using a 4-wire, 18-gauge shielded cable. The operator panel shall be capable of being panel mounted, handheld or wall mounted.
- C. Programmable thermostats and electromechanical controls shall not be acceptable.
- D. Controls shall be capable of interfacing with BMS as follows
 1. On/ Off input
 2. General alarm output
 3. Space temperature output
 4. Space humidity output
- E. The remote operator panel shall be mounted up to a maximum of 3280 feet away from the controller using a 4-wire, 18-gauge shielded cable. The operator panel shall be capable of being panel mounted, handheld or wall mounted. The operator panel shall be fitted in a plastic casing, equipped with an integrated 4-line by 20-character backlit LCD display.

2.16 RETURN AIR FILTERS

- A. Shall be two inch extended surface pleated type, premium grade filter, to handle average dust loading. Initial resistance of 0.20 inch W. G. based on 300 fpm air velocity, MERV8 efficiency based on the ASHRAE 52.2 test method. Filters shall be antimicrobial.
- B. Unit shall have an extended filter rack for even air distribution across the dehumidifier coil. The filter rack shall have a hinged door with compression fasteners. Filters must not be less than 14-inches from the evaporator coil face.

2.17 OUTDOOR AIR CONNECTION

- A. Filters shall be two-inch cleanable permanent type air filters suitable for commercial application. The filtering element shall be made from 100% virgin natural fibers, spun into a high loft, interlocking maze. The fibers shall be bonded to tough scrim backing for rigidity. The frame shall be made of galvanized, formed channel with drain holes punched for ease of cleaning. The frame shall enclose a 16-gauge wire air leaving grid and 10-gauge wire front support grid for maximum filter pad support. Initial resistance at 100% R.A.F. of 0.07-inch W.G., dust holding capacity of 232 grams/ft² and average arrestance efficiency of 67% based on 500 fpm air velocity.
- B. Manual balancing dampers shall be parallel type with overlapping blade and double seals to minimize leakage. Damper leakage shall be less than 0.4% of maximum flow at 10-inch W.C. differential. Damper blades shall be mounted on steel rods which rotate on

nylon bushings. Damper blades shall be extruded aluminum. All damper hardware shall be corrosion resistant.

2.18 AIR-COOLED AIR CONDITIONING

- A. Unit shall be equipped with air conditioning feature to reject all compressor heat to a Remote (Split) outdoor air-cooled condenser. The outdoor condenser shall be equipped with transformer and 24VAC control including contactor for fan motor.
- B. Unit shall be provided with a dry contact rated for 24VAC/5A to operate the remote outdoor condenser control.
- C. Refrigeration circuit shall include three-way refrigerant valve, receiver with pressure relief valve set at 600 psig sized to hold the outdoor condenser charge, pressure control valve and pressure differential valve, and two shutoff valves to isolate the outdoor condenser.
- D. Unit shall include an oil separator package if system charge is over 100 lb.
- E. Hot gas lines shall be fully insulated with not less than 3/8-inch closed cell insulation. Units without insulated hot gas lines in the air stream shall not be acceptable.

2.19 GAS FURNACE

- A. General: All modules will have a minimum thermal efficiency of 80%. The module shall employ a tubular heat exchanger and a draft inducer assembly to provide for positive venting of flue gases. Burner assemblies shall employ inshot type burners constructed of aluminized steel body and sintered metal flame holder with integral carryover plenum. Each burner will have an input of 50,000 Btuh. The ignition system will include a 6000 V Igniter and flame rod detection. Ceramic hot surface ignition systems are unacceptable. Gas-fired duct furnace(s) provided shall employ a tubular heat exchanger constructed of 16 gauge, minimum, type 304 stainless tubes, 2 1/4" diameter having a minimum wall thickness of .049". Tubes and shall be produced to ASTM A249 construction standards for heat exchanger application. Tubes shall employ integral formed-dimple restrictors to eliminate noise associated with expansion and contraction of internal baffles during heating cycles, and to provide for unobstructed drainage of condensate that occurs in the tubes during cooling operation. Drainage shall be configured so that burners and burner surfaces are not exposed to condensate during cooling system operation.
- B. Off/On Firing: The Duct furnace shall have a single stage control system. On a call for heat, control system shall initiate power to the exhaust fan and will light the main burners following a 30 second prepurge period after the airflow switch proves the fan operable. The burners will cycle to maintain an operating set point.

- C. High/Low Firing with Low-Fire-Start: The Duct furnace shall have a “Quiet Start” 2 stage control system capable of a proven low-fire ignition sequence to minimize noise associated with Cold Start conditions and incorporating a 2 speed draft inducer motor and 2 stage gas valve. On a call for heat, the control system shall initiate a low fire start with the draft inducer operating at low speed and at an input rate of between 25% and 55% maximum input rate, as necessary to provide for the minimum required system temperature rise.
- D. Controls Included: All modules will include an ignition control, roll out switch and air proving switch. Additionally, on full modulation models a fan relay, delay timer and high fire gas valve control relay are included. Modules to accept either 0 to 10vDC or 4 to 20ma input signals (signal provided by others) will be integral to the control system. Additionally, these modules will supply a suitable analog output signal to the modulating gas valve. Two independent and adjustable (when compared to the analog input signal) SPDT relays will be provided for fan and valve control.
- E. Sequence Of Operation: The thermostat closes on a call for heat providing 24 VAC to the ignition control. The 120-volt draft inducer is energized. The air proving switch closes initiating a 30 second pre purge. At the end of the pre purge period, the igniter and gas valve are energized. If the burners ignite within the 5-second trial for ignition period, power is maintained to the gas valve and the igniter is de-energized. The flame presence is continuously monitored by the flame rod. At this point we are in the steady state heating condition. The module will continue to operate until the thermostat is satisfied. The thermostat will then open and interrupt power to the ignition control and shut off the unit. The control is capable of up to three retrials if the above sequence of start up is interrupted at any point. Beyond that a manual resetting of the control is required.

2.20 SMART SAVER HEAT RECOVERY COILS - R-407C THERMO-SIPHON SYSTEM

- A. The air-to-air heat exchanger shall recover and transfer the energy from the exhaust air to the incoming make-up air resulting in 50% energy savings. This heat recovery process is independent of compressor operation and does not have any moving parts. Systems requiring compressor operation shall not be acceptable.
 - 1. Evaporator (Exhaust Air coil)
 - a. Shall not be less than six rows deep for maximum heat transfer with air velocity not to exceed 500 fpm, with 5/8-inch OD seamless copper tubing mechanically expanded with maximum ten aluminum fins per inch.
 - b. Coil shall have a 16-gauge galvanized casing and end plates.
 - c. Coil shall be factory tested at air pressures not less than 400 psig in a water bath.
 - d. Shall have HyPoxy® coated fins. Coating shall comply with ASTM B117/D1654 and ASTM D2126 for corrosion resistance.
 - 2. Condenser (Outdoor Air Coil)
 - a. Shall not be less than four rows deep for maximum heat transfer into the air with 5/8-inch OD seamless copper tubing mechanically expanded with maximum ten aluminum fins per inch.
 - b. Coil shall have a 16-gauge galvanized casing and end plates.

- c. Coil shall be factory tested at air pressures not less than 400 psig in a water bath.
 - d. Shall have HyPoxy®HyPoxy® coated fins. Coating shall comply with ASTM B117/D1654 and ASTM D2126 for corrosion resistance.
3. Refrigeration Circuit
- a. Both coils shall operate with R-407c refrigerant using a thermo-siphon system.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify roof curbs are installed and dimensions are as shown on shop drawings.

3.2 INSTALLATION

- A. Install units on seismic/vibration isolation curbs. Refer to Section 23 05 48.
- B. Connect units to supply and return ductwork with flexible connections. Refer to Section 23 33 00.
- C. Install condensate piping with trap and route from drain pan to nearest roof drain. Refer to Section 23 21 13.
- D. Install components furnished loose for field mounting.
- E. Install electrical devices furnished loose for field mounting.
- F. Install control wiring between unit and field installed accessories.
- G. Remove from roof and dispose off-site panels removed from units during installation of economizer, dampers, etc.

3.3 INSTALLATION - NATURAL GAS HEATING SECTION

- A. Connect natural gas piping in accordance with IFGC.
- B. Connect natural gas piping to unit, full size of unit gas train inlet. Arrange piping with clearances for burner service.
- C. Install the following piping accessories on natural gas piping connections. Refer to Section 23 11 23.
 - 1. Strainer.
 - 2. Pressure gage.
 - 3. Shutoff valve.
 - 4. Pressure reducing valve.

3.4 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Vacuum clean coils and inside of cabinets.
- C. Install temporary filters during construction period. Replace with permanent filters at Substantial Completion. Provide extra set of filters at Substantial Completion.

3.5 DEMONSTRATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate unit operation and maintenance.
- C. Furnish services of manufacturer's technical representative for minimum four hours to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

END OF SECTION

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Indoor air handling unit.
 - 2. Outdoor condensing unit.
- B. Related Sections:
 - 1. Section 23 04 00 – General Conditions for Mechanical Trades.
 - 2. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Vibration isolators.
 - 3. Section 23 09 23 - Direct-Digital Control System for HVAC: Controls remote from unit.
 - 4. Section 23 23 00 - Refrigerant Piping: Execution requirements for connection to refrigerant piping specified by this section.
 - 5. Division 26: Electrical connection to units.
- C. This project will be commissioned. Refer to Section 01 91 00 and Section 23 08 00 for commissioning information and responsibilities. The commissioning process will require additional labor, material, and/or other costs which must be provided by the work of the Division.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. Air-Conditioning and Refrigeration Institute:
 - 1. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
 - 2. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
 - 2. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. ASTM International:
 - 1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
- D. National Electrical Manufacturers Association:
 - 1. NEMA MG 1 - Motors and Generators.
- E. National Fire Protection Association:
 - 1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit data indicating:
 - 1. Cooling and heating capacities.
 - 2. Dimensions.
 - 3. Weights.
 - 4. Rough-in connections and connection requirements.
 - 5. Duct connections.
 - 6. Electrical requirements with electrical characteristics and connection requirements.
 - 7. Controls.
 - 8. Accessories.
- C. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.
- D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

- E. Manufacturer's Field Reports: Submit start-up report for each unit.
- F. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 77 00 - Closeout Procedures: Closeout procedures.
- B. Project Record Documents: Record actual locations of controls installed remotely from units.
- C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.7 QUALITY ASSURANCE

- A. Performance Requirements: Energy Efficiency Rating (EER) not less than prescribed by ASHRAE 90.1 when used in combination with compressors and evaporator coils when tested in accordance with ARI 210/240.
- B. Cooling Capacity: Rate in accordance with ARI 210/240.
- C. Sound Rating: Measure in accordance with ARI 270.
- D. Insulation and adhesives: Meet requirements of NFPA 90A.

- E. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.9 PRE-INSTALLATION MEETINGS

- A. Section 01 31 00 – Project Management and Coordination: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.
- C. Comply with manufacturer's installation instruction for rigging, unloading and transporting units.
- D. Protect units from weather and construction traffic by storing in dry, roofed location.

1.11 COORDINATION

- A. Section 01 31 00 - Project Management and Coordination: Requirements for coordination.
- B. Coordinate installation of condensing units with roof structure.
- C. Coordinate installation of air handling units with building structure.

1.12 WARRANTY

- A. Section 01 77 00 - Closeout Procedures: Requirements for warranties.
- B. Manufacturer's standard, no less than one year from date of Owner's acceptance.

1.13 MAINTENANCE MATERIALS

- A. Section 01 77 00 - Closeout Procedures: Requirements for maintenance materials.
- B. Furnish one set of extra filters.

PART 2 PRODUCTS

2.1 SPLIT SYSTEM AIR CONDITIONING UNITS

- A. Manufacturers:
 - 1. Daiken.
 - 2. The Trane Company.
 - 3. Mitsubishi.
- B. Product Description: Split system consisting of an indoor air handling unit and outdoor condensing unit including cabinet, evaporator fan, refrigerant cooling coil, compressor, refrigeration circuit, condenser, air filters, controls, air handling unit accessories, condensing unit accessories, and refrigeration specialties.

2.2 AIR HANDLING UNIT

- A. Configuration: As indicated on Drawings.
- B. Cabinet:
 - 1. Panels: Constructed of galvanized steel with baked enamel finish. Access Panels: Located on both sides of unit. Furnish with duct collars on inlets and outlets.
 - 2. Insulation: Factory applied to each surface to insulate entire cabinet with one inch thick aluminum foil faced glass fiber with edges protected from erosion.
- C. Evaporator Fan: Forward curved centrifugal type, resiliently mounted with adjustable belt drive and high efficiency motor complying with NEMA MG1, Type 1. Motor permanently lubricated with built-in thermal overload protection.
- D. Evaporator Coil: Constructed of copper tubes expanded onto aluminum fins. Factory leak tested under water. Removable, PVC construction, double-sloped drain pan with piping connections on both sides. Condensate evaporation trays are not permitted.
- E. Refrigeration System: Single refrigeration circuits controlled by factory installed thermal expansion valve.
- F. Air Filters: 2 inch 25 to 30 percent efficiency based on ASHRAE 52.1.

- G. Air Handling Unit Accessories:
 - 1. Vibration Isolators: As specified in Section 23 05 48.

2.3 CONDENSING UNIT

- A. General: Factory assembled and tested air cooled condensing units, consisting of casing, compressors, condensers, coils, condenser fans and motors, and unit controls.
- B. Unit Casings: Exposed casing surfaces constructed of galvanized steel with manufacturer's standard baked enamel finish. Designed for outdoor installation and complete with weather protection for components and controls, and complete with removable panels for required access to compressors, controls, condenser fans, motors, and drives.
- C. Custom External Finish / Painting: All external surfaces of the casing, support framing and accessories shall be prepared and painted. Paint shall be able to withstand a salt spray test in accordance with ASTM B117 for a minimum of 700 consecutive hours. Paint shall be custom off-white color as selected by architect.
- D. Compressor: Single refrigeration circuit with rotary or semi-hermetic reciprocating type compressors, resiliently mounted, with positive lubrication, and internal motor overload protection.
- E. Condenser Coil: Constructed of copper tubing mechanically bonded to copper fins, factory leak and pressure tested.
- F. Controls: Furnish operating and safety controls including high and low pressure cutouts. Control transformer. Furnish magnetic contactors for compressor and condenser fan motors.
- G. Condenser Fans and Drives: Direct drive propeller fans statically and dynamically balanced. Wired to operate with compressor. Permanently lubricated ball bearing type motors with built-in thermal overload protection. Furnish high efficiency fan motors.
- H. Condensing Unit Accessories: Furnish the following accessories:
 - 1. Controls to provide low ambient cooling to 0 degrees F.
 - 2. Time delay relay.
 - 3. Anti-short cycle timer.
 - 4. Disconnect switch.
 - 5. Coil with corrosion resistant coating capable of withstanding salt spray test of 1000 hours in accordance with ASTM B117.
 - 6. Condenser Coil Guard: Condenser fan openings furnished with PVC coated steel wire safety guards.
 - 7. Suction and discharge pressure gauges.
- I. Refrigeration specialties: Furnish the following:
 - 1. Charge of compressor oil.
 - 2. Holding charge of refrigerant.
 - 3. Replaceable core type filter drier.

4. Liquid line sight glass and moisture indicator.
5. Shut-off valves on suction and liquid piping.
6. Liquid line solenoid valve.
7. Charging valve.
8. Oil level sight glass.
9. Crankcase heater.
10. Pressure relief device.

J. Refrigerant: Furnish charge of refrigerant R-410A.

2.4 CONTROLS

A. Furnish interface to Direct Digital Control System specified in Section 23 09 23.

2.5 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Refer to schedules on Construction Drawings.
- B. Disconnect Switch: Factory mounted, non-fused type, interlocked with access door, accessible from outside unit, with power lockout capability.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 31 00 - Project Management and Coordination: Verification of existing conditions before starting work.
- B. Verify support for condensing unit is ready for unit installation.

3.2 INSTALLATION - AIR HANDLING UNIT

- A. Install condensate piping with trap and route from drain pan to condensate drainage system. Refer to Section 23 21 13.
- B. Install components furnished loose for field mounting.
- C. Install connection to electrical power wiring in accordance with Division 26.

3.3 INSTALLATION - CONDENSING UNIT

- A. Install condensing units on vibration isolators. Refer to Section 23 05 48.
- B. Install refrigerant piping from unit to condensing unit. Install refrigerant specialties furnished with unit. Refer to Section 23 23 00.
- C. Evacuate refrigerant piping and install initial charge of refrigerant.
- D. Install electrical devices furnished loose for field mounting.

- E. Install control wiring between air handling unit, condensing unit, and field installed accessories.
- F. Install connection to electrical power wiring in accordance with Division 26.

3.4 MANUFACTURER'S FIELD SERVICES

- A. Section 23 04 00 – Heating, Ventilating and Air Conditioning: Requirements for manufacturer's field services.
- B. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.

3.5 CLEANING

- A. Section 01 77 00 - Closeout Procedures: Requirements for cleaning.
- B. Vacuum clean coils and inside of unit cabinet.
- C. Install new throwaway filters in units at Substantial Completion.

3.6 DEMONSTRATION

- A. Section 23 04 00 – Heating, Ventilating and Air Conditioning: Requirements for demonstration and training.
- B. Demonstrate air handling unit operation and maintenance.
- C. Demonstrate starting, maintenance, and operation of condensing unit including low ambient temperature operation.
- D. Furnish services of manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

3.7 PROTECTION OF FINISHED WORK

- A. Section 01 77 00 - Closeout Procedures: Requirements for protecting finished Work.
- B. Do not operate air handling units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION

SECTION 238200 - HYDRONIC HEATING UNITS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Duct mounted hot water coils.
 2. Finned tube radiation.
 3. Cabinet unit heaters.
 4. Unit heaters.
- B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
 2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
 3. Section 23 07 00 - HVAC Insulation: Execution requirements for insulation specified by this section.
 4. Section 23 21 13 - Hydronic Piping: Execution requirements for connection of chilled water, hot water, and drain piping to units specified by this section.
 5. Section 23 21 16 - Hydronic Piping Specialties: Product requirements for hydronic piping specialties for placement by this section.
 6. Section 23 31 00 - HVAC Ducts and Casings: Execution requirements for ducts specified by this section.
 7. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connection to units specified by this section.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. Air-Conditioning and Refrigeration Institute:
 - 1. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
- B. Sheet Metal and Air Conditioning Contractors:
 - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations. Indicate schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers.
- C. Product Data: Submit coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions. Submit mechanical and electrical service locations, capacities and accessories or optional items.
- D. Manufacturer's Installation Instructions: Submit assembly, support details, and connection requirements.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- F. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.

4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access to valves.
- C. Operation and Maintenance Data: Submit manufacturers descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

1.7 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

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

1.9 PRE-INSTALLATION MEETINGS

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

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Accept units on site in factory packing. Inspect for damage. Store under roof.
- C. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.12 WARRANTY

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

PART 2 PRODUCTS

2.1 DUCT MOUNTED HOT WATER COILS

- A. Manufacturers:
 - 1. US Coil and Air
 - 2. Trane
 - 3. Daikin
- B. Casing:
 - 1. Die formed channel frame of 18 gage galvanized steel with 3/8 inch mounting holes on 3 inch centers.
 - 2. Furnish intermediate center tube supports for plate fin coils longer than 36 inches. Furnish intermediate tube supports for spiral fin coils at manufacturer's recommended intervals to eliminate sagging during operation.
- C. Water Coils:
 - 1. Headers: Cast iron with tubes expanded into header, seamless copper tube with silver brazed joints, or prime coated steel pipe with brazed joints.
 - 2. Tubes: 5/8 inch OD seamless copper or brass arranged in parallel or staggered pattern, expanded into fins, silver brazed joints.
 - 3. Fins: Aluminum continuous plate type with full fin collars or individual helical
Leak Testing: Air test under water to 200 psig for working pressure of 200 psig and 200 degrees F.
 - 4. Configuration: Self draining circuitry, with threaded plugs in headers for drain and vent; serpentine type with return bends on smaller sizes and return headers on larger sizes. Furnish threaded plugs in return bends or in headers opposite top and bottom of each tube.

2.2 FIN TUBE RADIATION

- A. Manufacturers:
 - 1. Airedale
 - 2. Vulcan
 - 3. Slant Fin
 - 4. Sterling
- B. Heating Elements: Seamless copper tubing, mechanically expanded into evenly spaced aluminum fins, suitable for soldered fittings.
- C. Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.
- D. Enclosures: 0.0478 inch thick steel up to 18 inches in height, 0.598 inch steel over 18 inches in height, with easily jointed components for wall to wall installation. Support rigidly, on wall or floor mounted brackets at least 3 feet on center maximum.
- E. Finish: Factory applied baked enamel of color as selected.
- F. Damper: Where heating media is not thermostatically controlled, furnish knob-operated internal damper at enclosure air outlet.
- G. Access Doors: For otherwise inaccessible valves, furnish factory-made permanently hinged access doors, 6 x 7 inch minimum size, integral with cabinet.

2.3 CABINET UNIT HEATERS

- A. Manufacturers:
 - 1. Airedale
 - 2. Vulcan
 - 3. Sterling
- B. Coils: Seamless copper tubing with evenly spaced aluminum fins mechanically bonded to tubing. Coils shall be leak tested to minimum 200 psig, air under water.
- C. Front panel: 16 gage steel with sound dampening insulation and tamper resistant locks.
- D. Finish: Factory applied baked enamel finish.
- E. Fans: Direct-drive, centrifugal, statically and dynamically balanced.
- F. Access area: Open area at each end of cabinet for electrical wiring and piping accessories. Provide with access door.
- G. Accessories: Provide permanent aluminum filter. For wall mounted unit, provide wall gasketing seal for recessed units. For floor mounted units, provide leveling legs for non recessed units.

2.4 UNIT HEATERS

- A. Manufacturers:
 - 1. Airedale
 - 2. Vulcan
 - 3. Sterling
- B. Coils: Seamless copper tubing, 0.025 inch minimum wall thickness, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.
- C. Casing: 0.0478-inch thick steel with threaded pipe connections for hanger rods.
- D. Finish: Factory applied baked enamel of color as selected.
- E. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.
- F. Air Outlet: Adjustable pattern diffuser on projection models and two four-way louvers on horizontal throw models.
- G. Motor: Permanently lubricated sleeve bearings on horizontal models, grease lubricated ball bearings on vertical models. Refer to Section 23 05 13.
- H. Control: Local multi-speed disconnect switch.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. For recessed units, verify recess dimensions are correct size.
- C. Verify wall construction is ready for installation.
- D. Verify ductwork is ready for installation.
- E. Verify concealed blocking and supports are in place and connections are correctly located.

3.2 INSTALLATION

- A. Install air coils in ducts and casings in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible. Refer to Section 23 31 00.
- B. Duct Mounted Coils: Support air coil sections independent of piping on steel channel or double angle frames and secure to casings. Furnish frames for maximum three coil

sections. Arrange supports to avoid piercing drain pans. Install with airtight seal between coil and duct or casing.

- C. Supports for Hung Equipment including duct mounted coils, unit heaters, cabinet unit heaters and radiant ceiling panels: Provide vibration isolation and seismic supports per Specification Section 23 0548. Support equipment independent of piping.
- D. Protect coils to prevent damage to fins and flanges. Comb out bent fins.
- E. Install coils level. Install cleanable tube fluid coils and level frame steam coils with 1: 50 pitch.
- F. Make connections to coils with unions and flanges.
- G. On water coils, install shut-off valve on supply piping and lockshield balancing valve on return piping. Locate water supply at bottom of supply header and return water connection at top. Install manual float operated automatic air vents at high points complete with stop valve. Install water coils to be drainable and install drain connection at low points. Refer to Section 23 21 13.
- H. On water and glycol heating coils, and chilled water cooling coils, connect water supply piping to leaving airside of coil (counter flow arrangement). Refer to Section 23 21 13.
- I. Install insulation air coil casings. Refer to Section 23 07 00.
- J. Insulate headers located outside airflow, insulate as specified for piping. Refer to Section 23 07 00.
- K. Install equipment exposed to finished areas after walls and ceilings are finished and painted. Avoid damage.
- L. Protection: Install finished cabinet units with protective covers during remainder of construction.
- M. Finned Tube Radiation: Locate on outside walls and run cover wall-to-wall unless otherwise indicated. Center elements under windows. Where multiple windows occur over units, divide element into equal segments centered under each window. Align cabinet joints with window mullions. Install wall angles where units butt against walls.
- N. Unit Heaters: Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.
- O. Hydronic Units: Install with shut-off valve on supply piping and lockshield balancing valve on return piping. Where not accessible, extend vent to exterior surface of cabinet for servicing. For cabinet unit heaters, fan coil units, and unit heaters, install float operated automatic air vents with stop valve. Refer to Section 23 21 13.

3.3 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- C. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.
- D. Install new filters.

END OF SECTION

SECTION 260400 - GENERAL CONDITIONS FOR ELECTRICAL TRADES

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. This section applies to certain sections of Division 8 "Openings", Division 11 "Equipment", Division 12 "Furnishings", Division 21 "Fire Protection", Division 22 "Plumbing", Division 23, "Mechanical,", Division 27 "Communications", Division 28 "Electronic Safety and Security", Division 33 "Utilities" and this section applies to all sections of Division 26, "Electrical" of this project specification unless specified otherwise in the individual sections.
- C. The Drawings of other trades (Architectural, Structural, Civil, Plumbing, Mechanical, Food Service, Fire Protection, Communications, and Electronic Safety and Security) shall be examined for coordination and familiarity of work with other Contractors. Any duplication or omission of provisions in this project should be brought to the attention of the Owners prior to Bidding.
- D. The Drawings of equipment suppliers shall be examined for coordination and familiarity of work with Owner's equipment suppliers.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 DESCRIPTION

- A. The General Conditions and Supplementary General Conditions are a part of this Division and are to be considered a part of this Contract.
- B. Where items of the General Conditions and Supplementary General Conditions are repeated in other Sections of the Specifications, it is merely intended to qualify or to call particular attention to them. It is not intended that any other parts of the General Conditions and Supplementary General Conditions shall be assumed to be omitted if not repeated therein. This Section applies equally and specifically to all Contractors supplying labor and/or equipment and/or materials as required under each Section of this Division. Where conflicts exist between the drawings and the specifications or between this section of the specifications and other sections, the more stringent or higher cost option shall apply.
- C. It is the intent of this Section of the Specifications to establish a standard of quality and performance characteristics for basic materials and installation methods used in building electrical, communications and electronic safety and security systems.

1.5 INTENT

- A. This contract is for all labor, materials and equipment required for installation. The system shall be complete and finished in all respects, tested and ready for operation. Work shall include calibration of equipment with factory settings. All materials, equipment and apparatus shall be new and of first class quality.
- B. Any apparatus, appliance, material or work not shown on drawings but mentioned in the specifications, or vice versa, or any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation as determined by good trade practice even if not particularly specified, shall be furnished, delivered and installed under their respective Divisions without any additional expense to the Owner.
- C. Minor details not usually shown or specified but necessary for proper installation and operation shall be included in the work as though they were hereinafter shown or specified.
- D. Work under each Section shall include giving written notice to the Owner and Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, it is mutually agreed that work under each Section has included the cost of all required items for the accepted, satisfactory functioning of the entire system without extra compensation.

- E. Wherever a particular piece of equipment, device or material is specifically indicated on the Drawings by model number, type, series or other means, that specification shall take precedence over equipment or materials specified herein. For example: If a particular switch is specified on the Drawings, its specification takes precedence over switch specified herein.

1.6 DEFINITIONS

- A. Word "Subcontractor" means specifically the subcontractor working under this Division. Other Contractors are specifically designated "Mechanical Subcontractor", "General Contractor" and so on. Note: Take care to ascertain limits of responsibility for connecting equipment which requires connections by two or more trades.
- B. Word "install" shall mean set in place complete with all mounting facilities and connections as necessary ready for normal use or service.
- C. Words "furnish" or "supply" shall mean purchase, deliver to, and off-load at the job site, all ready to be installed including where appropriate all necessary interim storage and protection.
- D. Word "provide" shall mean furnish (or supply) and install as necessary.
- E. Word "finished" refers to all rooms and areas scheduled to be painted in Room Finish Schedule on the drawings. All rooms and areas not covered in Schedule, including underground tunnels and areas above ceilings shall be considered not finished, unless otherwise noted.
- F. Words "approved equal" mean any product which in the opinion of the Engineer is equal in quality, arrangement, appearance, and performance to the product specified.
- G. Word "wiring" shall mean cable assembly, raceway, conductors, fittings and any other necessary accessories to make a complete wiring system. Word "product" shall mean any item of equipment, material, fixture, apparatus, appliance or accessory installed under this Division.
- H. Substitutions: Requests for changes in products, materials, equipment, and methods of construction required by Contract Documents proposed by the Contractor after award of the Contract are considered requests for "substitutions."
- I. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, other paragraphs or schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.
- J. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Engineer," "requested by the Engineer," and similar phrases.

- K. Approve: The term "approved," where used in conjunction with the Engineer's action on the Contractor's submittals, applications, and requests, is limited to the Engineer's duties and responsibilities as stated in General and Supplementary Conditions.
- L. Regulation: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.
- M. Remove: The term "remove" means "to disconnect from its present position, remove from the premises and to dispose of in a legal manner."
- N. Standard Product Warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.
- O. Special Warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

1.7 DRAWINGS

- A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. Consult the Architectural Drawings and Details for exact location of fixtures and equipment; where same are not definitely located, obtain this information from the Architect. (Do not scale the drawings)
- B. Work under each Section shall closely follow Drawings in layout of work; check Drawings of other Divisions to verify spaces in which work will be installed. Maintain maximum headroom; where space conditions appear inadequate, Owner and Engineer shall be notified before proceeding with installations.
- C. The Owner may, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades and/or for proper execution of the work.
- D. Where variances occur between the Drawings and Specifications or within either of the Documents, the item or arrangement of better quality shall be included in the Contract price. The Owner and Engineer shall decide on the item and the manner in which the work shall be installed.

1.8 SURVEYS AND MEASUREMENTS

- A. Before submitting his Bid, the Contractors shall visit the site and become thoroughly familiar with all existing conditions under which his work will be installed. All new equipment and systems shall be fully operational under this Contract before the job is considered complete. The Contractors shall be held responsible for any assumptions he makes, any omissions or errors he makes as a result of his failure to become fully familiar with the existing conditions at the site and the Contract Documents.

- B. The Contractor shall base all measurements, both horizontal and vertical, from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.
- C. Should the Contractor discover any discrepancies between actual measurements and those indicated which prevent following good practice or which interfere with the intent of the Drawings and Specifications, the Engineer will be notified and work will not proceed until instructions from the Engineer are received.

1.9 CODES AND STANDARDS

- A. Reference Standard Compliance
 - 1. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), and Underwriters Laboratories Inc. (UL), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.
 - 2. Independent Testing Organization Certificate: In lieu of the label or listing, indicated above submit a certificate from an independent testing organization, competent to perform testing, and approved by the engineer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.
- B. The Following Codes and Standards listed below apply to all electrical work. Wherever Codes and/or Standards are mentioned in these Specifications, the latest adopted edition or revision shall be followed:
State of Connecticut Department of Administrative Services (DAS) and Office School Construction Grants.
2016 Connecticut State Building Code
2016 Connecticut State Fire Safety Code
2012 International Building Code
2012 International Mechanical Code
2012 International Plumbing Code
2014 National Electrical Code
2012 International Energy Conservation Code
- C. The following Standards shall be used where referenced by the following abbreviations:
AIA American Institute of Architects
ANSI American National Standards Institute
ASME American Society of Mechanical Engineers
ASTM American Society of Testing and Materials
EPA Environmental Protection Agency
FM Factory Mutual
FSSC Federal Specification
IEEE Institute of Electrical and Electronics Engineers

NBS	National Bureau of Standards
NEMA	National Electrical Manufacturers Association
NETA	International Electrical Testing Association
NFPA	National Fire Protection Association
NSC	National Safety Council
OSHA	Occupational Safety and Health Administration
UL	Underwriters' Laboratories

- D. All materials furnished and all work installed shall comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction and the requirements of all Governmental departments having jurisdiction.
- E. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and Drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether shown on Drawings and/or specified or not.

1.10 PERMITS AND FEES

- A. The Contractor shall give all necessary notices, obtain all permits; and pay all Government and State sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the work, file all necessary Drawings, prepare all documents and obtain all necessary approvals of all Governmental and State departments having jurisdiction, obtain all required certificates of inspection for his work, and deliver a copy to the Owner and Engineer before request for acceptance and final payment for the work.

1.11 EQUIPMENT SUBSTITUTIONS

- A. In these Contract Documents, one or more makes of materials, apparatus or appliances may have been specified for use in this installation. These describe the basis of design and approved equivalents. This has been done for convenience in fixing the standard of workmanship, finish and design required for installation without consideration of any or all costs associated but not limited to (structural, mechanical, or electrical feeder, breaker, or transformer requirements). The Contractor acknowledges that not all requirements are shown for either alternate acceptable manufacturers listed or those alternates requiring a request for substitution and it is their responsibility to coordinate all requirements necessary to accommodate any change from the basis of design listed or scheduled. The Contractor is required to submit any and all costs (including costs associated or required by all trades) along with performance differences as part of their request for substitution. The details of workmanship, finish and design, and the guaranteed performance of any material, apparatus or appliance which the Contractor desires to deviate for those mentioned herein shall also conform to these standards.
- B. Where no specific make of material, apparatus or appliance is mentioned, any first-class product made by a reputable manufacturer may be submitted for the Engineers review.
- C. Where two or more names are given as approved manufacturers of equivalents, the Contractor must use the specified item or one of the named equivalents which still must

meet all of the performance characteristics of the basis of design make and model. Where one name only is used and is followed by the words “or approved equal”, the Contractor must use the item named or he is required to apply for a substitution. Where one name only is used, the Contractor must use that item named.

- D. Where the Contractor proposes to deviate (provide an equivalent or request for substitution) from the equipment or materials as hereinafter specified, they are required to submit a request for substitution in writing. The Contractor shall state in their request whether it is a substitution or a non approved equivalent to that specified and the amount of credit or extra cost involved. A copy of said request shall be included in the Base Bid with manufacturer’s equipment cuts. The Base Bid shall be based on using the materials and equipment as specified with no exceptions.
- E. Where the Contractor proposes to use an item of equipment other than specified or detailed on the Drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout, all such redesign and all new drawings and detailing required therefore shall be prepared by the Engineers/Architects of Record at the expense of the Contractor and at no additional cost to the Owner.
- F. Where such accepted deviation resulting from using an approved equivalent or substitution requires a different quantity and arrangement of piping, ductwork, valves, pumps, insulation, wiring, conduit and equipment from that specified or indicated on the Drawings, the Contractor shall, after acceptance by the Engineer, furnish and install any such additional equipment required by the system at no additional cost to the Owner, including any costs added to other trades due to the deviation.
- G. Equipment, material or devices submitted for review as an “equivalent” shall meet the following requirements:
1. The equivalent shall have the same construction features such as, but not limited to:
 - a. Material thickness, gauge, weight, density, etc.
 - b. Welded, riveted, bolted, etc., construction.
 - c. Finish, undercoating, corrosion protection.
 - d. In the case of lighting fixtures, equivalent shall also meet the form, shape, and function in the opinion of the Architect and Engineer.
 2. The equivalent shall perform with the same or better operating efficiency.
 3. The equivalent shall be locally represented by the manufacturer for service, parts and technical information.
 4. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as UL or NEMA labels.
- H. Equipment, material or devices submitted for review as a “substitution” shall meet the following requirements:
1. Substitution Request Submittal: Requests for substitution will be considered if received in writing 14 days before the bid date. Requests received later than 14 days before the bid date may be considered or rejected at the discretion of the Engineer/Owner. Once the Contractor submits a complete request for substitution as determined by the Engineer, the Engineer reserves the right to

request the time necessary to evaluate the request for substitution and review it with the Owner.

2. Submit three (3) copies of each request for substitution for consideration.
3. Identify the product, or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
 - a. Product Data, including Drawings and descriptions of products, fabrication and installation procedures.
 - b. Samples, where applicable or requested.
 - c. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect.
 - d. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate Contractors that will become necessary to accommodate the proposed substitution.
 - e. A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
 - f. Cost information, including a proposal of the net change, if any in the Contract Sum.
 - g. Certification by the Contractor that the substitution proposed is equal-to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.
 - h. Engineer's Action: Within one week of receipt of the request for substitution, the Engineer will notify the Contractor of acceptance or rejection of the proposed substitution. If a decision on use of a proposed substitute cannot be made or obtained within the time allocated, use the product specified by name. Acceptance of a product substitution will be in the form of an Addendum.
 - i. Other Conditions: The Contractor's substitution request will be received and considered by the Engineer when one or more of the following conditions are satisfied, as determined by the Engineer; otherwise requests will be returned without action except to record noncompliance with these requirements.
 - 1) The request is directly related to an "or equal" clause or similar language in the Contract Documents.
 - 2) The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.

- 3) A substantial advantage is offered the Owner, in terms of cost, time, energy conservation or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear. Additional responsibilities for the Owner may include additional compensation to the Engineer for redesign and evaluation services, increased cost of other construction by the Owner or separate Contractors, and similar considerations.

1.12 SUBMITTAL PROCEDURES

- A. Provide Submittals in accordance with the requirements of Division 1 and as indicated in the following.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.
 2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for resubmittals.
 1. Allow two weeks for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The Engineer will promptly advise the Contractor when a submittal being processed must be delayed for coordination.
 2. If an intermediate submittal is necessary, process the same as the initial submittal.
 3. Allow two weeks for reprocessing each submittal.
 4. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing.
- D. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.
 1. Include the following information on the label for processing and recording action taken.
 - a. Project name.
 - b. Date.
 - c. Name and address of Engineer.
 - d. Name and address of Contractor.
 - e. Name and address of subcontractor.
 - f. Name and address of supplier.
 - g. Name of manufacturer.

- h. Number and title of appropriate Specification Section.
 - i. Drawing number and detail references, as appropriate.
- E. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to Engineer using a transmittal form. Submittals received from sources other than the Contractor will be returned without action. On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.
- F. Except for submittals for record, information or similar purposes, where action and return is required or requested, the Engineer will review each submittal, mark to indicate action taken, and return promptly. Compliance with specified characteristics is the Contractor's responsibility.
- G. Action Stamp: The Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, to indicate the action taken.

1.13 SHOP DRAWINGS

- A. Submit newly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.
- B. The Contractor shall submit for review detailed shop drawings of all equipment and material specified in each section and coordinated ductwork layouts. No material or equipment may be delivered to the job site or installed until the Contractor has received shop drawings for the particular material or equipment which have been properly reviewed. Shop drawings shall be submitted within 60 days after award of Contract before any material or equipment is purchased. The Contractor shall submit for review copies of all shop drawings to be incorporated in the Electrical Contract. Refer to the General Conditions and Supplementary General Conditions for the quantity of copies required for submission. Where quantities are not specified, provide seven (7) copies for review.
- C. Provide shop drawings for all devices specified under equipment specifications for all systems including fire alarm, switchgear, clock, lighting, etc., or where called for elsewhere in the Specifications. Shop drawings shall include manufacturers' names, catalog numbers, cuts, diagrams, dimensions, identification of products and materials included, compliance with specified standards, notation of coordination requirements, notation of dimensions established by field measurement and other such descriptive data as may be required to identify and accept the equipment. A complete list in each category (example: all fixtures) of all shop drawings, catalog cuts, material lists, etc., shall be submitted to the Engineer at one time. No consideration will be given to a partial shop drawing submittal.

- D. Submittals shall be marked with the trade involved, i.e., Electrical, HVAC, Fire Protection, etc. when the submittal could involve more than one trade.
- E. Where multiple quantities or types of equipment are being submitted, provide a cover sheet (with a list of contents) on the submittal identifying the equipment or material being submitted.
- F. Failure to submit shop drawings in ample time for review shall not entitle the Contractor to an extension of Contract time. No claim for extension by reason of such default will be allowed, nor shall the Contractor be entitled to purchase, furnish and/or install equipment which has not been reviewed by the Engineer.
- G. The Contractor shall furnish all necessary templates, patterns, etc., for installation work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.
- H. Acceptance rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, review does not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the Contract Drawings and Specifications. Verify available space prior to submitting shop drawings.
- I. Acceptance of shop drawings shall not apply to quantity nor relieve Contractor of his responsibility to comply with intent of Drawings and Specifications.
- J. Acceptance of shop drawings is final and no further changes will be allowed without the written consent of the Engineer.
- K. Shop drawing submittal sheets which may show items that are not being furnished shall have those items crossed off to clearly indicate which items will be furnished.
- L. Bidders shall not rely on any verbal clarification of the Drawings and/or Specifications. Any questions shall be referred to the Engineer in writing at least five (5) working days prior to Bidding to allow for issuance of an Addendum.
- M. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.
- N. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).

- c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.14 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.15 COORDINATION DRAWINGS

- A. Prepare coordination drawings in accordance with Division 1 Section "PROJECT COORDINATION," to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
 1. Indicate the proposed locations of light fixtures, switchboards, panelboards, lighting inverters, conduits, cabinets, etc. Include the following:
 2. Clearances for installing and maintaining insulation.
 3. Clearances for servicing and maintaining equipment, including NEC requirements and space for equipment disassembly required for periodic maintenance.
 4. Equipment connections and support details.
 5. Exterior wall and foundation penetrations.
 6. Fire-rated wall and floor penetrations.
 7. Sizes and locations of required concrete pads and bases.

- B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
- C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
- D. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.
- E. Prepare a low voltage riser diagram indicating routing of all low voltage conduit to be installed for the Div. 27 AV systems. Refer to specifications and AV series contract documents for additional information.

1.16 COORDINATION WITH OTHER DIVISIONS

- A. All work shall be carried out in conjunction with other trades and full cooperation shall be given in order that all work may proceed with a minimum of delay and interference. Particular emphasis is placed on timely installation of major apparatus and furnishing other Contractors, especially the Contractor or Construction Manager, with information as to openings, chases, sleeves, bases, inserts, equipment locations, panels, etc., required by other trades.
- B. The Contractors are required to examine all of the Project Drawings and mutually arrange work so as to avoid interference with the work of other trades. In general, ductwork, heating, condenser, chilled water piping, sprinkler piping and drainage lines take precedence over water, gas and electrical conduits. The Engineer shall make final decisions regarding the arrangement of work which cannot be agreed upon by the Contractors.
- C. Where the work of the Contractor will be installed in close proximity to or will interfere with work of other trades, the Contractors will cooperate in working out space conditions to make a satisfactory adjustment.
- D. If the work under a Section is installed before coordinating with other Divisions or Sections or so as to cause interference with work of other Sections, the necessary changes to correct the condition shall be made by the Contractor causing the interference without extra charge to the Owner.
- E. If so directed in other Sections, the Contractor indicated shall prepare composite working drawings and sections clearly showing how the work is to be installed in relation to the work of other trades, at no extra charge to the Owner.
- F. Div. 27 Communications and AV Systems: This contractor is required to provide all required power, infrastructure (conduit, raceways, backboxes, drag lines, ...etc.) and installation of specialty backboxes provided by the listed Div. 27 sections to support the installation of the systems. Carefully review the requirements of these sections and coordinate all work with the associated Div. 27 Sections as listed herein.

- G. Div. 28 Fire Detection and Alarm; Access Control; Intrusion Detection; Video Surveillance and associated Division 28 Sections will be provided under separate bid packages. This contractor is required to provide all required power, infrastructure (conduit, raceways, backboxes, drag lines, telecommunications station outlets...etc.) and installation of specialty backboxes provided by the listed Div. 28 sections to support the installation of the systems. Coordinate all work with the associated Div. 28 Sections as listed herein.

1.17 WORKMANSHIP

- A. Service Support: The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.
- B. Modification of References: In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.
- C. The Contractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work together with all skilled workmen, journeymen, electricians, helpers and laborers required to unload, transfer, erect, connect, adjust, start, operate and test each system.
- D. Unless otherwise specifically indicated on the Drawings or Specifications, all equipment and materials shall be installed with the acceptance of the Engineer and in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.
- E. All labor for installation of electrical systems shall be performed by experienced, skilled tradesmen under the supervision of a licensed journeyman foreman. All work shall be of a quality consistent with good trade practice and shall be installed in a neat, workmanlike manner. The Engineer reserves the right to reject any work which, in his opinion, has been installed in a substandard, dangerous or unserviceable manner. The Contractor shall replace said work in a satisfactory manner at no extra cost to the Owner.

1.18 SHUTDOWNS

- A. When installation of a new system requires the temporary shutdown of an operating system, the connection of the new system shall be performed at such time as designated by the Owner.
- B. The Engineer and the Owner shall be notified in writing of the estimated duration of the shutdown period at least ten (10) days in advance of the date the work is to be performed.
- C. Work shall be arranged for continuous performance whenever possible. The Contractor shall provide all necessary labor, including overtime if required, to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.19 TEMPORARY UTILITIES

- A. General: Provide new materials and equipment; if acceptable to the Engineer, undamaged previously used materials in serviceable condition may be used. Provide materials suitable for the use intended.
- B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload facilities, or permit them to interfere with progress. Do not allow hazardous dangerous or unsanitary conditions, or public nuisances to develop or persist on the site.
- C. First Aid Supplies: Comply with governing regulations.
- D. Fire Extinguishers: Provide hand-carried, portable UL-rated, class "A" fire extinguishers for temporary offices and similar spaces. In other locations provide hand-carried, portable, UL-rated, class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposures.
- E. Provide temporary lighting in all areas, throughout construction activities.
 - 1. Use Charges: Cost or use charges for temporary facilities are not chargeable to the Owner or Engineer, and will not be accepted as a basis of claims for a Change Order.
 - 2. Temporary Electric Power Service: Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics during construction period. Include meters, transformers, overload protected disconnects, automatic ground-fault interrupters, and main distribution switch gear.
 - a. Except where overhead service must be used, install electric power service underground.
 - b. Power Distribution System: Install wiring overhead, and rise vertically where least exposed to damage. Where permitted, wiring circuits not exceeding 125 Volts, AC 20 ampere rating, and lighting circuits may be nonmetallic sheathed cable where overhead and exposed for surveillance.
 - 3. Temporary Telephones: Provide temporary telephone service for all personnel engaged in construction activities, throughout the construction period.
- F. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons or firms near the site.
- G. Termination and Removal: Unless the Engineer requires that it be maintained longer, remove each temporary facility when the need has ended, or when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces and replace construction that cannot be satisfactorily repaired. Materials and facilities

that constitute temporary facilities are property of the Contractor. The Owner reserves the right to take possession of Project identification signs.

1.20 PROJECT PHASING

- A. Work under each Section shall include all necessary temporary connections, equipment, conduit, wiring, fire alarm equipment and testing, security equipment and testing, communications equipment and testing, lighting and emergency lighting, fire stopping, connection of necessary mechanical equipment, labor, and material as necessary to accommodate the phasing of Construction as developed by the General Contractor or Construction Manager and approved by the Owner. All systems that pass-thru an area of the building under construction shall remain operational during all phases of construction. No extra compensation shall be granted the Contractor for work required to maintain systems operational or to accommodate the construction phasing of the project.

1.21 PROTECTION OF MATERIALS AND EQUIPMENT

- A. Work under each Section shall include protecting the work and material of all other Sections from damage by work or workmen and shall include making good all damage thus caused.
- B. The Contractor shall be responsible for work and equipment until the facility has been accepted by the Owner. Protect work against theft, injury or damage and carefully store material and equipment received on site which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of foreign material.
- C. Work under each Section includes receiving, unloading, uncrating, storing, protecting, setting in place and completely connecting equipment supplied under each Section. Work under each Section shall also include exercising special care in handling and protecting equipment and fixtures, and shall include the cost of replacing any of the equipment and fixtures which are missing or damaged.
- D. Equipment and material stored on the job site shall be protected from the weather, vehicles, dirt and/or damage by workmen or machinery. Insure that all electrical or absorbent equipment or material is protected from moisture during storage.

1.22 ADJUSTING AND TESTING

- A. After all the equipment and accessories to be furnished are in place, they shall be put in final adjustment and subjected to such operating tests so as to assure the Engineer that they are in proper adjustment and in satisfactory, permanent operating condition.
- B. Where requested by the Engineer, a factory-trained service representative shall inspect the installation and assist in the initial startup and adjustment to the equipment. The period of these services shall be for such time as necessary to secure proper installation and adjustments. After the equipment is placed in permanent operation, the service representative shall supervise the initial operation of the equipment and instruct the personnel responsible for operation and maintenance of the equipment. The service

representative shall notify the Contractor in writing that the equipment was installed according to manufacturers' recommendations and is operating as intended by the manufacturer.

1.23 CLEANING

- A. The Contractor shall thoroughly clean all equipment of all foreign substances, oils, dust, dirt, etc., inside and out before final acceptance by the Engineer.
- B. If any part of a system should be stopped or damaged by any foreign matter after being placed in operation, the system shall be disconnected, cleaned and reconnected wherever necessary to locate and/or remove obstructions. Any work damaged in the course of removing obstructions shall be repaired or replaced when the system is reconnected at no additional cost to the Owner.
- C. During the course of construction, all conduits shall be capped in an acceptable manner to insure adequate protection against the entrance of foreign matter.
- D. Upon completion of all work under the Contract, the Contractor shall remove from the premises all rubbish, debris and excess materials left over from his work.
- E. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.
 - 1. Remove labels that are not permanent labels.
 - 2. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compound and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
 - 3. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean. Vacuum carpeted surfaces and panelboard interiors.
 - 4. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean light fixtures and lamps.
- F. Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful or dangerous materials into drainage systems. Remove and dispose of ALL waste materials, packaging material, skids etc. from the site and dispose of in a lawful manner in accordance with municipal, state and federal regulations.
- G. Where extra materials of value remaining after completion of associated Work have become the Owner's property, arrange for disposition of these materials as directed.

1.24 OPERATING AND MAINTENANCE

- A. Upon completion of all work and tests, the Contractor shall furnish the necessary skilled labor and helpers for operating his system and equipment for a period specified under

each applicable Section of this Division. During this period, he shall fully instruct the Owner or the Owner's representative in the operation, adjustment and maintenance of all equipment furnished. The Contractor shall give at least seven (7) days notice to the Owner and the Engineer in advance of this period.

- B. The Contractor shall include the maintenance schedule for the principal items of equipment furnished under this Division.
- C. The Contractor shall physically demonstrate procedures for all routine maintenance of all equipment furnished under each respective Section to assure accessibility to all devices.
- D. An authorized manufacturer's representative shall attest in writing that the equipment has been properly installed prior to startup of any major equipment. The following equipment will require this inspection: emergency generator, fire alarm system, nurse call system, paging systems, etc. These letters will be bound into the operating and maintenance books.
- E. Refer to individual trade Sections for any other particular requirements related to operating instructions.
- F. Demonstration shall be recorded on CD/DVD disc with two (2) discs turned over to the Owner.

1.25 OPERATING AND MAINTENANCE MANUALS

- A. Prepare operating and maintenance manuals in accordance with the requirements of Division 1 and as follows. The Contractor shall prepare six (6) copies of a complete maintenance and operating instructions manual, bound in booklet form. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty, 3-ring, vinyl-covered binders, with pocket folders for folded sheet information. Mark appropriate identification on front and spine of each binder.
- B. Manual shall include the following:
 - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 - 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 - 4. Servicing instructions and lubrication charts and schedules.
 - 5. Emergency instructions.
 - 6. Spare parts list.
 - 7. Copies of warranties.
 - 8. Wiring diagrams.

9. Recommended "turn around" cycles.
 10. Inspection procedures.
 11. Shop Drawings and Product Data.
 12. Equipment start-up reports.
- C. Include in the manual, a tabulated equipment schedule for all equipment. Schedule shall include pertinent data such as: make, model number, serial number, voltage, normal operating current, belt size, filter quantities and sizes, bearing number, etc. Schedule shall include maintenance to be done and frequency.
- D. Maintenance and instruction manuals shall be submitted to the Owner at the same time as the seven (7) day notice is given prior to the instruction period.

1.26 ACCEPTANCES

- A. The equipment, materials, workmanship, design and arrangement of all work installed under the Electrical Sections shall be subject to the review of the Engineer.
- B. Within 30 days after the awarding of a Contract, the Electrical Contractor shall submit to the Engineer, for review, a list of manufacturers of equipment proposed for the work under the Electrical Sections. The intent to use the exact makes specified does not relieve the Contractor of the responsibility of submitting such a list.
- C. If extensive or unacceptable delivery time is expected on a particular item of equipment specified, the Contractor shall notify the Owner and Engineer, in writing, within 30 days of the awarding of the Contract. In such instances, deviations may be made pending acceptance by the Engineer or the Owner's representative.
- D. Where any specific material, process or method of construction or manufactured article is specified by reference to the catalog number of a manufacturer, the Specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings. In all cases, the Electrical Contractor shall verify the duty specified with the specific characteristics of the equipment offered for review. Equipment characteristics are to be used as mandatory requirements where the Contractor proposes to use an acceptable equivalent.
- E. If material or equipment is installed before it is reviewed and/or approved, the Contractor shall be liable for its removal and replacement at no extra charge to the Owner if, in the opinion of the Engineer, the material or equipment does not meet the intent of, or standard of quality implied by, the Drawings and Specifications.
- F. Failure on the part of the Engineer to reject shop drawings or to reject work in progress shall not be interpreted as acceptance of work not in conformance with the Drawings and/or Specifications. Work not in conformance with the Drawings and/or Specifications shall be corrected whenever it is discovered.

1.27 RECORD DRAWINGS

- A. General: Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Engineer's reference during normal working hours.
- B. Record Drawings: Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately; where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.
 - 1. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.
 - 2. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.
 - 3. Note related Change Order numbers where applicable.
 - 4. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.
 - 5. Final record documents shall be prepared in the latest Revit version and floppy disks or CD ROM of all drawings and a clean set of reproducible mylar sepia's shall be turned over to the Owner at the completion of the work.

1.28 WARRANTIES AND BONDS

- A. The following general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturers standard warranties on products and special warranties are to be included:
 - 1. General close-out requirements included in Section "Project Close-out."
 - 2. Specific requirements for warranties for the Work and products and installation that are specified to be warranted are included in the individual Sections of Divisions 2 through 28.
 - 3. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.
- B. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.
- C. Separate Prime Contracts: Each prime Contractor is responsible for warranties related to its own Contract.

1.29 WARRANTY REQUIREMENTS

- A. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.
- D. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, right and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.
- E. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- F. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.
- G. Submit written warranties to the Engineer prior to the date certified for Substantial Completion. If the Engineer's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Engineer.
- H. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Engineer within fifteen days of completion of that designated portion of the Work.
- I. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner through the Engineer for approval prior to final execution.
 - 1. Refer to individual Sections of Divisions 2 through 33 for specific content requirements, and particular requirements for submittal of special warranties.

- J. Form of Submittal: At Final Completion compile two copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- K. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2" by 11" paper.
 - 1. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the installer.
 - 2. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS," the Project title or name, and the name of the Contractor.
 - 3. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

1.30 GUARANTEES

- A. The Contractor shall guarantee all material and workmanship under these Specifications and the Contract for a period of one (1) year from the date of final acceptance by Owner. During this guarantee period, all defects developing through faulty equipment, materials or workmanship shall be corrected or replaced immediately by this Contractor without expense to the Owner. Such repairs or replacements shall be made to the Engineers satisfaction.
- B. Contractor shall provide name, address, and phone number of all contractors and subcontractors and associated equipment they provided

1.31 PROJECT CLOSE-OUT

- A. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications and similar documents.
- B. Deliver tools, spare parts, extra stock, and similar items.
- C. Complete start-up testing of systems, and instruction of the Owner's operating and maintenance personnel. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.
- D. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.
- E. Inspection Procedures: On receipt of a request for inspection, the Engineer will either proceed with inspection or advise the Contractor of unfilled requirements. The Engineer will prepare the Certificate of Substantial Completion following inspection, or advise the Contractor of construction that must be completed or corrected before the certificate will be issued.

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1. The Engineer will repeat inspection when requested and assured that the Work has been substantially completed.
2. Results of the completed inspection will form the basis of requirements for final acceptance.

END OF SECTION

CADD File Release Form

DELIVERY OF CADD FILES FOR: _____
Project Name

In accepting and utilizing any drawings or other data on any form of electronic media generated and provided by the Design Professional, the Client covenants and agrees that all such drawings and data are instruments of service of the Design Professional, who shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

The Client further agrees not to use these drawings and data, in whole or in part, for any purpose or project other than the project which is the subject of this Agreement. The Client agrees to waive all claims against the Design Professional resulting in any way from any unauthorized changes or reuse of the drawings and data for any other project by anyone other than the Design Professional.

In addition, the Client agrees, to the fullest extent permitted by law, to indemnify and hold the Design Professional harmless from any damage, liability or cost, including reasonable attorneys' fees and costs of defense, arising from any changes made by anyone other than the Design Professional or from any reuse of the drawings and data without the prior written consent of the Design Professional.

Under no circumstances shall transfer of the drawings and other instruments of service on electronic media for use by the Client be deemed a sale by the Design Professional, and the Design Professional makes no warranties, either express or implied, of merchantability and fitness for any particular purpose.

Client's Signature

Date

Company - Title

Architects' Signature

Date

Firm - Title

Owner's Signature

Date

Company - Title

SECTION 260503 - EQUIPMENT WIRING CONNECTIONS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes electrical connections to equipment.
- B. Related Sections:
 - 1. Section 26 05 19 – Building Wire and Cable.
 - 2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
 - 3. Section 26 27 26 – Wiring Devices.
 - 4. Section 26 28 13 – Fuses.
 - 5. Section 26 28 19 - Enclosed Switches.
 - 6. Section 26 29 13 – Enclosed Controllers.
- C. Related Requirements:
 - 1. This section applies to certain sections of Division 8 “Door Hardware”, Division 11 “Equipment”, Division 12 “Furnishings”, Division 21 “Fire Protection”, Division 22 “Plumbing”, Division 23, "Mechanical,", Division 27 “Communications”, and Division 28 “Electronic Safety and Security” of this project specification unless specified otherwise in the individual sections.
 - 2. The Drawings of other trades (Architectural, Plumbing, Mechanical, Food Service, Fire Protection, AV, Communications, and Electronic Safety and Security) shall be examined for coordination and familiarity of work with other Contractors. Any duplication or omission of provisions in this project should be brought to the attention of the Owners prior to Bidding.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project’s environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA WD 1 - General Requirements for Wiring Devices.
 - 2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit wiring device manufacturer's catalog information showing dimensions, configurations, and construction.
- C. Manufacturer's installation instructions.
- D. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Submittal procedures.
- B. Project Record Documents: Record actual locations, sizes, and configurations of equipment connections.

1.7 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 COORDINATION

- A. Section 01 30 00 - Administrative Requirements Coordination and project conditions.
- B. Obtain and review equipment schedules and specifications for equipment furnished under other sections.
- C. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
- D. Determine connection locations and requirements, including requirements for enclosed switches, enclosed controllers, variable frequency drives, control stations, safety devices, control wiring, and accessories for equipment furnished under other sections.
- E. Sequence rough-in of electrical connections to coordinate with installation of equipment. Do not proceed with rough-in without coordination of requirements for equipment furnished under other sections.
- F. Sequence electrical connections to coordinate with start-up of equipment.
- G. Refer to Table 1 at the end of this section for division of labor between the Division 26 Contractor and the Div. 27 Audio Visual Contractor.

PART 2 PRODUCTS

2.1 CORD AND PLUGS

- A. Manufacturers:
 - 1. Hubbell.
 - 2. Leviton.
 - 3. Bryant.
 - 4. Substitutions: Section 01 60 00 - Product Requirements
- B. Attachment Plug Construction: Conform to NEMA WD 1.
- C. Configuration: NEMA WD 6; match receptacle configuration at outlet furnished for equipment.
- D. Cord Construction: Type SO, SJO multi-conductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
- E. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements Coordination and project conditions.
- B. Verify equipment is ready for electrical connection, for wiring, and to be energized.

3.2 INSTALLATION

- A. Make electrical connections.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations, including pool equipment rooms.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Install receptacle outlet to accommodate connection with attachment plug.
- E. Install cord and cap for field-supplied attachment plug.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, safety devices and control devices to complete equipment wiring requirements.

- H. Install fuses, fuse holders and terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.
- J. Install conduit and wiring for interconnection of motorized door operator and motorized fire door control stations, safety devices and accessories to complete equipment wiring requirements.
- K. Install conduit and wiring for interconnection of specialty equipment (motorized divider partitions, scoreboards, motorized backboards, shot clocks...etc.) control stations, safety devices and accessories to complete equipment wiring requirements.
- L. Install conduit and wiring for interconnection of receptacles, lighting and switches furnished with equipment (fume hoods, food service equipment, furnishings...etc.).
- M. Install conduit and wiring for interconnection of alarm initiating devices, control panels and annunciators furnished with equipment.
- N. Install conduit and wiring for interconnection of power supplies furnished by other divisions.

3.3 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements Testing, adjusting, and balancing.
- B. Cooperate with utilization equipment installers and field service personnel during checkout and starting of equipment to allow testing and balancing and other startup operations. Provide personnel to operate electrical system and checkout wiring connection components and configurations.

TABLE 1 - PROJECT WORK SCOPE

ITEMS TO BE PROVIDED AND INSTALLED	Electrical Contractor		Audio & Video Contractor	
	Provides	Installs	Provides	Installs
Main Power Service Panel Boards and Circuit Breakers	x	x		
• Main Power Service Conduit and Conductors	x	x		
• Main Power Service Terminations		x		
Audio & Video Technical Power (AVTP) Transformers	x	x		
• Transformer Conduit and Conductors	x	x		
• Transformer Terminations		x		
AVTP Isolated Ground Conduit and Conductors	x	x		
• Isolated Ground Terminations		x◇		

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AVTP Distribution Panelboards and Circuit Breakers	x	x		
• Distribution Panelboard Conduit and Conductors	x	x		
• Distribution Panelboard Terminations		x		
AVTP Outlet Devices for Branch Circuits delivered to Audio & Video Equipment Racks and Devices			x	x
• Equipment Rack Back Boxes and Wall Plates			x	x
• Outlet Device Back Boxes		x	x	
• Outlet Device Wall Plates			x	x
• Branch Circuit Conduit and Conductors	x	x		
• Branch Circuit Termination				x
Conduit Riser Diagram	x			

◇ Installation criteria to be provided by Audio & Video Contractor

END OF SECTION

SECTION 260519 - BUILDING WIRE AND CABLE

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes building wire; and rated feeder wiring and wiring connectors and connections.
- B. Related Sections:
 - 1. Section 07 84 13 – Penetration Firestopping.
 - 2. Section 26 05 53 - Identification for Electrical Systems: Product requirements for wire identification.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- B. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.

2. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

1.5 SYSTEM DESCRIPTION

- A. Product Requirements: Provide products as follows:
 1. Solid conductor for feeders and branch circuits 10 AWG and smaller.
 2. Stranded conductors for control circuits.
 3. Conductor not smaller than 12 AWG for power and lighting circuits.
 4. Conductor not smaller than 14 AWG for control circuits.
 5. Increase wire size in branch circuits to limit voltage drop to a maximum of 3 percent.
- B. Wiring Methods: Provide the following wiring methods:
 1. Concealed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
 2. Exposed Dry Interior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
 3. Above Accessible Ceilings: Use only building wire, Type THHN/THWN insulation, in raceway, or metal clad MC cable for final connections to recessed VFR's.
 4. Wet or Damp Interior Locations: Use only building wire, Type THWN-2/XHHW-2 insulation, in rigid conduit.
 5. Exterior Locations: Use only building wire, Type XHHW-2 insulation.

1.6 DESIGN REQUIREMENTS

- A. Conductor sizes are based on copper.

1.7 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures Requirements for submittals.
- B. Product Data: Submit for building wire and each cable assembly type.
- C. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.

3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.8 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of components and circuits.

1.9 QUALITY ASSURANCE

- A. Provide wiring materials located in plenums with peak optical density not greater than 0.5, average optical density not greater than 0.15, and flame spread not greater than 5 feet (1.5 m) when tested in accordance with NFPA 262.
- B. Perform Work in accordance with the current issue of the State of Connecticut Building code.
- C. Maintain one copy of each document on site.
- D. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.10 QUALIFICATIONS

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

1.11 FIELD MEASUREMENTS

- A. Verify field measurements are as indicated on Drawings.

1.12 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Where wire and cable destination is indicated and routing is not shown, determine routing and lengths required.

PART 2 PRODUCTS

2.1 BUILDING WIRE

- A. Manufacturers:
 - 1. American Insulated Wire Corporation.
 - 2. General Cable Co.
 - 3. SouthWire.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Single conductor insulated wire.
- C. Conductor: Copper.
- D. Insulation: Type THHN/THWN for all branch circuits and feeders.

2.2 METAL CLAD CABLE (MC)

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc.
 - 2. General Cable Co.
 - 3. SouthWire.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Conductor: Copper.
- C. Use: Use only for final connections to interior equipment or to fish within drywall partitions. (all other circuits shall be in EMT or other raceway as indicated within Section 26 05 33).

2.3 METAL CLAD CABLE

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc.
 - 2. General Cable Co.
 - 3. SouthWire.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Conductor: Copper.

- C. Use: Use for final connections to recessed internal equipment or to fish within drywall partitions in the Health Services Exam and Cot rooms.. (all other circuits shall be in EMT or other raceway as indicated within Section 26 05 33).

2.4 WIRING CONNECTORS

- A. Split Bolt Connectors:
 - 1. IlSCO.
 - 2. Thomas Betts.
 - 3. Burndy.
 - 4. Buchanan.
 - 5. Substitutions: Substitutions: Section 01 60 00 - Product Requirements.
- B. Solderless Pressure Connectors:
 - 1. IlSCO.
 - 2. Thomas Betts.
 - 3. Burndy.
 - 4. Buchanan.
 - 5. Substitutions: Substitutions: Section 01 60 00 - Product Requirements.
- C. Spring Wire Connectors:
 - 1. IlSCO.
 - 2. Thomas Betts.
 - 3. Burndy.
 - 4. Buchanan.
 - 5. Substitutions: Substitutions: Section 01 60 00 - Product Requirements.
- D. Compression Connectors:
 - 1. IlSCO.
 - 2. Thomas Betts.
 - 3. Burndy.
 - 4. Buchanan.
 - 5. Substitutions: Substitutions: Section 01 60 00 - Product Requirements.

2.5 TERMINATIONS

- A. Terminal lugs for Wires 6 AWG and Smaller: Solderless, compression type copper.
- B. Lugs for Wires 4 AWG and Larger: Color keyed, compression type copper, with insulating sealing collars.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify interior of building has been protected from weather.

- C. Verify mechanical work likely to damage wire and cable has been completed.
- D. Verify raceway installation is complete and supported.

3.2 PREPARATION

- A. Completely and thoroughly swab raceway before installing wire.

3.3 INSTALLATION

- A. Type MC and HCFC cable may be used for drops within existing drywall partitions and final connections to normal power lighting fixtures. Provide EMT and building wire for all other circuits.
- B. Route wire and cable to meet Project conditions.
- C. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- D. Identify and color code wire and cable under provisions of this section. Identify each conductor with its circuit number or other designation indicated.
- E. Special Techniques--Building Wire in Raceway:
 - 1. Pull conductors into raceway at same time.
 - 2. Install building wire 4 AWG and larger with pulling equipment.
 - 3. Use of pulling compounds not allowed for pulling of wire used for isolated power systems.
- F. Special Techniques - Cable:
 - 1. Protect exposed cable from damage.
 - 2. Support cables above accessible ceiling, using spring metal clips or cable ties to support cables from structure. Do not rest cable on ceiling panels.
 - 3. Use suitable cable fittings and connectors.
- G. Special Techniques - Wiring Connections:
 - 1. Clean conductor surfaces before installing lugs and connectors.
 - 2. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
 - 3. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
 - 4. Install split bolt connectors for copper conductor splices and taps, 6 AWG and larger.
 - 5. Install solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
 - 6. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
- H. Install stranded conductors for control circuits 14 AWG and smaller. Install crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under screws.

- I. Install terminal lugs on ends of 600 volt wires unless terminal lugs are furnished on connected device, such as circuit breakers.
- J. Size lugs in accordance with manufacturer's recommendations for terminating wire sizes. Install 2-hole type lugs to connect wires 4 AWG and larger to copper bus bars.
- K. For terminal lugs fastened together such as on motors, transformers and other apparatus, or when spaced between studs is small enough that lugs can turn and touch each other, insulate for dielectric strength 2-1/2 times normal potential of circuit.
- L. Mineral Insulated Cable Installation:
 - 1. The wiring and cable shall be installed according to the manufacturers' recommendations, the instructions in the installation and specifications manual and the requirements of the UL Fire Resistance Directory listing.
 - 2. Provide brass glands, termination kits and fittings from the same manufacturer as the cable. Provide brass plates for entrance fittings to ferrous enclosures per the manufacturer's recommendations.

3.4 WIRE COLOR

- A. General:
 - 1. For wire sizes 10 AWG and smaller, install wire colors in accordance with the following:
 - a. Black and red for single phase circuits at 120/240 volts.
 - b. Black, red, and blue for circuits at 120/208 volts single or three phase.
 - c. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.
 - 2. For wire sizes 8 AWG and larger, identify wire with colored tape at terminals, splices and boxes.
- B. Neutral Conductors: White. When two or more neutrals are located in one conduit, individually identify each with proper circuit number.
- C. Branch Circuit Conductors: Install three or four wire home runs with each phase uniquely color coded.
- D. Feeder Circuit Conductors: Uniquely color code each phase as indicated above.
- E. Ground Conductors:
 - 1. For 6 AWG and smaller: Green.
 - 2. For 4 AWG and larger: Identify with green tape at both ends and visible points including junction boxes.

3.5 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.3.1.

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END OF SECTION

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Rod electrodes.
 - 2. Wire.
 - 3. Mechanical connectors.
 - 4. Exothermic connections.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
 - 1. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
 - 2. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.

- B. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- C. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.

1.5 SYSTEM DESCRIPTION

- A. Grounding systems use the following elements as grounding electrodes:
 - 1. Metal underground water pipe.
 - 2. Metal building frame.
 - 3. Metal underground gas piping system.
 - 4. Rod electrode.

1.6 PERFORMANCE REQUIREMENTS

- A. Grounding System Resistance: 10 ohms maximum.

1.7 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit data on grounding electrodes and connections.
- C. Test Reports: Indicate overall resistance to ground and resistance of each electrode.
- D. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer

literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.8 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of components and grounding electrodes.

1.9 QUALITY ASSURANCE

- A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and UL labeled.
- B. Maintain one copy of each document on site.
- C. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.10 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.
- B. Installer: Company specializing in performing work of this section with minimum 3 years experience.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

- D. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.12 COORDINATION

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

PART 2 PRODUCTS

2.1 ROD ELECTRODES

- A. Manufacturers:
 - 1. Copperweld, Inc.
 - 2. Erico, Inc.
 - 3. O-Z Gedney Co.
 - 4. Thomas & Betts, Electrical
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description:
 - 1. Material: Copper-clad steel.
 - 2. Diameter: 3/4 inch.
 - 3. Length: 10 feet.
- C. Connector: Connector for exothermic welded connection.

2.2 WIRE

- A. Material: Stranded copper.
- B. Foundation Electrodes: 4 AWG.
- C. Grounding Electrode Conductor: Copper conductor insulated.
- D. Bonding Conductor: Copper conductor bare or insulated.

2.3 MECHANICAL CONNECTORS

- A. Manufacturers:
 - 1. Copperweld, Inc.
 - 2. Erico, Inc.
 - 3. ILSCO Corporation
 - 4. O-Z Gedney Co.
 - 5. Thomas & Betts, Electrical.
 - 6. Substitutions: Section 01 60 00 - Product Requirements
- B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

2.4 EXOTHERMIC CONNECTIONS

- A. Manufacturers:
 - 1. Cadweld, Erico, Inc.
 - 2. Copperweld, Inc.
 - 3. ILSCO Corporation.
 - 4. O-Z Gedney Co.
 - 5. Thomas & Betts, Electrical.
 - 6. Substitutions: Section 01 60 00 - Product Requirements
- B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify final backfill and compaction has been completed before driving rod electrodes.

3.2 PREPARATION

- A. Remove paint, rust, mill oils, surface contaminants at connection points.

3.3 INSTALLATION

- A. Install in accordance with IEEE 142.
- B. Install rod electrodes at locations as indicated on Drawings. Install additional rod electrodes to achieve specified resistance to ground.
- C. Install grounding and bonding conductors concealed from view.
- D. Equipment Grounding Conductor: Install separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.
- E. Install continuous grounding using underground cold water system, driven rods and building steel as grounding electrode. Where water piping is not available, install artificial station ground by means of driven rods or buried electrodes.
- F. Permanently ground entire light and power system in accordance with NEC, including service equipment, distribution panels, lighting panelboards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.
- G. Accomplish grounding of electrical system by using insulated grounding conductor installed with feeders and branch circuit conductors in conduits. Size grounding

conductors in accordance with NEC. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment. Ground conduits by means of grounding bushings on terminations at panelboards with installed number 12 conductor to grounding bus.

- H. Grounding electrical system using continuous metal raceway system enclosing circuit conductors in accordance with NEC.
- I. Permanently attach equipment and grounding conductors prior to energizing equipment.
- J. Connections to Lightning Protection System: Bond grounding conductors, including grounding-conductor conduits, to lightning protection down conductors or lightning protection grounding conductors in compliance with NFPA 780.
- K. Common Ground Bonding with Lightning Protection System: Bond electric power system, grounding electrode system directly to lightning protection system earth connection at closest point to electric service grounding electrode. Use bonding conductor sized the same as system grounding conductor and install in conduit.

3.4 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Grounding and Bonding: Perform inspections and tests listed in NETA ATS, Section 7.13.
- C. Perform ground resistance testing in accordance with IEEE 142.
- D. Perform leakage current tests in accordance with NFPA 99.
- E. Perform continuity testing in accordance with IEEE 142.
- F. When improper grounding is found on receptacles, check receptacles in entire project and correct. Perform retest.
- G. Results of the above shall be documented in writing and provided within the O&M manuals and to the CX agent as part of the closeout.

END OF SECTION

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Each Contractor, Subcontractor and/or supplier providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary".

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 PHASE 2 SUPPORT REQUIREMENTS

- A. All electrical systems including equipment, conduit, junction boxes and accessories being hung from above shall not be supported from the existing "space truss" roof structure unless noted otherwise. Systems shall be supported from new framing only. Refer to structural drawings for locations of new framing. Provide supplemental framing as required.

1.5 SUMMARY

- A. Section Includes:
 - 1. Conduit supports.
 - 2. Formed steel channel.
 - 3. Spring steel clips.
 - 4. Sleeves.
 - 5. Mechanical sleeve seals.
 - 6. Equipment bases and supports.
- B. Related Sections:
 - 1. Section 03 30 00 - Cast-In-Place Concrete: Product requirements for concrete for placement by this section.
 - 2. Division 07 Section – Penetration Firestopping.

1.6 REFERENCES

- A. ASTM International:
 - 1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 3. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
 - 4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
- B. FM Global:
 - 1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.
- C. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.

1.7 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
- C. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
- D. Design Data: Indicate load carrying capacity of trapeze hangers and hangers and supports.
- E. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.

- F. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.8 QUALITY ASSURANCE

- A. High Performance Building Requirements:
1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.
- B. Installer: Company specializing in performing work of this section with minimum three years experience, approved by manufacturer.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.

PART 2 PRODUCTS

2.1 CONDUIT SUPPORTS

- A. Manufacturers:
 - 1. Allied Tube & Conduit Corp.
 - 2. O-Z Gedney Co.
 - 3. Thomas and Betts
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.
- C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.
- D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.
- E. Conduit clamps - general purpose: Two hole malleable iron for surface mounted conduits.
- F. Cable Ties: High strength nylon temperature rated to 185 degrees F, self-locking.

2.2 FORMED STEEL CHANNEL

- A. Manufacturers:
 - 1. Allied Tube & Conduit Corp.
 - 2. B-Line Systems.
 - 3. Unistrut Corp.
 - 4. Substitutions: Section 01 60 00 - Product Requirements
- B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.3 SPRING STEEL CLIPS

- A. Manufacturers:
 - 1. Allied Tube & Conduit Corp.
 - 2. B-Line Systems
 - 3. Unistrut Corp.
 - 4. Substitutions: Section 01 60 00 - Product Requirements
- B. Product Description: Mounting hole and screw closure.

2.4 SLEEVES

- A. Sleeves for conduit, raceway, cable tray, busway, or cable through Non-fire Rated Floors: 18 gage thick galvanized steel.
- B. Sleeves for conduit, raceway, cable tray, busway, or cable through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
- C. Sleeves for conduit, raceway, cable tray, busway, or cable through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed matching fire resistive rating of the penetration.

2.5 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
 - 1. Thunderline Link-Seal, Inc.
 - 2. NMP Corporation.
 - 3. PSI Link-Seal.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.
- C. Use: Provide for all penetrations through foundation walls.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify openings are ready to receive sleeves.

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
- B. Obtain permission from Architect before using powder-actuated anchors.
- C. Obtain permission from Architect before drilling or cutting structural members.

3.3 INSTALLATION - HANGERS AND SUPPORTS

- A. Anchors and Fasteners:
 - 1. Concrete Structural Elements: Provide precast inserts and expansion anchors.
 - 2. Steel Structural Elements: Provide beam clamps, spring steel clips, steel ramset fasteners, and welded fasteners.
 - 3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
 - 4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.
 - 5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
 - 6. Sheet Metal: Provide sheet metal screws.
 - 7. Wood Elements: Provide wood screws.
- B. Inserts:
 - 1. Install inserts for placement in concrete forms.
 - 2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.
- C. Install conduit and raceway support and spacing in accordance with NEC.
- D. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
- E. Install multiple conduit runs on common hangers.
- F. Supports:
 - 1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
 - 2. Install surface mounted cabinets and panelboards with minimum of four anchors.
 - 3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.
 - 4. Support vertical conduit at every floor.

3.4 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 4 inches thick and extending 6 inches beyond supported equipment. Refer to Section 03 30 00.
- B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members or formed steel channel. Brace and fasten with flanges bolted to structure.

3.5 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with adjustable interlocking rubber links.
- B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.
- C. Set sleeves in position in forms. Provide reinforcing around sleeves.
- D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- E. Extend sleeves through floors 6 inches above finished floor level. Caulk sleeves.
- F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with fire stopping insulation and caulk. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

3.6 FIELD QUALITY CONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

3.7 CLEANING

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

3.8 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.
- B. Related Sections:
 - 1. Section 07 84 13 – Penetration Firestopping
 - 2. Section 26 05 03 - Equipment Wiring Connections.
 - 3. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 4. Section 26 05 29 - Hangers and Supports for Electrical Systems.
 - 5. Section 26 05 53 - Identification for Electrical Systems.
 - 6. Section 26 27 26 - Wiring Devices.
 - 7. Section 26 51 00 – Interior Lighting.
 - 8. Section 26 52 00 – Emergency Lighting.
 - 9. Section 26 56 00 – Exterior Lighting.
 - 10. Section 28 31 00 – Fire Detection and Alarm.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
 - 2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
 - 3. ANSI C80.5 - Aluminum Rigid Conduit - (ARC).
- B. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
 - 3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 4. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 5. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - 6. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
 - 7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.5 SYSTEM DESCRIPTION

- A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.
- B. Underground more than 5 feet outside Foundation Wall: Provide PVC conduit.
- C. Underground within 5 feet from Foundation Wall: Provide rigid steel conduit.
- D. In or Under Slab on Grade: Provide PVC conduit with rigid steel conduit sweeps.
- E. Outdoor Locations, Above Grade: Provide rigid steel conduit. Provide cast metal or nonmetallic outlet, pull, and junction boxes.
- F. In Slab Above Grade: Provide rigid steel conduit. Provide cast boxes.
- G. Wet and Damp Locations: Provide rigid steel conduit. Provide cast metal outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.
- H. Wet or Damp corrosive environments (Pool and Pool Equipment Rooms): Use only building wire, Type THHN/THWN insulation, in Schedule 40 PVC conduit. Provide non-metallic WP boxes.
- I. Concealed Dry Locations: Provide EMT conduit. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

- J. Dry Finished Locations: Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- K. Exposed Dry Finished Locations: Provide surface metal raceway and fittings. Unless specified on drawings, requires design team approval for use of surface metal raceway in finished locations. Coordinate all vertical runs of surface raceway with the architect prior to installation.
- L. Existing Gymnasiums and Natatorium: Existing recessed backboxes and concealed conduits can be reused for devices shown on the electrical drawings in the same vicinity. Provide recessed backboxes in infill areas at columns in these spaces. Do not install exposed conduit or raceways below 12 ft. AFF in these spaces without prior approval from the Architect and Engineer.

1.6 DESIGN REQUIREMENTS

- A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

1.7 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit for the following:
 - 1. Flexible metal conduit.
 - 2. Liquidtight flexible metal conduit.
 - 3. Nonmetallic conduit.
 - 4. EMT.
 - 5. Raceway fittings.
 - 6. Conduit bodies.
 - 7. Surface raceway.
 - 8. Wireway.
 - 9. Pull and junction boxes.
- C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
- D. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).

- c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.8 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents:
 1. Record actual routing of conduits larger than 2 inch.
 2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.9 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- C. Protect PVC conduit from sunlight.

1.11 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate installation of outlet boxes for equipment connected under Section 26 05 03.
- C. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 PRODUCTS

2.1 METAL CONDUIT

- A. Manufacturers:
 - 1. Allied Tube and Conduit.
 - 2. Western Tube and Conduit.
 - 3. Wheatland Tube Company.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Rigid Aluminum Conduit: ANSI C80.5.
- D. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.2 FLEXIBLE METAL CONDUIT

- A. Manufacturers:
 - 1. Allied Tube and Conduit
 - 2. Western Tube and Conduit.
 - 3. Wheatland Tube Company.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Fittings: NEMA FB 1.

2.3 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Manufacturers:
 - 1. Carlon Electrical Products.
 - 2. Anamet Electrical.
 - 3. Allied Tube and Conduit.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Fittings: NEMA FB 1.

2.4 ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 - 1. Allied Tube and Conduit.
 - 2. Western Tube and Conduit.
 - 3. Wheatland Tube Company.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: ANSI C80.3; galvanized tubing.
- C. Fittings and Conduit Bodies: NEMA FB 1; steel, set screw type.

2.5 NONMETALLIC CONDUIT

- A. Manufacturers:
 - 1. Carlon Electrical Products.
 - 2. Thomas & Betts Corp.
 - 3. Allied Tube and Conduit.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: NEMA TC 2; Schedule 40/80 PVC.
- C. Fittings and Conduit Bodies: NEMA TC 3.

2.6 SURFACE METAL RACEWAY

- A. Manufacturers:
 - 1. Hubbell Wiring Devices.
 - 2. Thomas & Betts Corp.
 - 3. The Wiremold Co.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.
- C. General:
 - 1. System: Provide surface raceway systems for branch circuit and data network voice, video and other low-voltage wiring. Surface raceway system shall consist of raceway bases, covers, pre-divided raceway bases, dual covers, appropriate fittings and device mounting plates necessary for a complete installation.
 - 2. Configuration: Raceways shall be one- or two-piece design with base and snap-on cover, or three-piece design with base and two snap-on covers which snap side by side on a common base. Base shall be dividable with a fixed barrier for up to 4 compartments. Raceway shall be available in widths of 3/4" to 10" and depths of 17/32" to 5" Provide raceways from a company that can provide custom sizes if required. Raceway covers shall be available in tamper-resistant form with screws on access plates and covers of fittings, but

not on standard cover lengths. Raceways shall be multi-piece design with metal base and snap-on metal covers. Assembled base and cover is 5-3/4" wide by 2-1/8" high with a cross section area of 10.06 sq in. Base shall have 2 wiring channels, separated by 1 integral divider, large enough to accept standard power and communication devices without restricting capacity of the adjacent channel. The raceway base shall accept 2 covers that allow separation of services. The cover shall slightly curve and form the raceway sidewall. Provide the base with scored lines to facilitate sectioning of the raceway in 4" increments and include mounting holes, and tunnel knockouts in the divider wall that will facilitate the crossing over of services.

3. Fittings: Fittings shall include flat, internal and external elbows, couplings for joining raceway sections, wire clips, blank end fittings, and device mounting brackets and plates as applicable. Where required, provide tamper-resistant form, dividable with barriers and matching the size of the accompanying raceway base. Provide full capacity corner elbows and tee fittings to maintain a controlled 2" cable bend radius, meeting the specification for Fiber Optic and UTP cabling and exceeding the TIA/EIA-569-A requirements for communications pathways.
4. Device Brackets and Plates: Provide in sizes to match raceway width and with mounting holes located to ensure proper mounting of devices in up to 4 compartments. Device plates shall be available in any length from 6" to 60", with cutouts to accommodate various combinations of power and communications devices in up to 4 compartments. Provide 6" and 12" long device plates with a flange to overlap the joint of adjacent cover as applicable.
5. Communications Devices and Accessories: Raceway shall accommodate a complete line of connectivity outlets and modular inserts for UTP (including Category 5, 5e, 6) STP (150 ohm) fiber optic, coaxial, and other cabling types with matching faceplates and bezels to facilitate mounting. Where indicated, provide connectivity outlets and modular inserts by Ortronics or approved equal.

D. Classification:

1. Raceway and system components shall be UL and CUL listed.
2. Surface raceways shall be suitable for use in dry interior locations only, as covered in Article 386 (Surface Metal Raceways) 388 (Surface Nonmetallic Raceways) of the National Electrical Code.
3. Surface metal raceways and fittings shall be listed by Underwriters Laboratories under File Number E4376, Listing and Classification Number RJBT and File Number E41751, Listing and Classification Number RJPR respectively.
4. Systems shall comply with UL Standard UL5 for Surface Metal Raceways.
5. Larger 2 and 3 channel non-metallic raceways shall be UL Listed under File Nos. E90378 Guide RJTX and E90377 Guide RJYT, respectively.

E. Surface Mounted Metal Raceways: V700 One-Piece Metal Raceway, G4000 Series Multi-Channel Steel Raceway, V2100 Single-Channel Metal Raceway by The Wiremold Company or approved equal.

1. Material: Galvanized steel, minimum thickness 0.040".

2. Finish: Factory-applied polyester topcoat applied over ivory base suitable for field-applied topcoat, color by Architect.
3. Steel Device Brackets and Plates: Steel overlap device plate for horizontal installation of devices. Plate shall overlap cover to conceal seam.
4. Plastic Overlapping Cover Bracket and Faceplate: Plastic device mounting bracket and trim plate for horizontal installation of devices. Plate shall overlap cover to conceal seam. Faceplate shall accept a variety of power and data/communication devices. Plastic shall be compatible with UL 94 for Plastic.
5. Adjustable Length Raceway Couplings: Provide raceway base sections with adjustable couplings. Each pair of couplings works in conjunction with the raceway base's scored lines to allow less accurate field cuts. The coupling shall accommodate 4" of lateral movement and facilitate the ability of the raceway to maintain coordination with the wall framing as required. Each coupling shall provide a means of adding supplemental ground screws.
6. Fittings: Fittings shall include flat, internal and external elbows, tees, entrance fittings, wire clips, cover clips, couplings, support clips, and end caps. Covers for fittings shall overlap adjoining raceway covers a minimum of 3/8". Fittings shall be color matched to the raceway. Supply fittings with a base where applicable to eliminate mitering. Provide fittings with adjustable couplings that integrate with the raceway base. Provide a take-off fitting supporting dual services to adapt to existing flush wall boxes and other series of metallic raceways. Fittings shall have provisions to accept tamper resistant fasteners to fully secure the raceway.
 - a. Fiber Optic/UTP/STP Fittings: Corner elbows, tees, and entrance end fittings as required to maintain a controlled 2" [51mm] nominal cable bend radius that meets the specifications for Fiber Optic and UTP/STP cabling and exceeds TIA 569 requirements for communications pathways.
 - b. Obstacle Avoidance and Offset Fittings: Provide fittings as required to bypass large and small obstacles and small offsets in supporting wall. Small obstacle avoidance fitting capable of being converted into a take off fitting to transition to other metallic raceways.
7. Device Brackets and Plates:
 - a. Forward Fittings: Provide device brackets to install single-gang devices horizontally in either channel within the raceway. Provide horizontal device brackets with a single gang face plate. Horizontal device mounting brackets shall be a single piece with integral auxiliary grounding points. Device brackets and activation face plates shall allow the electrical or communications devices to face forward from the sidewall of the raceway.
 - b. Communications Devices and Accessories: Raceway shall accommodate a complete line of connectivity outlets and modular inserts for UTP (including Category 5, 5e, 6) STP (150 ohm) fiber optic, coaxial, and other cabling types with matching faceplates and bezels to facilitate mounting. Provide with complete line of preprinted station and port identification labels.

- F. Multi-service in wall boxes:
1. Multi-Service In-Wall Boxes: WallSource™ Multi-Service Box by The Wiremold Company or approved equal.
 - a. Provide construction box system for bringing power and low voltage devices to one location or to back feed surface wiring systems. System shall consist of in-the-wall boxes, mounting brackets, dividers, device mounting brackets, trim rings, and device plates for a complete installation in accordance with the Drawings.
 - b. Material: 0.050" thick galvanized steel with gray or ivory suitable for field painting.
 2. Classification and Use: Provide construction box system to be utilized in dry, interior locations only as defined by Article 300-15 of the National Electrical Code, as adopted by the National Fire Protection Association and approved by the American National Standards Institute. The box and system components shall be UL listed in accordance with UL 514A and UL514C. The device mounting bracket shall be molded from color matching UL approved resin.
 3. Boxes: Each box shall include the box, dividers and mounting brackets. Dimensions of each shall be a minimum of 32 cubic inches per gang and shall be manufactured of 16-gage minimum thick steel. The box shall accommodate standard power and communication devices.
 - a. The 2-gang box shall have knockouts located on top and bottom, 2-1/4" from the face to accommodate combinations of 1/2", 3/4", and 1" trade size conduits. Boxes of 4- or 6-gangs shall have knockouts to accommodate 1-1/2" trade size conduits.
 - b. Box shall have a separate ground terminal provided in each gang.
 - c. Box shall adjust for a flush installation with the finished wall. There shall be positive stops for surface mounting to 1/2", 5/8", 1" and 1-1/4" thick wallboard. Adjusting screws shall be located outside the box for adjustment prior to installation.
 4. Device Mounting Brackets: Self-leveling device mounting bracket shall accommodate standard power devices, connectivity inserts, and Wiremold 5507 series faceplates. Mounting bracket shall be available to accommodate other manufacturer's devices. Mounting bracket shall accommodate six power devices or 18 communications inserts. All faceplates, mounting brackets and trim rings shall be color matched.
 5. Communication Devices and Accessories: Box shall accommodate a complete line of connectivity outlets and modular inserts for UTP (including Category 5, 5e, 6) STP (150 ohm) fiber optic, coaxial, and other cabling types with matching faceplates and bezels to facilitate mounting. Where indicated, provide connectivity outlets and modular inserts by Ortronics or approved equal.
 6. Fiber Optic/UTP (including Category 5, 5e, 6) Radius: The depth of the box shall accommodate a 1-1/4" cable bend radius, which meets or exceeds the specifications for fiber optic and UTP cabling and TIA/EIA-569A requirements for communications pathways. A 1" controlled radius storage loop shall be available.
 7. Device Covers: Device cover plates in the following configurations shall be available: duplex device cover plates, single 1.40" and 1.59" diameter

receptacle cover plates, switch plates, GFCI cover plates, Sentrex surge receptacle cover plates and other rectangular faced plates. Single gang cover plates shall be modular in design.

8. Support Bracket: Provide support bracket for mounting on 16" on center studs on boxes with more than two gangs.
9. Dividers: Dividers shall be removable without any tools.

G. Finish: Architect to select from manufacturers standard color palette.

2.7 WIREWAY

A. Manufacturers:

1. Carlon Electrical Products.
2. Thomas & Betts Corp.
3. Hoffman.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: General purpose type wireway.

C. Knockouts: Manufacturer's standard.

D. Cover: Screw cover.

E. Finish: Rust inhibiting primer coating with gray enamel finish.

2.8 OUTLET BOXES

A. Manufacturers:

1. Erico Products.
2. Raco.
3. Thomas & Betts Corp.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.

1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
2. Concrete Ceiling Boxes: Concrete type.

C. Nonmetallic Outlet Boxes: NEMA OS 2.

D. Cast Boxes: NEMA FB 1, Type FD, aluminum. Furnish gasketed cover by box manufacturer.

E. Wall Plates for Finished Areas: As specified in Section 26 27 26.

F. Wall Plates for Unfinished Areas: Furnish gasketed cover.

G. Provide boxes listed for "EXTRA DUTY" for exterior receptacle locations.

2.9 PULL AND JUNCTION BOXES

- A. Manufacturers:
 - 1. Carlon Electrical Products.
 - 2. Hubbell Wiring Devices.
 - 3. Thomas & Betts Corp.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- C. Surface Mounted Cast Metal Box: NEMA 250; flat-flanged, surface mounted junction box:
 - 1. Material: Cast aluminum.
 - 2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 INSTALLATION

- A. Ground and bond raceway and boxes in accordance with Section 26 05 26.
- B. Fasten raceway and box supports to structure and finishes in accordance with Section 26 05 29.
- C. Identify raceway and boxes in accordance with Section 26 05 53.
- D. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.3 INSTALLATION - RACEWAY

- A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.
- B. Arrange raceway supports to prevent misalignment during wiring installation.
- C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29.

- E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports
- F. Do not attach raceway to ceiling support wires or other piping systems.
- G. Construct wireway supports from steel channel specified in Section 26 05 29.
- H. Route exposed raceway parallel and perpendicular to walls.
- I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.
- J. Route conduit in and under slab from point-to-point.
- K. Maintain clearance between raceway and piping for maintenance purposes.
- L. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.
- M. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- N. Bring conduit to shoulder of fittings; fasten securely.
- O. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.
- P. Install conduit hubs to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
- Q. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install factory elbows for bends in metal conduit larger than 2 inch size.
- R. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.
- S. Seal all raceway entering a building from the exterior with sealant identified for use with the cable insulation, shield or other cabling components.
- T. Install fittings to accommodate expansion and deflection where raceway crosses expansion joints.
- U. Install suitable pull string or cord in each empty raceway except sleeves and nipples.
- V. Install suitable caps to protect installed conduit against entrance of dirt and moisture.
- W. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.

- X. Close ends and unused openings in wireway.

3.4 INSTALLATION - BOXES

- A. Install wall mounted boxes at elevations to accommodate mounting heights as indicated on Drawings.
- B. Adjust box location prior to rough-in to accommodate intended purpose.
- C. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.
- D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- E. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- F. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- G. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic rated walls.
- H. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- I. Install stamped steel bridges to fasten flush mounting outlet box between studs.
- J. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- K. Install adjustable steel channel fasteners for hung ceiling outlet box.
- L. Do not fasten boxes to ceiling support wires or other piping systems.
- M. Support boxes independently of conduit.
- N. Install gang box where more than one device is mounted together. Do not use sectional box.
- O. Install gang box with plaster ring for single device outlets.

3.5 INTERFACE WITH OTHER PRODUCTS

- A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with Section 07 84 13.
- B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation.
- C. Locate outlet boxes to allow luminaires positioned as indicated on reflected ceiling plan.

- D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.6 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Adjust flush-mounting outlets to make front flush with finished wall material.
- C. Install knockout closures in unused openings in boxes.

3.7 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Clean interior of boxes to remove dust, debris, and other material.
- C. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 260534 - FLOOR BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes floor boxes; floor box service fittings; poke-through fittings; and access floor boxes.
- B. Related Sections:
 - 1. Section 07 84 13 –Penetration Firestopping.
 - 2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
 - 3. Section 26 27 26 - Wiring Devices: Receptacles for installation in floor boxes.
 - 4. Section 27 10 00 – Structured Cabling

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project’s environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit catalog data for floor boxes service fittings.
- C. Samples: Submit two of each service fitting illustrating size, material, configuration, and finish.
- D. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of each floor box and poke-through fitting.

1.7 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles

shall be documented in accordance with the High Performance Building Requirements of this Section.

3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.9 EXTRA MATERIALS

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

PART 2 PRODUCTS

2.1 FLOOR BOXES

- A. Manufacturers:
 1. Hubbell.
 2. Walker.
 3. Leviton.
 4. Wiremold/Legrand.
 5. Substitutions: Section 01 60 00 – Product Requirements.
- B. Floor Boxes: NEMA OS 1, suitable for on-grade applications.
- C. Adjustability: Fully adjustable.
- D. Material: Cast metal.
- E. Style: Flush with recessed devices and mounting brackets.
- F. Shape: Rectangular.

2.2 MULTI-SERVICE FLOOR BOX

- A. Manufacturers:
 1. Hubbell.
 2. Walker.
 3. Leviton.
 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Material: Cast-iron suitable for use on grade.
- C. Configuration: Fully adjustable with four independent wiring compartments that allow capacity for up to four duplex outlets or communications devices. Box shall permit

tunneling from adjacent or opposite compartments. Box shall provide a minimum of four 1" conduit hubs and four 1 1/4" conduit hubs. Flush mount style with recessed devices.

- D. Activation Cover: Die-cast flanged cover with brushed aluminum finish.
- E. Accessories: Device mounting plates, faceplates and bezels for duplex receptacle and communications devices.

2.3 HIGH CAPACITY MULTI-SERVICE FLOOR BOX

- A. Manufacturers:
 - 1. Hubbell.
 - 2. Wiremold/Legrand.
 - 3. Leviton.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Material: Concrete-tight stamped steel with fusion-bonded epoxy coating suitable for use on grade.
- C. Configuration: Fully adjustable with eleven gang capacity, including (1) six gang compartment, (1) three gang compartment, and (2) one gang compartment. Box shall provide a minimum of: (3) concentric 1 1/4" & 2" conduit hubs to and (2) concentric 1 1/4" & 1" conduit hubs to the six gang compartment; (2) concentric 1 1/4" & 2" conduit hubs to and (1) concentric 1 1/4" & 1" conduit hubs to the three gang compartment; and (3) concentric 1 1/4" & 2" conduit hubs to and (1) concentric 3/4" & 1" conduit hub to each one gang compartment.
- D. Activation Cover: Cast aluminum flush cover.
- E. Style: Flush mount style with recessed devices.
- F. Accessories: Device mounting plates, faceplates and bezels for duplex receptacle and communications devices.
- G. For use as indicated on drawings.

2.4 FOOD SERVICE AREA BOXES

- A. Manufacturers:
 - 1. Hubbell.
 - 2. Wiremold/Legrand.
 - 3. Leviton.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Material: Stainless Steel finishes on exposed surfaces.
- C. Configuration: Match utilization equipment requirements. Provide pedestal type fitting with matching floor box and required accessories in locations required.

2.5 POKE-THROUGH FITTINGS

- A. Manufacturers:
 - 1. Hubbell.
 - 2. Leviton.
 - 3. Wiremold/Legrand.
 - 4. Substitutions: Section 01 60 00 – Product Requirements.
- B. Product Description: Combination power/telecommunications assembly comprising service fittings, poke-through component, fire stops and smoke barriers, and junction box for conduit termination.
- C. Fire Rating: 2 hours.
- D. Service Fitting Type: Flush mount with recessed devices and brackets.
- E. Housing: cast aluminum.
- F. Device Plate: Brass.
- G. Configuration: Varies, provide with flush cover assemblies for receptacles, combination power/telecommunications or furniture feeds as indicated on drawings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Where use for a device is not specified, consult with Architect and Engineer prior to rough-in.
- C. Verify locations of floor boxes and outlets in work areas prior to rough-in.
- D. Verify openings in access floor are in proper locations.

3.2 INSTALLATION

- A. Refer to Floor Box Legend on drawings for types of floor boxes and poke-through fittings.
- B. Boxes and fittings are indicated on Drawings in approximate locations unless dimensioned. Adjust box location to accommodate intended purpose.
- C. Floor Box Requirements: Use cast floor boxes or stamped steel with fusion epoxy coating for installations in slab on grade; formed steel boxes are acceptable for other installations.
- D. Set floor boxes level.

- E. Install boxes and fittings to preserve fire resistance rating of slabs and other elements, using materials and methods specified in Section 07 84 00.
- F. Install protective rings on active flush cover service fittings.
- G. Confirm quantity of devices and cables intended for each box, and cable types before purchasing or setting devices.

3.3 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Adjust floor box flush with finish flooring material.

3.4 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Clean interior of boxes to remove dust, debris, and other material.

END OF SECTION

SECTION 260536 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes cable tray.
- B. Related Sections:
 - 1. Section 07 84 13 – Penetration Firestopping.
 - 2. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 3. Section 26 05 29 - Hangers and Supports for Electrical Systems

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. ASTM International:
 - 1. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 2. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

- B. National Electrical Manufacturers Association:
 - 1. NEMA FG 1 - Nonmetallic Cable Tray Systems.
 - 2. NEMA VE 1 - Metal Cable Tray Systems.
 - 3. NEMA VE 2 - Metal Cable Tray Installation Guidelines.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate tray type, dimensions, support points, and finishes.
- C. Product Data: Submit fittings and accessories.
- D. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
- E. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual routing of cable tray and locations of supports.

1.7 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience, and with service facilities within 100 miles of Project.

1.9 PRE-INSTALLATION MEETINGS

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

PART 2 PRODUCTS

2.1 METAL LADDER-TYPE CABLE TRAY

- A. Manufacturers:
 - 1. B-Line Systems.
 - 2. Cope.
 - 3. Thomas and Betts.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: NEMA VE 1, Class 20C ladder type tray.
- C. Material: Aluminum.
- D. Finish: Galvanized to ASTM A123/A123M; galvanize after fabrication..
- E. Inside Width: 18 inches or as indicated on Drawings.
- F. Inside Depth: 3 inches or indicated on Drawings.
- G. Straight Section Rung Spacing: 9 inches on center.
- H. Inside Radius of Fittings: 24 inches.

- I. Furnish manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.

2.2 WARNING SIGNS

- A. Engraved Nameplates: 1/2 inch black letters on yellow laminated plastic nameplate, engraved with: WARNING! DO NOT USE CABLE TRAY AS WALKWAY, LADDER, OR SUPPORT. USE ONLY AS MECHANICAL SUPPORT FOR CABLES AND TUBING!

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install metal cable tray in accordance with NEMA VE 2.
- B. Support trays and fasten to structure and finishes in accordance with Section 26 05 29. Install supports at each connection point, at end of each run, and at other points to maintain spacing between supports of 10 ft maximum.
- C. Install expansion connectors where recommended by manufacturer or as indicated on Drawings.
- D. Install firestopping in accordance with Section 07 84 00 to sustain ratings when passing cable tray through fire-rated elements.
- E. Ground and bond metal cable tray in accordance with Section 26 05 26.
 - 1. Provide continuity between tray components.
 - 2. Use anti-oxidant compound to prepare aluminum contact surfaces before assembly.
 - 3. Install 2 AWG bare copper equipment grounding conductor through entire length of tray; bond to each component.
 - 4. Make connections to tray using mechanical, compression or exothermic connectors.
- F. Install warning signs at 50 feet centers along cable tray, located to be visible.

END OF SECTION

SECTION 260540 - RACEWAYS AND BOXES FOR AUDIOVISUAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes for audiovisual systems.
- B. Related Sections:
 - 1. Section 07 84 13 – Penetration Firestopping
 - 2. Section 26 05 03 - Equipment Wiring Connections.
 - 3. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 4. Section 26 05 29 - Hangers and Supports for Electrical Systems.
 - 5. Section 26 05 53 - Identification for Electrical Systems.
 - 6. Section 26 27 26 - Wiring Devices.
- C. The Electrical Contractor shall refer to the large-format audiovisual system drawings for the locations and quantities of all audiovisual devices requiring cable raceway systems.

1.2 INTENT

- A. It is the intent of this section to inform the Electrical Contractor about specific requirements for the installation of the audiovisual cable raceway systems.
- B. Certain items related to the audiovisual cable raceway systems may require equipment or installation techniques which differ from those normally called out in Division 26.

1.3 SCOPE OF WORK

- A. The Electrical Contractor shall furnish and install the audiovisual cable raceway systems as outlined in this Section and Division 26.
- B. The Electrical Contractor does not furnish or install the audiovisual equipment. It is supplied by the Audiovisual Contractor.
- C. The division of labor between the Electrical Contractor and the Audiovisual Contractor is detailed in Table 1 at the end of this Section.

1.4 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood

products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.5 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.6 AUDIOVISUAL CABLE RACEWAY SYSTEM DETAILS

- A. The audiovisual cable raceway systems consist of the following:
 - 1. The Metallic Conduit System is a network of empty conduits into which the Audiovisual Contractor shall install the cables for the audiovisual system.
- B. Unless specifically called out otherwise, all audiovisual system wiring listed in the audiovisual schedule of terminations shall be run in metallic conduit.

1.7 SUBMITTALS

- A. The Electrical Contractor shall submit a conduit riser diagram for all audiovisual system wiring.

PART 2 – REFER TO SECTION 260533

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- A. Prior to installation, the Electrical Contractor shall submit a riser diagram for all audiovisual system conduit.
- B. No installation work shall proceed until the conduit riser has been approved, in writing, by the Electrical Engineer and the Audiovisual Designer.

3.2 INSTALLATION - WIRE GROUPS IN CONDUIT

- A. The audiovisual location drawings and the audiovisual schedule of terminations indicate the origins and destinations for all audiovisual cables. The method of cable routing described in those documents indicates the maximum number of conduit runs required to install the audiovisual systems.
- B. The actual diameter and path of each conduit run shall be determined by the Electrical Contractor in accordance with field conditions.
- C. Should the Electrical Contractor choose to combine cable runs from individual terminations into a common conduit, then they must conform to the wire grouping, conduit fill, and conduit separation requirements listed in this Section.
- D. To prepare the required conduit riser diagram, the Electrical Contractor must group cables by wiring type; determine the total number of cables in each conduit run; determine the diameter of each conduit run; determine the actual routing of each conduit run.
- E. Refer to Paragraph 3.3 of this Section for wiring group and conduit separation requirements.
- F. Refer to Table 5 at the end of this Section for audiovisual cable specifications and conduit capacities.

3.3 INSTALLATION - CONDUIT SEPARATION

- A. Audiovisual system wiring is divided into separate groups according to their nominal voltage levels. These wiring groups must never be intermixed within a given conduit run. See Table 2 at the end of this Section for wire type information.
- B. Conduits carrying audiovisual wiring must maintain a minimum separation from conduits carrying other types of audiovisual wiring. When necessary, ninety degree crossings in close proximity are acceptable. See Table 3 at the end of this Section for audiovisual conduit separation requirements.
- C. Conduits carrying audiovisual wiring must maintain a minimum separation from conduits carrying other types of electrical wiring. Unusually heavy current demands in; or long parallel runs with; electrical services may dictate greater separations to avoid interference with the audiovisual system. See Table 4 at the end of this Section for electrical conduit separation requirements.

3.4 INSTALLATION - METALLIC CONDUIT SYSTEM

- A. The metallic conduit system is specified by information called out in the large-format audiovisual system drawings:
 - 1. The location drawings indicate the position of each audiovisual device and the method of mounting each device.

- a. The schedule of terminations lists each audiovisual device; indicates the quantities, types, and groupings of all cables connected to each device; and lists the destination for all cables exiting each device.
- B. Refer to Table 5 at the end of this Section for audio cable specifications and conduit sizing requirements.
- C. In most cases, each run of this conduit system shall be bonded to the audio termination back boxes which are provided by the Audiovisual Contractor. The only exception is conduit which is routed to the audio equipment racks. Conduit runs entering or exiting the audio equipment racks shall be electrically isolated from the racks. PVC or other non-conductive fittings shall be used to isolate the conduit from the audiovisual equipment racks.
- D. Provide all empty conduits with pull lines.

3.5 INSTALLATION - CABLE SLEEVES

- A. Install per architectural detail drawings with threaded cap at each end of sleeve. These caps shall be lubricated for easy removal and held captive by a chain.

TABLE 1 - PROJECT WORK SCOPE

ITEMS TO BE PROVIDED AND INSTALLED	Electrical Contractor		Audiovisual Contractor	
	Provides	Installs	Provides	Installs
Audiovisual Equipment Racks and Devices			x	x
1. Metallic Conduit between Audiovisual Devices and Audiovisual Equipment Racks	x	x◇		
2. Conduit Insulation Bushings between Metallic Conduit and Audiovisual Equipment Racks	x	x◇		
3. Audiovisual Equipment Rack Cabling			x	x
4. Audiovisual Equipment Rack Terminations				x
5. Audiovisual Device Back Boxes and Floor Boxes		x◇	x	
6. Audiovisual Device Metallic Conduit	x	x◇		
7. Audiovisual Device Cabling			x	x
8. Audiovisual Device Termination				x
Audiovisual Cable Sleeves	x	x		
Audiovisual Pull Boxes	x	x		
Conduit Riser Diagram	x			

◇ Installation criteria to be provided by Audiovisual Contractor

TABLE 2 - AUDIOVISUAL WIRING TYPES

Audiovisual system wiring is divided into wiring groups according to their nominal voltage levels:

	Wiring Type
Group A	Microphones and other sensitive wiring (0 mV to 100 mV)
Group B	Line level wiring (100 mV to 10 V)
Group C	Loudspeaker and control wiring (10 V to 70 V)
Group D	Telephone, video, control and digital circuits
Group E	Fiber optic cable

Note: These wiring groups must never be intermixed within a given conduit run!

TABLE 3 - AUDIO CONDUIT SEPARATION

Minimum conduit separation between conduits carrying wiring of different audiovisual groups is as follows:

	Group A	Group B	Group C	Group D	Group E
Group A	adjacent	6"	12"	12"	adjacent
Group B	-	adjacent	12"	6"	adjacent
Group C	-	-	adjacent	6"	adjacent
Group D	-	-	-	adjacent	adjacent
Group E	-	-	-	-	adjacent

Note: Ninety degree crossings in close proximity are acceptable.

TABLE 4 - ELECTRICAL CONDUIT SEPARATION

Minimum conduit separation between conduits carrying audiovisual wiring and other electrical service conduit is as follows:

	Group A	Group B	Group C	Group D	Group E
Dimmer controlled lighting	24"	12"	6"	12"	adjacent
SCR controlled services	24"	12"	6"	12"	adjacent
220/440VAC circuits	6"	6"	adjacent	adjacent	adjacent
All other services	6"	6"	adjacent	adjacent	adjacent

Note: Heavy current demands in or long parallel runs with the above services may dictate greater separations to avoid interference with the audiovisual systems.

TABLE 5 - CONDUIT SIZING FOR AUDIO CABLES

Audio Cable (dimensions in inches)				Maximum number of audio cables allowed in each conduit size (Based on 40% fill of EMT)						
Mfr	Type	OD	Area	3/4"	1"	1-1/4"	1-1/2"	2"	2-1/2"	3"
Belden	1351A	0.290	0.066	3	5	9	12	20	35	53
Belden	1502R	0.250	0.049	4	7	12	17	27	48	72
Belden	1694A	0.274	0.059	4	6	10	14	23	40	60
Belden	1696A	0.234	0.043	5	8	14	19	31	54	82
Belden	1700A	0.200	0.031	7	11	19	26	43	75	113
Belden	2412	0.220	0.038	5	9	15	21	35	61	93
Belden	7710A	0.770	0.466	0	1	1	2	3	5	8
Belden	7712A	0.970	0.739	0	0	1	1	2	3	5
Belden	7810A	0.405	0.129	2	3	5	6	10	18	27
Belden	8240	0.193	0.029	7	12	20	28	46	80	121
Belden	8281	0.305	0.073	3	5	8	11	18	32	48
Belden	8444	0.185	0.027	8	13	22	30	50	87	132
Belden	8451	0.138	0.015	14	23	40	54	90	157	237
Belden	8465	0.282	0.062	3	6	10	13	21	38	57
Belden	8467	0.314	0.077	3	4	8	11	17	30	46
Belden	8471	0.274	0.059	4	6	10	14	23	40	60
Belden	8473	0.340	0.091	2	4	7	9	15	26	39
Belden	8477	0.386	0.117	2	3	5	7	11	20	30
Belden	8489	0.257	0.052	4	7	12	16	26	45	68
Belden	8620	0.376	0.111	2	3	5	7	12	21	32
Belden	8734	0.194	0.030	7	12	20	28	45	79	120
Belden	8760	0.222	0.039	6	9	15	21	35	61	91
Belden	9451	0.135	0.014	15	24	42	57	94	164	247
Belden	9460	0.230	0.042	5	8	14	20	32	56	85
Belden	9831	0.330	0.086	2	4	7	9	15	27	41
Belden	9844	0.390	0.119	2	3	5	7	11	20	30
Belden	9941	0.230	0.042	5	8	14	20	32	56	85
Crestron	DM-CBL-NP	0.580	0.264	0	1	2	3	4	8	13
Crestron	DM-CBL-8G-NP	0.244	0.047	4	7	12	17	28	50	75
Trade	#08 THHN	0.216	0.037	6	9	16	22	37	64	97
Trade	#10 THHN	0.164	0.021	10	16	28	39	64	111	168
Trade	#12 THHN	0.130	0.013	16	26	45	61	101	177	267
Trade	#14 THHN	0.111	0.010	22	36	62	84	139	242	366

Note: Minimum conduit size allowed for audio cables is 3/4 inch.

END OF SECTION

SECTION 260553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Nameplates.
 - 2. Labels.
 - 3. Wire markers.
 - 4. Conduit markers.
 - 5. Stencils.
 - 6. Warning Signs and Labels.
 - 7. Underground Warning Tape.
 - 8. Misc. Identification Products.
- B. Related Sections:
 - 1. Section 09 90 00 - Painting and Coating: Execution requirements for painting specified by this section.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures Submittal procedures.
- B. Product Data:
 - 1. Submit manufacturer's catalog literature for each product required.
 - 2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.
- C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.
- D. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of tagged devices; include tag numbers.

1.6 COORDINATION

- A. Coordinate identification names, abbreviations, colors and other features with requirements of other Sections requiring identification. Use consistent designations throughout the project.
- B. Coordinate installation of identification application with completion of covering and painting of surfaces where identification is to be applied.

- C. Install identification before installation of acoustical ceilings and similar concealment.

1.7 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept identification products on site in original containers. Inspect for damage.
- C. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- D. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Install nameplates only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

PART 2 PRODUCTS

2.1 NAMEPLATES

- A. Manufacturers:
 - 1. Seton.
 - 2. Brady.
 - 3. Ideal Industries
 - 4. Substitutions: Section 01 60 00 - Product Requirements. Product Description: Laminated three-layer plastic with engraved black letters on white contrasting background color. White letters on Red background for emergency equipment.

- B. Product Description: Laminated three-layer plastic with engraved white letters on black contrasting background color.
- C. Letter Size:
 - 1. 1/8 inch high letters for identifying individual equipment and loads.
 - 2. 1/4 inch high letters for identifying grouped equipment and loads.
- D. Minimum nameplate thickness: 1/8 inch.

2.2 EQUIPMENT LABELS

- A. Manufacturers:
 - 1. Seton.
 - 2. Brady.
 - 3. Ideal Industries
 - 4. Substitutions: Section 01 60 00 - Product Requirements. Product Description: Laminated three-layer plastic with engraved black letters on white contrasting background color. White letters on Red background for emergency equipment.

2.3 WARNING LABELS AND SIGNS

- A. Manufacturers:
 - 1. Seton.
 - 2. Brady.
 - 3. Ideal Industries
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Comply with NFPA 70 and OSHA 29 CFR 1910.145.
- C. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated. Use for interior applications.
- D. Baked-enamel Warning Signs:
 - 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend and size required for application.
 - 2. ¼ inch grommets in corners for mounting.
 - 3. Use for exterior applications.

2.4 WIRE MARKERS

- A. Manufacturers:
 - 1. Seton.
 - 2. Brady.
 - 3. Ideal Industries

2.5 CONDUIT AND RACEWAY MARKERS

A. Manufacturers:

1. Seton.
2. Brady.
3. Ideal Industries

B. Legend:

1. 208 Volt System: 208 VOLTS.
2. 480 Volt System: 480 VOLTS
3. Emergency Power Systems: Emergency (with voltage following "Emergency")
4. Standby Power Systems: Standby (with voltage following standby).
5. Telephone System: Telephone
6. Voice/Data Systems: Voice/Data
7. Security System: Security
8. Audiovisual System: AV

2.6 UNDERGROUND WARNING TAPE

A. Manufacturers:

1. Seton.
2. Brady.
3. Ideal Industries
4. Substitutions: Section 01 60 00 - Product Requirements. Description: 4 inch wide plastic tape, detectable type, colored yellow with suitable warning legend describing buried electrical lines.

2.7 DEVICE IDENTIFICATION

A. Service Equipment:

1. Labeling:
 - a. Indicate the maximum available fault current at the equipment, including the date the fault current calculation was performed. Label shall include warning for "Arc Flash Hazard" and requirement for "PPE protection".
 - b. Indicate Equipment designation.
2. Identification:
 - a. Permanent directory at the service and utility meters indicating the location and feeders for:
 - 1) Generator and automatic transfer switches indicating emergency and standby power sources.
 - 2) Fire Pump controller and disconnecting means locations and power source.

B. Fire Pump:

1. Fire Pump Controller Identification:
 - a. Indicate power supply origins (service and generator) of sources feeding the controller and jockey pump.
 - b. Indicate location and feeders of remote disconnecting means.

2. Fire Pump Remote Disconnecting Means identification:
 - a. Indicate equipment name.
 - b. Indicate power supply origins (service and generator) of sources feeding the fire pump controller.
 - c. Indicate location of the fire pump controller.
- C. Panelboards:
 1. Labeling:
 - a. Indicate power supply origin (panelboard or transformer) of source feeding the panelboard.
 - b. Indicate Panelboard designation.
- D. Roof Top HVAC Equipment Disconnects:
 1. Labeling:
 - a. Indicate equipment name.
 - b. Indicate source panel and circuit number.
- E. Receptacles:
 1. Labeling:
 - a. Indicate source panel and circuit number at each cover plate.
 - b. Cover plates shall be labeled with information indicated above using a permanent label.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Install identifying devices after completion of painting.
- B. Nameplate Installation:
 1. Install nameplate parallel to equipment lines.
 2. Install nameplate for each interior electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners, or adhesive.
 3. Install nameplates for each interior control panel and major control components located outside panel with corrosive-resistant mechanical fasteners.
 4. Install nameplates for each exterior control panel and equipment enclosure to equipment front using corrosive-resistant fasteners or rivets.
 5. Secure nameplate to inside surface of door on recessed panelboard in finished locations.
 6. Install nameplates for the following:
 - a. Switchboards.
 - b. Panelboards.
 - c. Transformers.
 - d. Disconnects.

- e. Transfer Switches.
 - f. Motor Starters.
 - g. Control Panels.
- C. Label Installation:
- 1. Install label parallel to equipment lines.
 - 2. Install label for identification of individual control device stations.
 - 3. Install labels for permanent adhesion and seal with clear lacquer.
- D. Wire Marker Installation:
- 1. Install wire marker for each conductor at panelboard gutters, pull boxes and junction boxes.
 - 2. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.
 - 3. Install labels at data outlets identifying patch panel and port designation.
- E. Underground Warning Tape Installation:
- 1. Install underground warning tape along length of each underground conduit, raceway, or cable 6 to 8 inches below finished grade, directly above buried conduit, raceway, or cable.

END OF SECTION

SECTION 260573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes electrical connections to equipment.
- B. Related Sections:
 - 1. Section 26 05 19 – Building Wire and Cable.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 SECTION INCLUDES

- A. Performance requirements for overcurrent protective devices.
- B. Short circuit study.
- C. Coordination study and analysis.

1.5 RELATED REQUIREMENTS

- A. Section 26 24 13 - Switchboards: Overcurrent protective devices in switchboards.
- B. Section 26 24 16 - Panelboards: Overcurrent protective devices in panelboards.

1.6 REFERENCE STANDARDS

- A. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems; 2001.
- B. IEEE 399 - IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis; 1997.
- C. NFPA 70 - National Electrical Code; 2011.

1.7 SUBMITTALS

- A. See Section 01 31 00 - Project Management, Coordination and Commissioning: for submittal procedures.
- B. Study Preparer's Qualifications.
- C. Study Report: Submit protective device studies as specified, prior to submission of product data submittals or ordering or fabrication of protective devices.
 - 1. Evaluation of product data submittals by Engineer will not commence until acceptable preliminary studies in sufficient detail to ensure that device selection will be adequate have been submitted.
 - 2. Include stamp or seal and signature of preparing engineer.
- D. Product Data: In addition to submittals specified elsewhere, submit manufacturer's time-current curves for all protective devices.
- E. Field Engineer Qualifications.
- F. Field Inspection Report: Show final adjusted settings of protective devices.
- G. Certificates: Prior to final inspection, certify that field adjustable protective devices have been set in accordance with requirements of protective device analysis.
- H. Project Record Documents: Revise protective device study as required to show as-built conditions.
 - 1. Submit not less than 60 days prior to final inspection of electrical system.
 - 2. Include hard copies in operation and maintenance data submittals.
 - 3. Include all files prepared using software packages, on CD-ROM, with file name cross-references to specific pieces of equipment and systems.

- I. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.8 PROTECTIVE DEVICE STUDY

- A. Analyze the specific electrical and utilization equipment (according to NEC definition), the actual protective devices to be used, and the actual feeder lengths to be installed.
1. Scope of Studies: All new emergency distribution wiring and equipment, from primary source (including generator) to transfer switches, buses and emergency branch circuit panelboards.
 2. Primary Source, for Purposes of Studies: Utility company primary protective devices.
 3. Study Methodology: Comply with requirements and recommendations of NFPA 70, IEEE 399, and IEEE 242.
 4. Report: State the methodology and rationale employed in making each type of calculation; identify computer software package(s) used.
- B. One-Line Diagrams: Prepare schematic drawing of the emergency electrical distribution system, with all electrical equipment and wiring to be protected by the protective devices; identify nodes on the diagrams for reference on report that includes:
1. Calculated fault impedance, X/R ratios, utility contribution, and short circuit values (asymmetric and symmetric) at the main switchboard bus and all downstream devices containing protective devices.
 2. Breaker and fuse ratings.
 3. Transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
 4. Identification of each bus, with voltage.

5. Conduit materials, feeder sizes, actual lengths, and X/R ratios.
- C. Short Circuit Study: Calculate the fault impedance to determine available 3-phase short circuit and ground fault currents at each bus and piece of equipment during normal conditions, alternate operations, emergency power conditions, and other operations that could result in maximum fault conditions.
1. Show fault currents available at key points in the system down to a fault current of 7,000 A at 480 V and 208 V.
 2. Include motor contributions in determining the momentary and interrupting ratings of the protective devices.
 3. Primary Fault Level Assumptions: Obtain data from utility company.
 4. Report: Include all pertinent data used in calculations and for each device include:
 - a. Device identification.
 - b. Operating voltage.
 - c. Protective device.
 - d. Device rating.
 - e. Calculated short circuit current, asymmetrical and symmetrical, and ground fault current.
- D. Coordination Study: Perform an organized time-current analysis of each protective device in series from the individual device back to the primary source, under normal conditions, alternate operations, and emergency power conditions.
1. Graphically illustrate that adequate time separation exists between series devices, including upstream primary device.
 2. Plot the specific time-current characteristics of each protective device on log-log paper.
 3. Organize plots so that all upstream devices are clearly depicted on one sheet.
 4. Also show the following on curve plot sheets:
 - a. Device identification.
 - b. Voltage and current transformer ratios for curves.
 - c. 3-phase and 1-phase ANSI damage curves for each transformer.
 - d. No-damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum short circuit cutoff point.
 - h. Simple one-line diagram for the portion of the system that each curve plot illustrates.
 - i. Software report for each curve plot, labeled for identification.
- E. Analysis: Determine ratings and settings of protective devices to minimize damage caused by a fault and so that the protective device closest to the fault will open first.
1. Required Ratings and Settings: Derive required ratings and settings of protective devices in consideration of upstream protective device settings and optimize system to ensure selective coordination.
 2. Identify any equipment that is underrated.
 3. Identify specified protective devices will not achieve required protection or coordination but with minor changes can be made to do so; provide such modified devices at no additional cost and identify them on submittals as "revised in accordance with Protective Device Coordination Study"; minor

- changes include different trip sizes in the same frame, time curve characteristics of induction relays, CT ranges, etc.
4. Identify specified protective devices that will not achieve required protection or coordination and cannot be field adjusted to do so, and for which adequate devices would involve a change to the contract sum.
 5. In all cases where adequate protection or coordination cannot be achieved at no extra cost, provide a discussion of alternatives and logical compromises for best achievable coordination.
- F. Protective Device Rating and Setting Chart: Summarize in tabular format the required characteristics for each protective device based on the analysis; include:
1. Device identification.
 2. Relay CT ratios, tap, time dial, and instantaneous pickup.
 3. Circuit breaker sensor rating, long-time, short-time, and instantaneous settings, and time bands.
 4. Fuse rating and type.
 5. Ground fault pickup and time delay.
 6. Input level and expected response time at two test points that are compatible with commonly available test equipment and the ratings of the protective device.
 7. Highlight all devices that as furnished by Contractor will not achieve required protection.

1.9 QUALITY ASSURANCE

- A. Study Preparer Qualifications: Electrical testing agency regularly engaged in short circuit and coordination studies, with at least 5 years experience in work of this type, and employing professional electrical engineer licensed in the State of Connecticut to perform the studies.
- B. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.
- C. Contractor Responsibility: Provide all project-related data needed by study preparer, including equipment, wire sizes, insulation types, conduit types, and actual circuit lengths.
- D. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

PART 2 PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
 - 1. CGI CYME.
 - 2. EDSA Micro Corporation.
 - 3. ESA Inc.
 - 4. Operation Technology, Inc.
 - 5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

2.3 PROTECTIVE DEVICES

- A. Provide protective devices of ratings and settings as required so that the protective device closest to the fault will open first.
- B. In addition to requirements specified elsewhere, provide overcurrent protective devices having ratings and settings in accordance with results of this analysis.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance.
 - 1. Proceed with coordination study only after relevant equipment submittals have been assembled.

3.2 FIELD QUALITY CONTROL

- A. Provide the services of a qualified field engineer and necessary tools and equipment to test, calibrate, and adjust the installed protective devices to conform to requirements determined by the coordination analysis.

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- B. Adjust installed protective devices having adjustable settings to conform to requirements determined by the coordination analysis.
- C. Submit report showing final adjusted settings of all protective devices.
- D. Results of the above shall be documented in writing and provided within the O&M manuals and to the CX agent as part of the closeout.

END OF SECTION

SECTION 260800 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. OPR and BoD documentation are included by reference for information only.

1.2 SUMMARY

- A. This Section includes general requirements that apply to implementation of the commissioning process without regard to specific systems, assemblies, and components.
- B. Related Sections include the following:
 - 1. Division 01 Section 019113 General Commissioning Requirements for general commissioning process activities.
 - 2. Division 23 HVAC
 - 3. Division 26 Electrical

1.3 DEFINITIONS

- A. Commissioning Plan: A document, prepared by CxA, that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. Quality Assurance: A program for the systematic monitoring and evaluation of the various aspects of a system, assembly, or component to ensure that standards of quality are being met. This is the responsibility of the CxA.
- D. Quality Control: A system for ensuring the maintenance of proper standards in systems, assemblies, and components. This is the responsibility of the Contractor.
- E. Official: State or Local official having jurisdiction over the conveying systems
- F. Systems, Assemblies, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, equipment, and components.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION CHECKLISTS

- A. The CxA shall provide Construction Checklists to the Contractors for execution that will indicate expected Quality Control features required for a highest-quality installation. The contractor shall complete the checklists as construction progresses and return them to the CxA as indicated in Section 019113 General Commissioning Requirements.
- B. Checklists for this section will include:
 - 1. Lighting and lighting control systems
 - 2. Emergency power system
- C. A sample installation checklist is included to show the typical scope and rigor of the process.

3.2 PREREQUISITES TO TESTING

- A. Prior to the testing of these systems or assemblies, the Contractor shall certify that:
 - 1. The system or assembly is completely installed and functional
 - 2. Work performed by other trades, but essential for this system or assembly's operation, is complete (e.g., electrical components are wired and power is provided)
 - 3. All contractor-performed start-up procedures and Pre-Functional Tests are complete.
 - 4. The system or assembly is ready for the Owner to take beneficial use.

3.3 SYSTEM OR ASSEMBLY TEST REQUIREMENTS

- A. The CxA will provide Functional Performance Test procedures to the Contractor for execution for the following specific systems, assemblies, and components:
 - 1. Lighting and lighting control systems
 - 2. Emergency power system
- B. Acceptance criteria and test details will be in accordance with the related sections including the following:
 - 1. Division 01 Section 019113 General Commissioning Requirements for general commissioning process activities.
 - 2. Division 26 Electrical
- C. A sample functional performance test is included to show the typical scope and rigor of the process.

3.4 TEST REPORTS

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- A. Provide copies of all reports required in the listed reference sections (see Section 1.2 SUMMARY above for the sections) for review.

3.5 SAMPLE FORMS

**Sample Installation Checklist
Panelboards**

Complete for each Panelboard
Panelboard ID# from drawings:
Reference Specification:

Model Verification

	Specified	Submitted	Installed
Manufacturer	Eaton-Cutler Hammer, General Electric, Square D Co., Siemens		
Model Number			
Serial Number	N/A	N/A	
Capacity			

Installation Checks

ID	Description	Pass	Fail	Notes
1.	Panelboards have hinged front cover, entire front trim hinged to box and standard door within hinged trim cover.	<input type="checkbox"/>	<input type="checkbox"/>	
2.	Directory card with transparent protective cover mounted inside panel door.	<input type="checkbox"/>	<input type="checkbox"/>	
3.	Panelboards shown with a neutral shall have a full size insulated neutral bar installed	<input type="checkbox"/>	<input type="checkbox"/>	
4.	Panelboards shall have bolt on Circuit breakers.	<input type="checkbox"/>	<input type="checkbox"/>	
5.	Distribution panelboards shall have main circuit breakers; breakers larger than 600 amps shall be bolt on and shall be microprocessor based with true RMS sensing trip units.	<input type="checkbox"/>	<input type="checkbox"/>	
6.	Panelboards are installed such that the highest breaker handle is not more than 6'6" AFF.	<input type="checkbox"/>	<input type="checkbox"/>	
7.	Typewritten directory of panelboard loads including circuit number, equipment served, and room number.	<input type="checkbox"/>	<input type="checkbox"/>	
8.	Panelboard identification with plastic laminated nameplate (white with black lettering) mounted to panel with screws. Nametag to indicate panel name, amperage, voltage, phase and panel fed from.	<input type="checkbox"/>	<input type="checkbox"/>	
9.	Verify equipment is clean and free from damage.	<input type="checkbox"/>	<input type="checkbox"/>	
10.	Verify Panelboard is size and voltage as specified in contract documents, including breaker quantities and sizes.	<input type="checkbox"/>	<input type="checkbox"/>	
11.	Verify panelboard is installed to provide all working space requirements and clearances per NEC and local codes.	<input type="checkbox"/>	<input type="checkbox"/>	
12.	Verify that no piping, ductwork, or other equipment foreign to the electrical trade passes through the area extending from the floor to the structural ceiling with the width and depth equal to the panel and extending additional 6" on either side.	<input type="checkbox"/>	<input type="checkbox"/>	
13.	Panelboards that are part of the emergency distribution system are installed in space fully protected by an approved automatic fire suppression system or installed in space with a (1) one hour fire rating.	<input type="checkbox"/>	<input type="checkbox"/>	

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Approvals (only one required)

	Name (printed neatly)	Signature	Date
Manufacturer Representative			
Construction Administrator			
Commissioning Agent			

Sample Functional Performance Test
Switchboard MDP

1. Participants

<u>Name/Representing</u>	<u>Participation (Testing, Witness, etc)</u>
/	
/	
/	

Party filling out this form _____ Date of test _____

2. Prerequisite Checklist

(Y/N) Factory testing results by the switchboard manufacturer have been provided for testing the ground fault protection system for circuit testing and verification of the tripping of the ground fault relays and also include polarity verification of the interconnection of the ground fault sensor circuits.

(Y/N) Field test reports have been provided for switchboard start up and testing and includes test procedure used and test results that comply with testing requirements. Included with the electrical contractors field start up and installation testing for the switchboard verify the ground fault protection system has been field tested and the test result have been provided.

(Y/N) A short circuit and protection coordination study has been provided and the switchboard protective relays and breakers settings have been adjusted per the study recommendations.

(Y/N) The electrical contractor has certified that their internal commissioning is complete and the project is ready for third-party verification. EC initials: _ _ . Date: _ _ .

(Y/N) The general contractor has certified that the construction is substantially complete and ready for third-party verification. GC initials: _ _ . Date: _ _ .

3. Notes

4. Functional Testing Record:

Perform a visual verification of installed Switchboard # MDP

Seq. ID	Switchboard Location	Test Procedure (including special conditions)	Expected Response	Pass Y/N	Notes
1.		Verify switchboard is installed on 4" concrete pad.)	Concrete curb installed	Y / N	

Seq. ID	Switchboard Location	Test Procedure (including special conditions)	Expected Response	Pass Y/N	Notes
2.		Verify operation of digital metering monitor: view the following : <ol style="list-style-type: none"> 1. Phase currents (each phase) 2. Ph-PH voltages (3ph) 3. Ph-Neutral voltages (3ph) 4. Frequency 	All values indicated on monitor display screen.	Y / N	
3.		Verify Switchboard identifications, all switchboard compartments to have nameplate identifications.	Nameplates installed	Y / N	
4.		Operate selective circuit breakers and verify correct operations.	Circuits breaker operated open/closed	Y / N	
5.		Verify circuit breakers with adjustable trip units are adjusted per the coordination study results (compare with study results).	Circuit breaker trip units match study.	Y / N	
6.		Verify switchboard is installed with quantity and sizes of breakers as indicated in the contract documents.	Circuit breakers installed per design.	Y / N	

-- END OF TEST --

END OF SECTION 260800

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Contactors.
 - 2. Switches.
 - 3. Switch plates.
 - 4. Occupancy sensors.
 - 5. Photocells.
 - 6. Photocell control unit.
 - 7. Classroom dimming control systems.

- B. Related Sections:
 - 1. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections specified by this section.
 - 2. Section 26 05 19 – Building Wire and Cable.
 - 3. Section 26 05 33 - Raceway and Boxes for Electrical Systems: Product requirements for raceway and boxes for placement by this section.
 - 4. Section 26 05 53 - Identification for Electrical Systems: Product requirements for electrical identification items for placement by this section.
 - 5. Section 26 27 26 - Wiring Devices: Product requirements for wiring devices for placement by this section.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit manufacturer's standard product data for each system component.
- C. Manufacturer's Installation Instructions: Submit for each system component.
- D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
- E. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record the following information:
 - 1. Actual locations of components and record circuiting and switching arrangements.
 - 2. Wiring diagrams reflecting field installed conditions with identified and numbered system components and devices.

- C. Sustainable Design Closeout Documentation
 - 1. Lighting Control System Manufacturer to provide Enhanced Start-up documentation that details the start-up procedure being performed including a process to follow, details on tests performed and an area that documents any test results.
- D. Operation and Maintenance Data:
 - 1. Submit replacement parts numbers.
 - 2. Submit manufacturer's published installation instructions and operating instructions.
 - 3. Recommended renewal parts list.

1.6 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.7 QUALIFICATIONS

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

1.8 COORDINATION

- A. Section 01 30 00 - Administrative Requirements Coordination and project conditions.
- B. Carefully review lighting control details and diagrams in the contract drawings to determine control zones, switching, dimming and override capabilities.
- C. Where details and wiring diagrams are shown as typical for spaces: coordinate control zones, daylight zones, switch locations, sensor locations with room furniture, layout and daylight fenestrations to achieve design intent.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept components on site in manufacturer's packaging. Inspect for damage.

- C. Protect components by storing in manufacturer's containers indoor protected from weather.

1.10 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
- B. Furnish five year manufacturer warranty for components.

1.11 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for extra materials.
- B. Furnish six of each switch type.
- C. Furnish six of each occupancy sensor type.
- D. Furnish two of each photocell type.

PART 2 PRODUCTS

2.1 LIGHTING CONTACTORS

- A. Manufacturers:
 - 1. Automatic Switch Co.
 - 2. Cutler-Hammer.
 - 3. Square D Model.
 - 4. Siemens.
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: NEMA ICS 2, magnetic lighting contactor.
- C. Configuration: Electrically or mechanically held, 2 wire control, as indicated on drawings.
- D. Coil Operating Voltage: as indicated on drawings.
- E. Poles: To match circuit configuration and control function with spare poles as indicated on drawings.
- F. Contact Rating: Conductor overcurrent protection, considering derating for continuous loads.
- G. Accessories:
 - 1. Cover Mounted Pilot Devices: NEMA ICS 5, heavy-duty.
 - 2. Selector Switch: ON/OFF/AUTOMATIC function, with rotary action.
 - 3. Auxiliary Contacts: Two field convertible in addition to seal-in contact.
 - 4. Relays: NEMA ICS 2.

5. Control Power Transformers: Furnish fused primary and secondary, and bond unfused leg of secondary to enclosure.
- H. Enclosure: NEMA ICS 6, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
 1. Interior Dry Locations: Type 1.
 2. Exterior Locations: Type 3R.

2.2 SWITCHES

- A. Manufacturers:
 1. Hubbell Incorporated
 2. Leviton Manufacturing Co., Inc.
 3. Pass and Seymour/Legrand
 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Specification Grade, toggle switch rated 120/277V 20A minimum.
 1. Material: Plastic.
 2. Color: By Architect.
- C. Key Switch: Spade key type. Match non-key switch ratings.

2.3 SWITCH PLATES

- A. Manufacturers:
 1. Hubbell Incorporated.
 2. Leviton Manufacturing Co., Inc.
 3. Pass and Seymour/Legrand.
 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Specification Grade.
 1. Material: Stainless steel.

2.4 OCCUPANCY AND DAYLIGHT SENSORS

- A. Manufacturers:
 1. As indicated on Symbol list and as indicated in plan details.
 2. Substitutions: Section 01 60 00 - Product Requirements.
- B. Separate sensitivity and time delay adjustments with LED indication of sensed movement. User adjustable time-delay: 30 seconds to 12 minutes.
- C. Furnish with manual override.
- D. Provide vacancy sensor operation where indicated.
- E. Operation: Silent.
- F. Room Sensors: As indicated on Drawings.

2.5 ROOM CONTROLLERS

- A. Refer to riser diagrams and details on drawings for types, configurations, level of quality and performance requirements.

2.6 LIGHTING CONTROL RELAY PANELS

- A. Refer to riser diagrams and details on drawings for types, configurations, level of quality and performance requirements.
- B. Install a lighting control system consisting of relay panel(s), control switches, and other controlling devices. The devices are connected by low voltage and line voltage wiring. The general operation of lighting and controlled loads shall include:
 - 1. Interior lighting: Manual switch and on/off with automatic time scheduled shut off.
 - 2. Scheduled on/off loads: Time on, time off by automatic time schedule with after hour override capability, blink warning and shutoff.
 - 3. Time clock control: Astronomic on/time off, time on/astronomic off, photocell on/time clock off.

2.7 PHOTOCELLS

- A. Manufacturers:
 - 1. Tork
 - 2. AMF
 - 3. Hubbell.
 - 4. LC&D
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. General: Consist of sensor mounted as indicated on Drawings with adjustable photo eye. Device shall be mounted to rigid conduit and face north orientation. Sensor shall be 120V rated and shall control exterior lighting in concert with time clock, via contactor coil.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Mount switches, occupancy sensors and photocells as indicated on Drawings.
- B. Install wiring in accordance with Section 26 05 19.
- C. Use only properly color coded, stranded wire. Install wire sizes as indicated on Drawings. Install wire in conduit in accordance with Section 26 05 33.
- D. Identify power wiring with circuit breaker number controlling load. When multiple circuit breaker panels are feeding into relay panel, label wires to indicate originating panel designation.

- E. Define each dimmer's load type, shade settings, and set control functions.
- F. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.
- G. Ensure that daylight sensor placement minimizes sensors view of electric light sources; ceiling mounted and fixture-mounted daylight sensors shall not have direct view of luminaries.
- H. Systems Integration:
 - 1. Equipment Integration Meeting:
 - a. Facility Representative to coordinate meeting between Facility Representative, Systems Integrator, Lighting Control System Manufacturer and other related equipment manufacturers to discuss equipment and integration procedures prior to system startup

3.2 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.
- B. Test each system component after installation to verify proper operation.
- C. Test relays and switches after installation to confirm proper operation.
- D. Confirm correct loads are recorded on directory card in each panel.
- E. Adjust time delay to 'off' for 20 minutes maximum.
- F. Set point for daylight sensors to be set at 40 fc.
- G. Lighting control relay panels - Furnish services for minimum of one day for check, test, and start-up. Perform the following services:
 - 1. Test operation of remote controlled devices.
 - a. Simulate dark conditions and verify proper operation of contactors and exterior fixtures controlled.
 - b. Simulate shut-off times for interior lighting and verify proper operation of override switches and "blink" warnings.
 - 2. Repair or replace defective components.
- H. Test relays and switches after installation to confirm proper operation.
- I. Confirm correct loads are recorded on directory card in each panel.

3.3 DEMONSTRATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

- B. Demonstrate operation of the following system components:
 - 1. Operation of switches.
 - 2. Operation of each type of occupancy sensor and daylight controls.
 - 3. Operation of photocell.

- C. Furnish 1 day on-site system training to instruct Owner's personnel in operation and maintenance of system. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

3.4 CLOSEOUT ACTIVITIES

- A. On-site Walkthrough:
 - 1. Lighting Control System Manufacturer to provide a factory certified Field Service Engineer to demonstrate system functionality of the system prior to on-site training.

- B. Contractor shall provide system documentation after the equipment has been installed including:
 - 1. Lighting control relay panel operational summary sheet.
 - 2. Lighting control relay panel programming record sheet.

END OF SECTION

SECTION 260953 – STAGE LIGHTING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. All work of this section shall comply with the requirements of all other sections of the Project, and with all Drawings and all other Contract Documents, including all Addenda.

1.2 MODIFICATIONS TO GENERAL CONDITIONS

- A. Where any requirements of this section modify, change or add to any part of the Project Specifications, the remaining, unaltered provisions of that part of that section shall remain in effect. Where any requirement of this section and any requirement of Project Specification conflict, the most rigorous provision shall apply.

1.3 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include complying with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Construction Services / Bureau of School Facilities' High Performance School Construction Bulletin, November 2012.

1.4 DEFINITIONS

- A. "Owner" as used in this section means the representative of the Branford Public Schools.
- B. "Contractor" as used in this section refers to that subcontractor directly responsible for supply of the Stage Lighting System.
- C. "Electrical Contractor" or "EC" as used in this section refers to the contractor responsible for supply and installation of all electrical wiring, conduit, fasteners, terminations and labor for the Project.
- D. "Project" as used in this section refers to the renovations/new construction to Francis Walsh Intermediate School, including, but not limited to the work described in this section.
- E. "Consultant" as used in this section refers to THEATER DESIGN INC.

- F. "Architect" as used in this section refers to ANTINOZZI ASSOCIATES.
- G. "Electrical Engineer" as used in this section refers to Consulting Engineering Services.
- H. "Construction Manager" as used in this section refers to the contractor responsible for the construction of the Project.
- I. "Supply" as used in this section means, "to supply, complete with instruction for installation (installation by others)".
- J. "Provide" as used in this section means "supply, install and make operable".
- K. "NIC" as used in this section and on the contract drawings means "not included in this subcontract, not to be supplied".
- L. "By Others" as used in this section and on the contract drawings means "not included in this subcontract, supplied as part of another subcontract".
- M. "Or As Approved" as used in this section and on the contract drawings means "substitution only after written approval by Consultant.

1.5 SCOPE OF WORK

- A. All equipment shall perform as specified in each part of this section when installed on site. All details of this section apply to completed work on site. Failure to meet any requirement of this section on site shall be deemed sufficient cause for rejection of equipment.
- B. Examine all sections of Project Specifications and determine their relationship to the work of this section. Provide all products, and execute all work, of this section in accordance with applicable requirements of the Project Specification to provide an interrelated electrical system.

1.6 QUANTITIES

- A. In case of a discrepancy in the quantities within this specification or between this specification and the bid drawings, the larger quantity shall prevail.
- B. Should any quantities identified in the specification be insufficient to meet the design intent of the specification, the bidder shall bring this fact to the attention of the Architect and Consultant.
- C. High Performance Building Requirements:
 - 1. Adhesives or sealants used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113 "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Submittal Requirements of this Section.

3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Submittal Requirements of this Section.

1.7 WORK INCLUDED IN THIS SECTION

- A. Supply all Stage Lighting System components including: relay racks, emergency transfer devices, dimmer banks, all dimmer modules and electronics as specified herein.
- B. Supply all Stage Lighting System network racks, including all devices required to allow operation of the system.
- C. Coordination with electrical contractor and other trades as may be required.
- D. Supply all Stage Lighting System control systems including: control consoles, control accessories and video accessories; stage lighting control systems; and all control panels and pendants as specified herein.
- E. Supply all Stage Lighting System distribution devices including: control outlet panels, plugging box panel faces, multi-circuit cables, and multi-cable junction as specified herein.
- F. Supply of all back boxes for Stage Lighting System panels and devices.
- G. Supply all Stage Lighting fixtures as specified.
- H. Supply site inspection reports and installation instructions as specified.
- I. Factory testing, engineering checkout, field-testing, and completion checkout as specified.
- J. Supply "as built" drawings, guarantee and warranty, operations manuals, instruction, and software updates as specified.
- K. High Performance Building Requirements:
 1. Adhesives or sealants used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113 "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Submittal Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Submittal Requirements of this Section.

1.8 RELATED WORK BY ELECTRICAL CONTRACTOR

- A. The work of the Electrical Contractor shall specifically include, but not be limited to, all of the following:
 1. Receipt and installation of Stage Lighting System

2. Electrical service from power mains through fused safety switches, to primary terminals of dimmer racks.
3. Emergency power supply, distribution and protection, except as noted.
4. Placement and installation of equipment, except as noted herein.
5. All materials (conduit, wire and junction boxes) and labor
6. Assembly and installation of stage lighting fixtures and accessories as directed by Owner's representative.
7. All wire terminations for:
 - a. 120-volt power wiring into the Stage Lighting dimmer bank
 - b. 120-volt, branch circuit, load wiring from the dimmer bank to all of the distribution devices and/or branch circuits or fixtures
 - c. Architectural lighting fixtures
 - d. Any architectural lighting control systems that are not part of the Stage Lighting system
 - e. Work lighting fixtures, receptacles, and local low voltage switches

1.9 RELATED WORK BY OTHERS

- A. Dimmer room and control room furnishings and finishes.
- B. Control room glazing.
- C. Architectural lighting
- D. Equipment painting and finishing, except as noted.
- E. Auditorium light pipe

1.10 RESPONSIBILITIES

- A. All work of this Section shall be furnished under a single subcontract and be the responsibility of a single Stage Lighting Systems contractor, except where specifically assigned to the Electrical Contractor (EC).
- B. Make any and all alterations to standard design and construction of any equipment necessary to meet any and all requirements of this Section.
- C. The Stage Lighting System Contract Documents describe performance attributes of systems to be provided, including means of operation and control, dimensions and profiles, and visual appearances. Assume all responsibility for engineering of systems described, including modification of and addition to any details as required fulfilling the design intent of Stage Lighting Contract Documents.

- D. Provide timely inspection, and instruction to the Electrical Contractor to ensure proper installation of all elements of Stage Lighting System. This paragraph also includes any elements noted on the Stage Lighting Contract Documents (as "NIC.") for installation at a later date.
- E. Omissions and/or errors within Stage Lighting Contract Documents shall not relieve the Electrical Contractor of the responsibility for providing a properly functioning installation of the Stage Lighting System as described.
- F. Correct or replace, at no cost to Owner, any system or part of system found not meeting specifications at time of Completion Checkout, or any time during warranty period.
- G. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.11 QUALIFICATIONS

- A. The Contractor shall be the exclusive designer and engineer of all electronic dimming and control equipment. The Contractor shall provide the following information as part of their bid package:
 - 1. List of not less than five projects of similar size and scope completed within the five years on which Contractor has provided full services: product engineering, shop drawings, manufacture, commissioning and training. In each instance, indicate specifics of scope of fabrication and installation. Include a contact list: name, address and phone numbers of person(s) directly responsible for operation and maintenance of equipment in each facility.
 - 2. List of representative current projects and approximate contract value. Include list of names, phone numbers and addresses of owner, owner's representatives and architect.

3. For projects described, above, list of names of persons who supervised preparation of shop drawings, manufacture of components, and installation of equipment.
 4. List of names, phone numbers, and addresses of persons who would do project management, product engineering, supervision of shop drawing, supervision of testing and user training for Stage Lighting System should this contract be awarded.
 5. The Contractor shall maintain a full-time field engineering staff.
- B. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.12 LISTED MANUFACTURERS

- A. Only equipment from listed manufacturers will be considered. Listed Stage Lighting Systems manufacturers are:
1. **ETC**
www.etcconnect.com
- B. Bids from listed Stage Lighting Systems Integrators, or their authorized agents, must be submitted with all of the information listed under Bid Submittals.

1.13 REVIEW AND INTERPRETATION DURING BIDDING

- A. Submit any questions or comments as directed in the General Conditions to the parties indicated.
- B. Notify Architect, Electrical Engineer and Consultant of any omissions, discrepancies or ambiguities in the Stage Lighting contract documents so a clarification may be issued. Notify Architect, Engineer and Consultant if exception is taken to any statement, indication or criterion in this specification section
- C. Obtain all other contract documents, including architectural, structural, mechanical and electrical, and check to ensure there are no conflicts with work of this section. Notify Architect, Electrical Engineer and Consultant of all such conflicts, with any suggested alterations to resolve conflicts.
- D. Submit all above notifications in writing to Architect and Consultant no less than 14 days prior bid opening date. Lack of notification shall be understood to indicate acceptance of all requirements of the Stage Lighting contract documents.
- E. Interpretations or corrections to the Stage Lighting contract documents shall be issued by Addendum. Interpretations or corrections given by any other method will not be binding.

1.14 SUBSTITUTIONS

- A. Substitutions in this specification section and on the Stage Lighting contract drawings will only be considered where noted "Or As Approved." Submit requests for approval of substitutions in writing as noted in the General Conditions and to Consultant no less than 14 days prior to bid opening. Consultant shall be the sole judge of acceptability of substituted items.
- B. Approved substitutions will be listed by Addendum. Substitutions approved by any other method will not be binding.

1.15 CODES AND STANDARDS

- A. Supply materials, components and assemblies that are UL, CE listed and meet all applicable codes, standards, and specifications applying to the work of this section.

1.16 OWNER'S TESTING AGENCY

- A. If any work is required to be specially tested or approved, whether by the Owner's instructions or by any laws, ordinances or any public authority, the Contractor shall give Owner's representative timely notice of its readiness for inspection, and of dates of inspections to be made by other authorities, through General Contractor. Contractor is responsible for time, labor, materials and fees associated with such .

1.17 BID SUBMITTAL

- A. Provide two sets of complete bills of materials as part of the bid proposal. Include a complete list of all distribution apparatus, control panels without electronics, control panels with integral electronics, manual and memory control boards and accessories, dimmer racks, dimmer modules, dimmer electronics, auxiliary equipment, spare parts and custom or special equipment.

- B. List any exceptions taken. Cite specific reference by page and paragraph and briefly describe nature of exception. The absence of this list shall indicate acceptance of all terms of the contract documents.
- C. Include standard catalog cut sheets (with options identified) of all equipment. Note all custom modifications or deviations from those standard cut sheets and specifications.
- D. Bill of materials is for the purpose of evaluating bids only. Architect and Consultant shall use bill of materials and included documents to establish which bids meet specification. Bids not meeting the specification, based upon review of bill of materials, will be rejected. The Bill of Materials, however, shall not be the exclusive determinant of the equipment and services required for performance of the work of this section.

1.18 SCHEDULE OF SHOP DRAWING SUBMITTALS

- A. After award of contract, but prior to beginning work on shop drawings, submit a list of proposed submittals, including a preliminary drawing index and a list of specification-sheets.
- B. Also submit a proposed schedule of submittals, fabrication, and installation work. Architect and Consultant reserve the right to modify or disapprove such a schedule.

1.19 PROJECT MEETING

- A. Meet with Architect and Consultant, at offices of Architect, Consultant or General Contractor, after schedule has been submitted and prior to beginning work on shop drawings. Project manager and project engineer must attend, and be prepared to review schedule and to discuss concepts described in Stage Lighting contract documents and proposed methods of execution of those concepts.

1.20 SHOP DRAWINGS

- A. Supply the number of sets of shop drawings required in Project Specifications, for submittal to Consultant. Provide 1 copy of each cut sheet and equipment manual with each set of shop drawings. Submit all shop drawings as directed for distribution.
- B. Prepare all shop drawings under supervision of a qualified project engineer. Include names and contact telephone numbers of project manager and project engineer with shop drawing package.
- C. Engineer, design and draft all shop drawings to represent actual fabrication and installation drawings and details. Copies or tracings of contract drawings will not be acceptable as shop drawings and shall be rejected.
- D. Submit shop drawings as a package containing all drawings, details, layouts, schedules and schematics necessary to fully explain design features, appearance, fabrication, installation, function and operation of each system completely. Supply a fully referenced index of drawings.
- E. Include the following information and data with shop drawings:
 - 1. Wiring diagrams for all control systems, clearly identifying any changes from the Electrical contract documents.

2. Power supply requirements, clearly identifying any changes from the Electrical contract documents.
 3. Scale floor plans of all dimmer rooms, showing locations of all Stage Lighting System equipment, noting any necessary clearances for cooling or access, and noting acceptable locations for control, power and load conduit entries.
 4. Installation instructions for all items supplied in this section for installation by EC.
 5. Details of all distribution panels and back boxes.
 6. Details of all control panels and back boxes.
 7. Duplicate of bill of materials described above.
 8. Complete detailed list of all spare parts and assemblies.
 9. Specification sheets as may be appropriate.
- F. Shop drawings shall not be reviewed prior to approval of schedule of submittals, or prior to post-tender meeting.
- G. Shop drawing packages that are incomplete will not be reviewed until such time as complete set of relevant drawings, cut sheets and other information is submitted.
- H. Review of shop drawings by Consultant is for conformance with design concept and for conformance with information given in the Stage Lighting contract documents. Nonconformities and errors detected during review shall be noted on shop drawings and returned to Contractor on completion of review. Consultant is not responsible for completeness or accuracy of the Contractor shop drawings. Acceptance of shop drawings including deviations and inconsistencies not detected during review shall not relieve the Contractor from sole responsibility to provide materials and work conforming to the letter and spirit of the Stage Lighting contract documents.
- I. No Stage Lighting equipment shall be manufactured, fabricated, shipped or installed prior to shop drawings being reviewed by Architect, Engineer, General Contractor and Consultant. Only shop drawings returned marked "Reviewed" or "Make Corrections as Noted" may be used by contractor in the work. Correct and resubmit any shop drawings marked "Revise and Resubmit" or "Rejected."
- J. If field dimensions obtained after approval of shop drawings require changes in size, detail or similar considerations, revised shop drawings shall be submitted for review.
- K. All shop drawings shall identify THEATER DESIGN INC, as the theater consultant, along with its website: www.theaterdesigninc.com.

1.21 SAMPLES

- A. Submit all samples identified Project Specifications, or as requested by Consultant. Submit samples identified in this section at the times identified in this section.

1.22 MOCK UPS

- A. Submit samples of all control and panel covers and all labels.
- B. Provide other samples as requested by Consultant.

1.23 INSTALLATION INSTRUCTIONS

- A. Supply installation instructions for all items supplied in this section, as reviewed and approved with the shop drawings, to Electrical Contractor for coordination. Such instructions shall be fully coordinated with trades doing adjoining work and with site conditions. Instructions shall include inter-equipment connection diagrams with terminal designations.

1.24 INSPECTION REPORTS

- A. If conditions exist that are contrary to proper installation of Stage Lighting System, directly inform Electrical Contractor, and Consultant of the discrepancies. Failure to inform Electrical Contractor shall constitute acceptance of installation and place responsibility for any revisions or additions necessary to properly install work of this section with Contractor.

1.25 OPERATIONS MANUALS

- A. Supply five (5) copies of an Operations Manual, in approximately 8-1/2" (205) x 11" (275) 3-ring binders. Where page is larger than 8-1/2" x 11", said page shall be folded to fit within the binder. Each Manual shall contain; a complete description of the system operation, all equipment operating instructions, all equipment schematics, all equipment service manuals, recommended maintenance procedures, all equipment data sheets, all system test data, all warranty information, and all as built drawings. The manuals shall be fully indexed for ease of use.
- B. Use the following outline to organize the Operations Manual:
 - 1. Table of Contents (w/ page reference)
 - 2. List of Illustrations
 - 3. List of Tables
 - 4. Operator Safety Summary
 - 5. Servicing Safety Summary
 - 6. Section 1 - Specification of System
 - a. Introduction
 - b. Description of System(s)
 - c. General Description of Major Elements (including location and function)
 - d. Special Features
 - e. Detailed Description of Contents of Dimmer Racks (custom equipment)
 - f. Accessories
 - g. Operating Conditions
 - 7. Section 2 - Operating Instructions (Manuals and Cut sheets)

- a. Dimmers
 - b. StageLighting Control Console(s)
 - c. Stage Lighting Control Network(s)
 - d. Stage Lighting Accessories
 - e. StageLighting Control
 - f. Work Lighting Control
8. Section 3 - Maintenance
- a. Static Sensitive Components
 - b. Preventive Maintenance
 - c. Trouble Shooting
 - d. Corrective Maintenance
 - e. Introduction
 - f. Maintenance Precautions
 - g. Obtaining Replacement Parts
 - h. List of Spare Parts
 - i. Service Calls
 - j. Shipping Back to Manufacturer
9. Section 4 - Manufacturer Information
- a. Contact Addresses and Telephone Numbers
 - b. Sales and Service Offices and Hours of Operation
 - c. Contact Addresses and Telephone Numbers for Equipment from Other Manufacturers:
 - 1). Multi-pin Connectors
 - 2). Video Amplifiers
 - 3). Printers
 - 4). Monitors
 - 5). Switches
 - 6). Other
10. Section 5 - Warranty (include complete document)
11. Section 6 –As Built Drawings (11x1).
12. Section 7 - Schematic Drawings of All Electronic Equipment
13. Index
- C. Submit a draft to Consultant for approval at least 4 weeks prior to completion checkout. If manual is rejected, revise as needed and resubmit prior to delivering to Owner.
- D. Certain payments to Contractor shall be retained until Owner receives Operations Manual in good order as specified.

1.26 RECORD DRAWINGS

- A. The Contractor shall provide "as built" record shop drawings including any late changes or adjustments which occur as corrections to punch list items or as change orders after Substantial Completion of Contract. As-Builts shall be in the form of a PDF file designed to print to 11x17. At Substantial Completion of Contract, the Contractor shall prepare a complete set of their shop drawings for incorporation into the Operations Manual.
- B. Certain payments to the Contractor shall be retained until Owner receives the Record Drawings in good order as specified.

1.27 GUARANTEE AND WARRANTY

- A. Provide a one (1) year written guarantee covering all labor, materials and workmanship incorporated into the work. Warranty shall commence from date of Owner acceptance. Indicate date of expiration on warranty.
- B. Carry out all warranty work with no additional cost to Owner for any parts, labor, or transportation. Provide warranty replacement equipment within 24 hours of notice by Owner. Provide on site warranty repair within 2 days of notice.
- C. If a particular component, part or piece of equipment fails more than three times during the warranty period; the failure shall be deemed due to an error in product engineering. In that case, within 24 hours of notice by Owner, take whatever action is necessary to modify or correct the defect by design change. Provide temporary backup or replacement equipment within 24 hours of notice. Provide permanent, redesigned, replacement equipment on a work schedule that does not conflict with rehearsals or performances.
- D. Warranty on components and equipment modified or replaced due to error in product engineering shall be same as for original components and equipment and shall commence from date of installation of modified or replaced component or equipment.

1.28 CONTINUING MAINTENANCE PROPOSAL

- A. After Substantial Completion, submit to the Owner a proposal for continuing maintenance and service, to commence upon expiration of the warranty period.

1.29 TRAINING

- A. Supply training to Owner's operating personnel on operation and care of system for not less than eight (8) hours. Instruction shall include, but not be limited to: operation of the systems and equipment, proper maintenance of all systems, trouble-shooting, replacement procedures for user replaceable parts, and operating procedures to obtain maximum usage of systems.
- B. Deliver all copies of approved Operations Manual to Owner prior to first instruction session, and review it as part of that session. Owner shall schedule training session at their convenience.
- C. Instruction must be by qualified expert operators who have actual experience with systems in performance conditions. Submit instructor's qualifications to Consultant for approval at least 2 weeks prior to Completion Checkout.

1.30 SOFTWARE UPDATES

- A. Provide, at no cost to Owner, any software updates of the operating programs of any and all specified control consoles and other equipment through end of the warranty period via download from the manufacture's website or on a disk.
- B. This software update provision shall in no way be construed as relieving Contractor of responsibility to provide operating programs capable of meeting specification at time of delivery of equipment, during warranty period, or after warranty period.

1.31 DESCRIPTION OF SYSTEMS

- A. The Stage Lighting System shall consist of dimmers and control panels and circuit and data distribution at the auditorium of Francis Walsh Intermediate School. Control for all systems located in lighting control area at the audience cross-aisle. The dimmer bank for the Stage lighting shall be as noted on the bid documents.

PART 2 – PRODUCTS

2.2 GENERAL

- A. Do not purchase or fabricate any materials, components or items to be used in Stage Lighting System prior to approval of shop drawings.
- B. Use only materials, components and items in Stage Lighting equipment by a recognized manufacturer specializing in professional Stage lighting and electrical equipment and that conforms to industry practice and applicable code standards. Use only components that are less than two years old, and have never been used previously.
- C. Select all components on the basis that each item, or an equivalently performing substitute, shall be obtainable by Owner for a period of 10 years, should further spares be required.
- D. Verify all site conditions before fabrication is started. Manufacture all items to site verified dimensions. Accept responsibility for all costs rising from changes or corrections that are result of failure to coordinate equipment details with job conditions and designated equipment locations.

2.3 MATERIALS

- A. Use only materials that are structurally, mechanically and electrically sound, conforming to all governing code requirements for fabrication of all Stage Lighting equipment. Machine and finish operating parts of all equipment to conform to industry practice and operational intent of equipment, where not specified herein or indicated on drawings.
- B. Use only finishes which are durable and capable of withstanding normal usage. Finish all equipment cabinets with one coat of primer and one coat of enamel unless otherwise indicated. Use heat resistant epoxy or other durable high-temperature baked-on enamel finish where cabinets are subject to high temperature.

2.4 EQUIPMENT AND SYSTEMS

A. DIMMER RACK ENCLOSURE

1. Electrical

- a. Design Dimmer rack enclosure for 3-phase 4-wire 120/208-volt 60-Hz AC operation. Provide power input lugs sized to receive feed wiring as required for each rack section of dimmer bank. Dimmer banks shall be capable of accepting input voltages of up to 135-volts between any phase and neutral.
- b. Design Dimmer rack enclosure to be capable of accepting DMX-512/1990 protocol digital control signal and Ethernet control signal. Selection of signal protocol shall be automatic and shall not require use of mechanical transfer relays.
- c. Design Dimmer rack enclosure so that control signal input of each individual dimmer rack is fully opto-isolated from control signal input of any other rack, and fully opto-isolated from any control signal output.

2. Fabrication

- a. Dimmer rack enclosure shall be U.L. and or CE listed and appropriately labeled. Each dimmer bank shall consist of freestanding factory assembled racks, re-assembled on site to form complete bank. Rear access shall not be necessary for installation, maintenance, or repair. Equipment mounting and support rails shall be fabricated from 14-gauge steel with all remaining surfaces of 16-gauge steel.
- b. Each rack shall have provisions for plug-in dimmer modules that can be installed by user, requiring no tools, tuning or adjustment. Each rack shall have guides provided on dimmer trays to ease insertion and withdrawal of dimmer modules. Any spare dimmer module slots shall be fully wired and prepared for future installation of dimmers and load wiring. Furnish blank modules for wired dimmer slots for which dimmer modules are not provided. Provide cover plates for permanently empty spaces. Where possible use such spaces for storage of spare dimmer and control modules.
- c. Factory wire and dress neatly all power and signal connections. Provide adequate space for installing Electrical Contractor wiring alongside factory wiring. Clearly label all terminals and connectors.
- d. Furnish all floor mounted racks with "MWP" isolators.
- e. Mount fans in each rack to maintain temperature of all components at proper operating levels with all dimmers under full load, provided ambient room temperature does not exceed 40 degrees C. Provide for automatic shut-off of all dimmers in each rack should safe operating temperature of that rack be exceeded. Provide indicator pilot lights for each phase.
- f. Dimming curve characteristics shall be selectable via the control console.

- g. Provide hinged panel faces for all access panels, breaker panels, and control panels in dimmer bank. Fasten all panel faces, vent covers, etc. in place with 1/4 turn slotted oval head fasteners.
 - h. Dimmer rack enclosure will only require front access for installation and maintenance.
 - i. Dimmer system to include Power-Over-Internet (POI) injector
3. Mechanical
- a. Dimmer rack enclosure to be fabricated from 18-gauge steel, with hinged lockable full height door containing electrostatic air filter
 - b. Finish to be fine textured scratch resistant epoxy paint.
1. Labeling
- a. Label each dimmer rack, identifying: contents and rack I.D. number, Contractor name, address and phone number. If any part of dimmer bank can be damaged by operation with empty dimmer slots, each rack label shall include the warning: "DO NOT OPERATE SYSTEM UNLESS ALL DIMMER SLOTS ARE FILLED WITH EITHER DIMMER MODULES OR DUMMY MODULES," in letters at least 1/2" (12mm) high.
 - b. Label each dimmer module space with proper dimmer number. Numbers shall be as large as possible, up to 1/2" (12mm).
 - c. All labels shall be white characters engraved on black lamacoid strips, adhered and mechanically fixed.
2. Back-up
- a. Dimmer racks shall be capable of providing a minimum of twenty (20) back-up cues. These cues shall be programmed directly from cues created by the lighting control console. Cues shall have assignable fade up/down times. Playback shall be available either through the lighting control console or a dedicated, portable control console.
3. House Light Dimmer Rack Enclosure
- a. Supply a Dimmer Bank of sufficient size to accommodate all house lighting dimmers. Provide all control electronics necessary for proper operation. Contractor is responsible to coordinate with the electrical engineer and electrical contractor to determine the quantity of house light circuits and the type of dimmer or relay modules required to allow dimming of houselights to 1%.
 - b. House Light dimmer rack to contain:
 - P-ADP control processor

- P-SPM power module
- FLO-0 to 10 option card
- UBPO batter back up option
- R-20 modules, as required, to power LED house light fixtures
- ELV-10 module (for LED aisle lights)

B. Dimmer Modules

1. General

- a. Review the Electrical Contract Documents and examine nature of loads on each dimmer. Where indicated, provide dimmers capable of safely dimming low voltage transformer loads from full voltage to no voltage and from no voltage to full voltage in smooth and even fashion, and dimmers capable of safely dimming fluorescent loads.

2. Fabrication

- a. All dimmer modules shall be U.L. /CE listed. All dimmer modules shall be fully factory wired plug-in units designed to slide into dimmer bank. Modules shall be of rugged, heavy-duty construction. Power, signal and ground pins shall be oversized and recessed in self-aligning housing to avoid handling and insertion damage. Pin mating sequence shall be ground first, then control, then neutral, and lastly hot. Provide contoured handle for ease of insertion and withdrawal.

3. Module Interchangeability

- a. Dimmer modules of the same capacity shall be fully interchangeable. Dimmer modules of different capacity shall be configured so they may not be interchanged.

4. Electronics

- a. All dimmer electronics shall be completely solid state. Dimmers shall utilize two silicon controlled rectifiers in a back-to-back electrical configuration, a snubbing network and all required gating circuitry on high voltage side of an integral opto-coupled control voltage isolator.
- b. All dimmers shall be switchable into non-dim mode either through the main control console.

5. Isolation

- a. Dimmers employing triac power switching devices, pulse transformers, or other isolating devices shall not be acceptable. 2.4kW SSR power switching devices shall have minimum rating of 40 amps; 6.0kW SSR power switching devices shall have minimum rating of 80 amps.

6. Over Current Protection

- a. Each dimmer shall be protected by fully magnetic or thermal magnetic circuit breaker (10,000 A.I.C. at 120/240-VAC, 1-phase) of appropriate capacity mounted on face-plate of dimmer. Breaker may be used as dimmer disconnect and shall be U.L. /CE listed. Under overload conditions breaker shall disconnect power to dimmer module before damage can be done to power devices. Circuit breaker shall have maximum "must trip" rating of 125% of rated capacity.
7. Input Voltage
 - a. Each dimmer module shall be capable of accepting input voltage of up to 135 volts between phase and neutral.
 8. Operating Temperature
 - a. Provide adequate heat sinking to ensure that all components remain at safe operating temperature (50⁰ Celsius or less) for any dimmer properly installed in dimmer bank.
 9. Hot Patching
 - a. Dimmer module shall be capable of "hot patching" cold incandescent loads up to twice full rated capacity of dimmer without damage to dimmer.
 10. Response to Control
 - a. Switch-on versus switch-off response time shall be within 0.1 seconds for all loads.
 11. Flashover and Interaction
 - a. Dimmers shall prevent false triggering of SSR's and shall not cause any interaction with other dimmers while system is operating. Line transients on AC input shall not cause any dimmer to turn on.
 12. Hysteresis
 - a. Output of dimmer shall repeat regardless of direction of movement of control signal.
 13. Dimmer Curve
 - a. Output RMS voltage versus Control Console setting shall follow "square law dimming curve".
 - b. Alternate dimming curves shall be available via the control console, including customized dimming curves for all or selected dimmers.
 14. Power Output
 - a. The power efficiency of each type of dimmer shall be 90% at 80% of full load.
 - b. Dimmer output shall have DC component of less than 100 milli-volts at all phase angles and load conditions to allow for dimming of low voltage sources.

15. Dimmer Module

- a. Rise Time (75% Load)
All dimmers shall have integral inductive toroidal filters sized so that voltage rise time shall not be less than less than 500 microseconds measured and installed on site at 90° conduction angle from 10% to 90% of output wave form with dimmer operating at 75% of maximum load.
- b. Rate of Rise/Slew Rate (75% Load)
Voltage rate of rise for all dimmers must not exceed 135 milli-volts per microsecond for all dimmers at any point in the wave under 75% of maximum load.

16. Harmonic Content

- a. Design and install inductors in all dimmers to minimize the dB levels of the odd-numbered harmonics. Testing procedures are outlined in Part 3 of this specification.

17. Acceptable Dimmer Rack Enclosure and Modules

- a. ETC Drd-12/24 enclosure and supported dimmer modules.

C. RELAY RACK(S)

1. General

- a. Relay rack to be UL/CE listed
- b. Rack to comply with ANSI DMX512-A Standard
- c. Rack to be a 68" H x 14.5" W x 4.25" deep wall-mounted unit.
- d. Provide IQ-48 with network card and 20amp breakers.

2. Mechanical

- a. Dimmer rack enclosure to be fabricated from 18-gauge steel, with hinged lockable full height door containing electrostatic air filter
- b. Finish to be fine textured scratch resistant epoxy paint.

3. Electrical

- a. Rack to operate at 120/208V, three phase, 4-wire plus ground
- b. Maximum current input to be 200 amps.
- c. Rack shall have a short circuit rating of 10,000-42,000 amps symmetrical.

D. LIGHTING CONTROL RACK

1. General

- a. Relay rack to be UL/CE listed
- b. Rack to be DWR-24-26 wall-mount rack.

E. CONTROL SYSTEMS

1. Provide all following Stage Lighting Control systems:
 - a. Stage Lighting Control
 - b. Entry Station Control
 - c. Work light Station Control
 - d. DMX / network Station
2. Switching control between panels or pendants shall not require mechanical control transfer relays. Switching control between panels or pendants shall not cause visible flicker or change in lighting levels when settings on panels or pendants are identical. Provide local trim potentiometers at each station in order to balance control voltage levels if required.

F. STAGE LIGHTING CONTROL

1. Supply all required control cables to connect the console to the lighting control receptacles. In addition provide all other cables required for auxiliary devices (i.e. monitors). Cables shall be manufacturers standard for each type. Provide separate 10' long AC power cable for control console, terminated in connector to fit local power outlet.
2. Supply one (1) set of all cables in manufacturers' standard lengths. In addition supply one (1) set of all cables 25'-0" (7.5M) long.
3. Provide adequate integral or demountable task light, with dimmer, for control console. All consoles longer than 18" (460mm) shall have at least two task lights. Provide Littlite "G" series or "L-1.
4. Provide heavy-duty PVC dust covers for control console and monitors. Covers shall be in "new condition" at completion checkout.
5. Fabrication
 - a. Fabricate console according to quality level outlined herein.
 - b. Operating surfaces of control consoles shall be fabricated of steel, aluminum or other rigid material, reinforced where necessary to prevent noticeable panel deflection. Panel markings shall be engraved; photo etched or silk-screened to provide durable long-life legends.
 - c. All electronic components shall be readily available from at least two recognized manufactures.
 - d. Backup systems shall operate independently of console power supply, data bus, or other active components.

- e. LED monitors shall be capable of full screen update (100% change of data) within 250 milliseconds.
 - f. Control console shall store 256 discrete levels for any channel and provide smooth, step-less transitions. Control console shall make no fewer than 20 fade steps per second under any fade time or cue content condition.
 - g. No console controller position or memory playback level shall deviate from a linear curve by more than plus or minus 1%. Control outputs shall be optically isolated. Each output shall be isolated from other outputs. Fuses shall protect all drive lines.
6. Lighting Control Console
- a. Furnish one (1) Control Console. Console shall be microprocessor-based system designed specifically for theatrical lighting control applications. Console shall be engineered for ease and clarity of operation and shall incorporate visual displays to assist operator in all modes of operation.
 - b. The lighting control program shall be stored in nonvolatile read- only-memory, and cue information shall be stored in high-speed random-access-memory with memory retention protection.
 - c. Provide facility for connection to remote video monitors, hand-held focus remote, hard copy printer, and Ethernet signal input.
 - d. Provide two 12" (minimum) (300mm) high resolution color flat LED screen monitors for display of system related information to include, but not be limited to: channel levels, cue information, patching information, effects information, sub-master levels and assignments, fader times and assignments, and other console status information.
7. System Capacity
- a. 4096 (min,) outputs. Quantity to be upgradable. Final quantity to be determined during shop drawing review.
 - b. 16,000 control channels
 - c. 999 cue lists
 - d. 10,000 cues
 - e. 200 active playbacks
 - f. 999 submasters
 - g. 4 x 1000 palettes (intensity, focus, color, beam

- h. 1,000 presents (all palette)
- i. 1,000 groups.
- j. 1,000 effects (relative, absolute or step).
- k. 1,000 each: macros, snapshots and curves
- l. Solid state hard drive
- m. USB ports for flash drives, pointing devices, keyboards, etc
- n. Interfaces
 - 1). Two (2) individually configurable Ethernet ports,
 - 2). ETCNet2 and Net3 ports or as approved, powered by CAN, Artnet and Avab UDP output protocols.
 - 3). Two (2) DMX512 ports
 - 4). Contact closure triggers via D-Sub connector
 - 5). Three (3) female IEC connectors
 - 6). Three (3) display port connectors (1280x1024 resolution) and display port to DVI adapters
 - 7). Eleven (11) USB ports
 - 8). Wireless remote focus
 - 9). MIDI In/Out (MIDI timecode, MIDI show control)
 - 10). MIDI Timecode, MIDI show Control via Gateway
 - 11). SMPTE Timecode via Gateway
 - 12). OSC
 - 13). UDP settings
 - 14). Contact closure (12 analog inputs, 12 SPDT contact outputs, RS-232) via Gateway

8. Acceptable Lighting Control Consoles

- a. ETC Ion 1.5k with a 2x20 fader wing

G. CONTROL CONSOLE ACCESSORIES

- 1. Provide Stage Control Systems that will accommodate all following Control Console Accessories, requiring only connection of each accessory to control receptacle as specified herein. Ensure that wiring network for each accessory, particularly remote video, functions as specified below.
- 2. CONTROL SYSTEMS

- a. In addition to Theatre Lighting Control Systems specified above, provide all following Stage Lighting Control systems:
 - 1). House Lighting Control
 - 2). Entry Station Control
 - 3). Lighting Control Pendant
 - 4). Worklight Control
 - b. Switching control between panels or pendants shall not require mechanical control transfer relays. Switching control between panels or pendants shall not cause visible flicker or change in lighting levels when settings on panels or pendants are identical. Provide local trim potentiometers at each station in order to balance control voltage levels if required.
3. House Lighting Control System
- a. The House Lighting Control System allows level adjustment of each control channel of Stage light dimmers, recording and selecting for playback of a minimum of (12) different preset lighting states, and control of the fade time between presets and manual faders. The system shall be a micro-processor based lighting control system. System operating program shall be stored in programmable read-only memory.
 - b. It shall be possible to customize operation of the Stage Lighting Control System by programming plug-in, nonvolatile data cartridge or floppy disc. Such customizing shall include, but not be limited to channel/dimmer assignments or restricted control locations. Data storage facilities shall retain their memory for an indefinite period of time. In case of power failure, the control module shall retain preset memory for a minimum of 72 hours.
 - c. The House Lighting Control System shall be enabled at only one location at a time.
 - d. Preset Control
 - 1 - covered TAKE CONTROL pushbutton
 - 1 – LCD screen
 - e. Programming of presets shall be possible through a manufacturer supplied software program and/or via the preset control. It shall be possible to establish and record: levels, presets, fade times, cross-fades, pushbutton assignment, dimmer patch, macros and configuration printout. Storage of all system information shall be possible via zip stick or similar external storage device.
 - f. Provide quantities noted on contract drawings.
4. Entry and Work Light Control Panels
- a. The Entry Control System instantly brings selected dimmed Stage lights to full with the push of one button. The system is always enabled at every location, and must remain functional regardless of the state of any other control systems.

- b. Contents
 - 1 - covered ENTRY pushbutton
 - 1 - NORMAL pushbutton
 - c. Provide quantities noted on contract drawings.
5. Control Console Station
- a. The Stage lighting control console will plug directly into the receptacles on this station to control the dimmers.
 - b. Contents
 - 1). As noted on Contract drawings
 - c. Provide quantities noted on contract drawings.
6. 2-Port Gateway Portable Unites
- a. The Gateway panel will allow moving lights, scrollers and other similar equipment operating via DMX protocol to be controlled by the Stage lighting control console.
 - b. Contents
 - 1). Manufacturer's standard
 - c. Provide quantities noted on contract drawings.

H. LIGHTING CONTROL PANELS

1. General
- a. Furnish Stage Lighting Panels in quantities indicated on contract documents. Furnish all pushbuttons, potentiometers, receptacles, terminals, and panel faces for all panels as indicated on Stage Lighting drawings and described herein. Review the Electrical contract documents and examine type, exact location, mounting, and quantity of each panel. Bring any discrepancy concerning quantities and types to attention of Architect, Electrical Engineer and Consultant prior to bid for clarification. Unless specifically instructed otherwise at that time, furnish the greater quantity of each panel type.
 - b. Supply panel faces and enclosures for all surface mounted panels, sized as shown on the Stage Lighting drawings.
 - c. Furnish only panel faces for all recessed panels, which will mount to standard back boxes provided by Electrical Contractor. Furnish panel faces for recessed panels with no markings other than legends shown on Stage Lighting drawings.

- d. Provide NEMA 3 enclosures for any panels located outdoors.
2. Samples
 - a. Provide samples, as requested, of panel finishes and engraving after approval of shop drawings, but prior to manufacture. Provide samples, as requested, of connectors, potentiometers, pushbuttons and indicators with first shop drawing submittal.
3. Fabrication
 - a. Fold or grind smooth all panel edges so no sharp edges protrude. Do not allow face of any surface mounted box to overhang back box.
 - b. Fabricate all panel and pendant faces of heavy gauge steel or aluminum. Fabricate back boxes for surface mounted panels of the same material used for the panel face.
 - c. Finish all panel and pendant faces, and all surface mounted control panel back boxes in satin black. Aluminum shall be brushed and anodized black. Steel shall be primed and painted with satin black baked enamel.
 - d. Provide hinge or drawer access to electronics for all panels and rack-mounted panels. When required for architectural finishes, provide electronics in adjacent panels. Provide terminal strips and neatly bundled wiring to facilitate access.
 - e. Provide nickel-plated slot or Phillips type, oval head, mounting screws, complete with nylon cup washers. Provide lock washers for all nuts.
 - f. Provide cover plates for floor mounted panels which support weight of one person and allow for cable exit with cover closed.
 - g. "Mini XLR" or "D" type connectors are not acceptable.
 - h. All equipment door locks shall use the same key. Provide one key for equipment door lock, plus 2 spare.
 - i. Provide only panel mounted fuses and breakers. Provide indicating fuse holders, which are illuminated when the fuse has failed. If fuses must be concealed, ensure they are easily accessible, with panel mounted indicator lights labeled accordingly. Provide spare fuses mounted within panel.
 - j. Clearly and permanently label all internal switches on panel front.
 4. Labeling
 - a. Provide manufacturer's standard labeling. Provide text and size for all legends as indicated on Stage Lighting drawings. Do not fabricate any legend prior to final approval of samples and shop drawings by Consultant.

2.5 STAGE LIGHTING FIXTURES

- A. Each lighting fixture shall be provided with the following accessories: c-clamp, safety cable, color frame and 18" (450mm) pigtail(s) with connectors necessary for function and operation. For cyc lights, also provide hanging clamps and cyc lens.
- B. Lighting fixtures by ETC except noted otherwise.
- C. Fixtures
 - (18) Coemar Parlight LED RGBA, with 12 degree lens kit and barn doors
 - (20) ColorSource Spot with 19 degree EDLT lens tube
 - (50) ColorSource Spot with 15-30 degree EDLT zoom lens tube
 - (9) Chroma Q Color Force 48 cyc lights
 - (20) Apollo Right Arm. Each unit to have a power plug for the unit and a female Edison connector

2.6 STAGE LIGHTING ACCESSORIES

- 1. 500' (150.0M) Black sash cord
- 2. (80) 10'-0" Powercon jumpers
- 3. (20) Top hats
- 4. (20) Template holders
- 5. (80) DMX control cables with male XLR connector at one end and female XLR at the other.
- 6. (40) 15' DMX control cables with male XLR connector at one end and female XLR at the other.
- 7. (18) SELRW-7.5 Round Wide diffusion
- 8. (18) SELMW-7.5 Medium round diffusion

PART 3 – EXECUTION

3.2 STAGE LIGHTING SYSTEM INTEGRATOR

- A. Assume responsibility to supply equipment and instruction for complete and working installation of all Stage Lighting Equipment specified in this section, coordinated with work of EC and all other subcontractors. Coordinate with EC and other subcontractors through GC.

3.3 COORDINATION WITH OWNER AND CONSULTANT

- A. CONTRACTOR shall submit all drawings, schedules, and other communications relating to work of this section as directed.

3.4 ENVIRONMENTAL CONDITIONS

- A. Ship Stage Lighting System equipment to site only after notification by EC that storage facilities are available to protect equipment prior to installation, as described below. EC shall install Stage Lighting equipment only when site conditions provide mechanical, electrical, and weather protection for each class of equipment, as described below.

- B. Pack all equipment in sturdy containers to provide mechanical protection during shipping and storage. Provide padding as necessary to protect equipment from vibration and shock. Provide inner plastic sheeting to protect equipment from moisture and dust. Keep plastic covers on equipment until such time as installation areas have been completed and conditions exist as indicated below.

- C. Maintain storage and installation conditions for each class of equipment according to the following:

1. CLASS 1

- a. Distribution apparatus, back boxes, face plates, terminal boxes, and empty dimmer rack frames may be stored in weather protected spaces under "normal" construction site conditions provided that no electronic components are contained within devices, that storage boxes are sturdy and well sealed, and that equipment is protected with imperforate inner plastic sheeting.
- b. EC may install this class of equipment in weather protected spaces under "normal" construction site conditions provided that equipment is protected from dust and moisture by sturdy imperforate plastic sheeting and completely covered with corrugated cardboard held securely in place by duct tape. Cardboard covers shall not be removed until area is broom cleaned. Under no circumstances shall equipment remain uncovered overnight during installation or while work that causes high dust or moisture levels in area of placement is taking place.

2. CLASS 2

- a. Dimmer modules, dimmer control assemblies, control panels, spare parts and test equipment shall be stored and protected per Class 1 devices, except that all equipment shall be stored in air conditioned, secure space. Do not ship this class of equipment until such space exists on site and is approved by Architect, Consultant and Owner.
- b. EC shall not install equipment in this class until area of installation is broom cleaned, "blown" clean with pressurized air, mopped, air conditioned and secure. EC may install control panels with electronic components under Class 1 conditions, but elec-

tronic components must be removed and not installed until area of installation meets Class 2 conditions.

3. CLASS 3

- a. Control Consoles, Designer Remotes, Focus Remotes, Video Monitors, Printers, and computer component spare parts shall not be shipped to site until control and dimmer rooms are finished, air conditioned, broom cleaned, "blown" clean with pressurized air, mopped, secure and in all respects complete and ready for occupation. This class of equipment shall not be unpacked until Stage Lighting system is complete in all other respects.
- b. If control and dimmer rooms are complete in time to use this Class of equipment for Engineering Checkout and Field Testing and Adjustment, equipment may be unpacked for this purpose, but must be re-packed should there be a lapse of time greater than 2 weeks between completion of these testing and Completion Checkout.
- c. Under no circumstances may equipment in this Class be removed from control or dimmer rooms into or through spaces which are not in all respects complete and ready for occupation

3.5 REVIEW OF FIELD CONDITIONS

- A. Confirm by site visit and by report from EC all field conditions that may affect manufacture and installation of Stage Lighting System equipment prior to fabrication. Provide any additional hardware, panels and back boxes to accommodate field conditions. Submit all changes to equipment and mounting details to Consultant for review prior to fabrication.

3.6 INSTALLATION INSTRUCTION

- A. Supply specific, detailed direction to EC as required for proper installation of all Stage Lighting System equipment, coordinated with actual site conditions, as per Part 1 of this section.
- B. ITEMS PLACED AND ATTACHED TO EXISTING WORK
 1. CONTRACTOR shall supply all items required to properly install and secure Stage Lighting System equipment in place.
 2. EC shall place, install, and connect all Stage Lighting System equipment.

3.7 ALTERATION OF EQUIPMENT DETAILS

- A. If any panel, distribution box, or other device requires relocation or change of mounting detail, and this fact is not known until after shipment due to sequence of work, modify equipment or provide new equipment to fit revised location or mounting detail. Notify Consultant of any such changes, and submit all changes to Consultant for review prior to fabrication.

3.8 WIRING

- A. CONTRACTOR shall describe to the EC appropriate length cable loops, terminations, etc.; or any other wiring procedure (beyond customary trade practice) required for successful operation.

3.9 MARKING

- A. All equipment shall be permanently and logically marked for ease of EC installation.

3.10 PAINTING AND TOUCH UP

- A. Supply EC with all paint and supplies to correct minor cosmetic damage to equipment. Ensure that all equipment is clean and in perfect condition at time of Completion Checkout.
- B. Repair or replace any equipment that has suffered non-cosmetic damage prior to time of Completion Checkout. Claims arising from repair or replacement of such damage shall be considered only after final acceptance of system by Owner.

3.11 CLEAN UP

- A. CONTRACTOR shall instruct EC to clean all racks, panels and boxes of dirt, dust, and debris, re-assemble all equipment, and replace all panels, covers and screws prior to time of Completion Checkout.

3.12 PROTECTION OF CONTROL EQUIPMENT

- A. Do not use any control equipment intended for installation for the purpose of checking out wiring or circuitry prior to proper conditions existing on site, as specified above. Equipment may be used for such testing only in specific areas where such proper conditions exist.

3.13 ENGINEERING CHECKOUT

- A. Prior to energizing of Stage Lighting control systems, perform complete system checkout to verify that all items are correctly installed and shall safely operate as specified herein.
- B. FIELD TESTING AND ADJUSTMENT
- C. Perform all tests and adjustments specified below upon completion of installation of Stage Lighting System, but no later than six weeks prior to Beneficial Occupation of facility, or portion of facility containing Stage Lighting System, by Owner.

3.14 TEST PROCEDURES

- A. Prior to Consultant's inspection perform all following tests:
 1. Inspect all device labels to ensure that devices are correctly and clearly labeled as specified and shown in drawings.
 2. Test all circuits for proper wiring, polarity, and connection to proper dimmer; and inspect for correct labeling.
 3. Test at random at least 10% of dimmers for dimmer rise time, rate of rise time, and efficiency. If any dimmers fail, test 100% of dimmers.
 4. Test at random at least 10% of dimmers and non-dims for overload and dead short protection. If any devices fail, test 100% of dimmers and non-dims.
 5. Test all power receptacles provided in this section.

6. Test for proper readings of internal cards and devices in Control Console.
7. Test all Control operations, including transfer of memory to and from magnetic storage medium. Test all diskettes provided. Test hardcopy-printing facilities.
8. Test all control panels for all functions. Test each control transfer circuit a minimum of 20 times for reliable transfer of control. Test other panel functions a minimum of 10 times consecutively from each panel.
9. Test all functions of all remote devices and all control plug-in points at least 10 times. When remote devices are NIC, contract, but accommodation for these devices is included, provide identical devices for testing purposes.
10. Test video systems for clear screen and high resolution of characters with no interference, "snow", color degradation, pixel shift, etc. Test video screen switching devices.
11. Test all extension cables, adapters, etc.
12. Repair or replace any equipment that fails to conform to specification.
13. Upon completion of testing, supply Owner, Architect and Consultant a complete report on all field-testing and adjustment, certifying that system conforms to specification and that installation is complete and ready for inspection.

3.15 COMPLETION CHECKOUT

- A. Schedule inspection by Owner, Architect and Consultant no earlier than upon receipt of above specified report, but no later than four (4) weeks prior to Beneficial Occupation of facility, or portion of facility containing Stage Lighting System, by Owner.
- B. At request of Consultant, repeat any and all test specified in "Field Testing and Adjustment" above in presence of Owner, Architect and Consultant.
- C. Should Owner, Architect or Consultant judge that any equipment fails to conform to specification, repair or replace that equipment within 15 days. Should work inspected not be substantially complete at time of Completion Checkout, complete that work and schedule a second check-out. Provide all equipment and personnel specified above.
- D. It is the intent of this specification section that Completion Checkout occurs over a period of two (2) site visits by the Consultant. The second visit is intended for review of CONTRACTOR compliance with punch list items prepared during first visit.
- E. Should additional visits by Consultant be required due to CONTRACTOR failure to comply with FIELD TESTING AND ADJUSTMENT, above; and/or should Stage Lighting installation be insufficiently complete to allow Completion Checkout to occur, then the CONTRACTOR shall be liable for all of Consultant's expenses related to additional visits. (These expenses shall include, but not be limited to: airfare, lodging and local travel.)

3.16 FINAL SUBMITTALS

- A. After Completion Checkout, submit all of the following to the Owner:

16030
11/17/2017

FRANCIS WALSH INTERMEDIATE SCHOOL /
BOARD OF EDUCATION CENTRAL OFFICES
BRANFORD, CONNECTICUT
State Project No.s: 014-0034 EA / 014-0035 BE-EA

1. Receipts for delivery of uninstalled miscellaneous items, including all spare parts as detailed in Part 2.
 2. 5 copies of the Operations Manual, as detailed in Part 1.
 3. Record Drawings, as detailed in Part 1.
 4. Guarantee and Warranty, as detailed in Part 1.
 5. Continuing Maintenance Proposal, as detailed in Part 1.
 6. All equipment door locks, as detailed in Part 2.
- B. All of the above must be submitted prior to final acceptance of, and final payment for, the work of this section.

END OF SECTION

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes two-winding transformers; shielded transformers; autotransformers; and buck-and-boost transformers.
- B. Related Sections:
 - 1. Section 26 05 33 - Raceway and Boxes for Electrical Systems.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA ST 1 - Specialty Transformers (Except General Purpose Type).
 - 2. NEMA ST 20 - Dry Type Transformers for General Applications.
- B. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- C. Department of Energy: DOE 2016 Energy Efficiency standard.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures Submittal procedures.
- B. Product Data: Submit outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.
- C. Test Reports: Indicate loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.
- D. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of transformers.

1.7 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles

shall be documented in accordance with the High Performance Building Requirements of this Section.

3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 TWO-WINDING TRANSFORMERS

- A. Manufacturers:
 1. General Electric.
 2. Square D.
 3. Eaton/Cutler Hammer
 4. Substitutions: Section 01 60 00 - Product Requirements
- B. Product Description: NEMA ST 20, factory-assembled, air-cooled, Energy Star rated, dry type transformers, ratings as indicated on Drawings.
- C. Primary Voltage: 480 volts, 3 phase.
- D. Secondary Voltage: 208Y/120 volts, 3 phase.
- E. Insulation system and average winding temperature rise for rated kVA as follows:
 1. 1-15 kVA: Class 185 with 115 degrees C rise.
 2. 16-500 kVA: Class 220 with 150 degrees C rise.
- F. Case temperature: Do not exceed 35 degrees C rise above ambient at warmest point at full load.
- G. Winding Taps:
 1. Transformers Less than 15 kVA: Two 5 percent below rated voltage, full capacity taps on primary winding.
 2. Transformers 15 kVA and Larger: NEMA ST 20.

- H. Sound Levels: NEMA ST 20.
- I. Basic Impulse Level: 10 kV for transformers less than 300 kVA, 30 kV for transformers 300 kVA and larger.
- J. Ground core and coil assembly to enclosure by means of visible flexible copper grounding strap.
- K. Mounting:
 - 1. 1-15 kVA: Suitable for wall mounting.
 - 2. 16-75 kVA: Suitable for wall, floor, or trapeze mounting.
 - 3. Larger than 75 kVA: Suitable for floor (pad) mounting.
- L. Coil Conductors: Continuous copper windings with terminations brazed or welded.
- M. Enclosure: NEMA ST 20, Type 1. Furnish lifting eyes or brackets.
- N. Isolate core and coil from enclosure using vibration-absorbing mounts.
- O. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.2 SOURCE QUALITY CONTROL

- A. Production test each unit according to NEMA ST20.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify mounting supports are properly sized and located including concealed bracing in walls.

3.2 INSTALLATION

- A. Set transformer plumb and level.
- B. Use flexible conduit, in accordance with Section 26 05 33, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- C. Support transformers in accordance with Section 26 05 29.
 - 1. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by manufacturer.
 - 2. Mount floor-mounted transformers on concrete housekeeping pads with vibration isolating pads suitable for isolating transformer noise from building structure.
 - 3. Mount trapeze-mounted transformers as indicated on Drawings.

- D. Provide seismic restraints as required by the most recent adopted version of the State of Connecticut Building Code. .
- E. Install grounding and bonding in accordance with Section 26 05 26.
- F. Provide labeling in accordance with Section 260553.
- G. Where primary disconnecting means is not within line of sight of the transformer. Provide permanent signage indicating the location of the disconnecting means.

3.3 FIELD QUALITY CONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.2.1.

3.4 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Measure primary and secondary voltages and make appropriate tap adjustments.

END OF SECTION

SECTION 262203 - LOW-VOLTAGE TRANSFORMERS FOR NONLINEAR LOADS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes individually mounted harmonic mitigating dry-type transformers, 600V maximum, for general power and lighting applications meeting the NEMA Premium Efficiency transformer program (or proposed US Department of Energy Candidate Standard Level 3 (CSL-3) energy efficiency.
- B. Harmonic mitigating dry-type transformers to be supplied to feed 208/120V normal and emergency panels with branch circuit loads predominantly connected to computers and data processing equipment.
- C. Related Sections:
 - 1. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
 - 2. Section 26 22 00 - Low-Voltage Transformers.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
 - 2. NEMA ST 20 - Dry Type Transformers for General Applications.
- B. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- C. Department of Energy: DOE 2016 Energy Efficiency standard.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, k-factor, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.
- C. Test Reports: Indicate loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.
- D. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of transformers.

1.7 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

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

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 TRANSFORMERS FOR NONLINEAR LOADS

- A. Manufacturers:
 - 1. General Electric.
 - 2. Square D.
 - 3. Eaton/Cutler Hammer.
 - 4. Harmonics Limited.
 - 5. Substitutions: Section 01 60 00 - Product Requirements.

- B. Product Description: NEMA ST 20, factory-assembled, air cooled dry type transformers, ratings as indicated on Drawings, designed to supply 100 percent nonlinear load.
- C. Primary Voltage: 480 volts, 3 phase.
- D. Secondary Voltage: 208Y/120 volts, 3 phase.
- E. Core Flux Density: Below saturation at 10 percent primary overvoltage.
- F. Insulation and temperature rise: Class 220 insulation system with 150 degrees C average winding temperature rise.
- G. Case temperature: Do not exceed 35 degrees C rise above ambient at warmest point at full load.
- H. Winding Taps:
 - 1. Transformers Less than 15 kVA: Two 5 percent below rated voltage, full capacity taps on primary winding.
 - 2. Transformers 15 kVA and Larger: NEMA ST 20.
- I. Sound Levels: NEMA ST 20.
- J. Basic Impulse Level: 10 kV for transformers less than 300 kVA, 30 kV for transformers 300 kVA and larger.
- K. Harmonic Mitigation – Shall be a single-output harmonic mitigating isolation transformer with low zero sequence output impedance designed to reduce the voltage distortion created by triplen harmonic currents:
 - 1. 3rd, 9th & 15th (triplen) harmonics and other zero sequence currents shall be treated within the secondary windings through cancellation of the zero sequence fluxes. Simply trapping these currents in the delta primary winding is NOT acceptable.
 - 2. For 5th, 7th, 17th & 19th harmonics, provide the appropriate primary-secondary phase shift in order to cancel these harmonic currents with those of other loads fed from the same primary supply.
 - 3. The Harmonic Mitigation shall be by electromagnetic means only.
- L. Ground core and coil assembly to enclosure by means of visible flexible copper grounding strap.
- M. Mounting:
 - 1. 1-15 kVA: Suitable for wall mounting.
 - 2. 16-75 kVA: Suitable for wall, floor, or trapeze mounting.
 - 3. Larger than 75 kVA: Suitable for floor (pad) mounting.
- N. Coil Conductors: Continuous copper windings with terminations brazed or welded. Individually insulate secondary conductors and arrange to minimize hysteresis and eddy current losses at harmonic frequencies. Size secondary neutral conductor at twice secondary phase conductor ampacity.

- O. Electrostatic Shield: Copper, between primary and secondary windings and grounded.
- P. Enclosure: NEMA ST 20, Type 1 ventilated. Furnish lifting eyes or brackets.
- Q. Isolate core and coil from enclosure using vibration-absorbing mounts.
- R. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.2 SOURCE QUALITY CONTROL

- A. Production test each unit according to NEMA ST 20.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify mounting supports are properly sized and located, including concealed bracing in walls.

3.2 INSTALLATION

- A. Provide harmonic mitigating transformers for 208/120V branch circuit distribution and branch circuit panelboards except as noted. Do not feed kitchen equipment or stage dimmer racks from panels supplied by harmonic mitigating transformers.
- B. Set transformer plumb and level.
- C. Use flexible conduit, in accordance with Section 26 05 33, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- D. Support transformers in accordance with Section 26 05 29.
 - 1. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by manufacturer.
 - 2. Mount floor-mounted transformers on housekeeping pads with vibration isolating pads suitable for isolating transformer noise from building structure.
 - 3. Mount trapeze-mounted transformers as indicated on Drawings.
- E. Provide seismic restraints as required by the most recent adopted version of the State of Connecticut Building Code.
- F. Install grounding and bonding in accordance with Section 26 05 26.
- G. Provide labeling in accordance with Section 260553.
- H. Where primary disconnecting means is not within line of sight of the transformer. Provide permanent signage indicating the location of the disconnecting means.

3.3 FIELD QUALITY CONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.2.1.

3.4 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Measure primary and secondary voltages and make appropriate tap adjustments.

END OF SECTION

SECTION 262413 - SWITCHBOARDS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes main and distribution switchboards with type 1 surge protection device.
- B. Related Sections:
 - 1. Section 01 90 00 – Building Commissioning Requirements.
 - 2. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 3. Section 26 05 53 - Identification for Electrical Systems.
 - 4. Section 26 05 73 – Overcurrent Protective Device Coordination Study.
 - 5. Section 26 28 13 - Fuses.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
 - 1. IEEE C57.13 - Standard Requirements for Instrument Transformers.
 - 2. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

- B. National Electrical Manufacturers Association:
 - 1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
 - 2. NEMA FU 1 - Low Voltage Cartridge Fuses.
 - 3. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
 - 4. NEMA PB 2 - Deadfront Distribution Switchboards.
 - 5. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less.

- C. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures and 26 04 00: Submittal procedures.

- B. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars for each phase, neutral, ground, switchboard instrument details and integral type 1 surge protection (SPD).

- C. Product Data: Submit electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of equipment and components.

- D. Test Reports: Indicate results of factory production and field tests.

- E. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements.
Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets,

manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations, configurations, and ratings of switchboards and their components on single line diagrams and plan layouts.
- C. Operation and Maintenance Data: Submit spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.7 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

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

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Deliver in shipping splits, individually wrapped for protection and mounted on shipping skids, and coordinated with maximum clear width openings into the facility.
- C. Accept switchboards on site. Inspect for damage.
- D. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.
- E. Handle in accordance with NEMA PB 2.1. Lift only with lugs provided. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.10 ENVIRONMENTAL REQUIREMENTS

- A. Conform to NEMA PB 2 service conditions during and after installation of switchboards.

1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.12 SEQUENCING

- A. Sequence Work to avoid interferences with building finishes and installation of other products.

1.13 MAINTENANCE MATERIALS

- A. Furnish two of each key.
- B. Furnish two fuse pullers.

1.14 EXTRA MATERIALS

- A. Furnish three of each size and type of fuse installed.

PART 2 PRODUCTS

2.1 DISTRIBUTION SWITCHBOARDS

- A. Manufacturers:
 - 1. General Electric.
 - 2. Square D.
 - 3. Eaton/Cutler Hammer.
 - 4. Substitutions: Not permitted.
- B. Product Description: NEMA PB 2, enclosed switchboard with electrical ratings and configurations as indicated on Drawings.
- C. Device Mounting:
 - 1. Main Section: Individually mounted and compartmented.
 - 2. Energy Reduction Maintenance setting (ERMS) system
 - 3. Distribution Section: Group mounted.
 - 4. Integral type 1 surge protection
- D. Bus:
 - 1. Material: Copper with tin plating. Fully rated (no reductions).
 - 2. Connections: Bolted, accessible from front for maintenance.
 - 3. Insulation: Fully insulate load side bus bars.
- E. Ground Bus: Extend length of switchboard.

- F. Line and Load Terminations: Accessible from front only of switchboard, suitable for conductor materials and sizes as indicated on Drawings.
- G. Utility Metering Compartment: Furnish metering transformer compartment for Utility Company's use, in accordance with Utility Company requirements.
- H. Metering Compartment: Furnish metering transformer provisions, current sensors and space for installation of panel mount power meter. Refer to Instrumentation Section 2.8 for additional information.
- I. Pull Section: Size as indicated on Drawings. Arrange as indicated on Drawings.
- J. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, insulated and braced for short circuit currents. Furnish continuous current rating as indicated on Drawings.
- K. Enclosure: Type 1 - General Purpose.
- L. Align sections at front and rear.
- M. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

2.2 FUSIBLE SWITCH ASSEMBLIES

- A. Manufacturers:
 - 1. General Electric.
 - 2. Square D.
 - 3. Siemens.
 - 4. Eaton/Cutler Hammer
 - 5. Substitutions: Not permitted.
- B. Product Description: NEMA KS 1, Type HD, load interrupter knife switch. Handle lockable in OFF position.
- C. Fuse clips: Designed to accommodate NEMA FU 1, Class R fuses.

2.3 MOLDED CASE CIRCUIT BREAKER

- A. Manufacturers:
 - 1. General Electric.
 - 2. Square D.
 - 3. Siemens.
 - 4. Eaton/Cutler Hammer.
 - 5. Substitutions: Not permitted.
- B. Product Description: NEMA AB 1, molded-case circuit breaker.

- C. Main 3000 amp circuit breaker shall have Long time, Short time, Instantaneous and ground fault protection (LSIG) functions. These functions shall similar to those functions found on a Square D PowerPact circuit breaker. Circuit breaker shall have energy reduction maintenance setting (ERMS) system. Provide the following:
 - a. Energy Reduction Maintenance Setting Switch (ERMS)
 - 1) For the Main circuit breaker above 1200 amps, provide a maintenance OFF ON selector switch on the compartment door to switch the circuit breaker instantaneous tripping characteristics to an alternate setting temporarily during maintenance activity.
 - 2) Provide a lock feature for the ERMS switch so that it may be locked in either the OFF or ON maintenance mode position.
 - 3) Provide a blue LED indicating light to indicate trip unit is in the ERMS mode.
- D. Field-Adjustable Ampere Circuit Breaker: Circuit breakers with frame sizes 125 amperes and larger have adjustable/changeable trip units.
- E. Field-Adjustable Trip Circuit Breaker: Circuit breakers with frame sizes 200 amperes and larger have mechanism for adjusting long time, short time, continuous current setting for automatic operation.
- F. Current Limiting Circuit Breaker: Circuit breaker indicated as current-limiting have automatically-resetting current limiting elements in each pole. Let-through Current and Energy: Less than permitted for same size Class RK-5 fuse.

2.4 GROUND FAULT DEVICES

- A. Provide integral ground fault sensing and protective device within switchboard as required by NEC.

2.5 PHASE FAILURE RELAY

- A. Provide integral phase failure relays within switchboard.

2.6 SURGE PROTECTIVE DEVICE

- A. Manufacturers:
 - 1. General Electric.
 - 2. Square D.
 - 3. Siemens.
 - 4. Eaton/Cutler Hammer
 - 5. Current Technology.
 - 6. Substitutions: Not permitted.
- B. Product Description: IEEE C62.41, factory-mounted surge protective device, selected to meet requirements for high exposure (200,000A) and to coordinate with system

circuit voltage. integral type 1 surge protection at 480vY 3 phase with L-N=1200 L-G=1200 N-G=1200 and L-L 2000

- C. Minimum surge current rating per phase: 320 kA.
- D. Surge Protective device module shall be integral to switchboard and shall be fused.

2.7 SOURCE QUALITY CONTROL

- A. Furnish shop inspection and testing in accordance with NEMA PB 2.

2.8 INSTRUMENTATION

- A. Provide a Square D Class 3020 PM8244 PowerLogic Power Meter with display. Device shall be panel mounted in the switchboard. Devices by others will be considered providing all the following specifications are met.
- B. The Power Meter shall be equipped with a two (2)-line by sixteen(16)-character LCD display for electrical circuit information.
- C. The information displayed by the Power Meter shall include the following quantities:
 - 1. Current, per-phase
 - 2. Volts, phase-to-phase & phase-neutral
 - 3. Real Power (kW), three-phase total
 - 4. Reactive Power (kVAR), three phase total
 - 5. Apparent Power (kVA), three phase total
 - 6. Power Factor, true, per-phase & three-phase total
 - 7. Frequency
 - 8. Current Demand, per phase and neutral, present and peak
 - 9. Real Power Demand (kWd), three phase total, present and peak
 - 10. Reactive Power Demand (kVARd), three phase total, present and peak
 - 11. Apparent Power Demand (kVAd), three phase total, present and peak
 - 12. Real Energy (kWh), three phase total
 - 13. Reactive Energy (kVARh), three phase total
 - 14. Apparent Energy (kVAh), three phase total
 - 15. Energy Accumulation Modes, signed, absolute, energy in, energy out
 - 16. Watt-hour KYZ Pulse Initiator Output
 - 17. Total Harmonic Distortion, Voltage
 - 18. Total Harmonic Distortion, Current
 - 19. Date/Time Stamping.
 - 20. Communications port for Power Monitoring Systems communications and Modbus RTU communications.
- D. The Power Meter shall be accurate to .25% for voltage and current sensing, .50% for power, energy, & demand sensing, and 1% for power factor sensing.
- E. All information stored in the Power Meter shall be remotely accessible through data communications.

- F. The Power Meter shall be UL Listed, rated for an operating temperature range of 0C to 55C and have an overcurrent withstand rating of 500 amps for 1 second.
- G. The Power Meter metering inputs shall utilize industry standard current transformers (5A secondary CT's), have VT inputs for direct connection of VT leads to up to 600V, and adhere to UL standard 508 for dielectric voltage-withstand.
- H. Each Circuit Monitor shall have built-in data communications to allow multipoint communication to multiple computer workstations, programmable controllers, and other host devices, at a minimum data rate of 9600 baud.
- I. The data communications shall be optically isolated to provide reliable operation.
- J. Power meter shall include a pulse output for interconnection with the Building Management System.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify surface is suitable for switchboard installation.

3.2 INSTALLATION

- A. Install in accordance with NEMA PB 2.1.
- B. Tighten accessible bus connections, SPD connections and mechanical fasteners after placing switchboard.
- C. Install fuses in each switch and coordinate sizes with connected load.
- D. Install engraved plastic nameplates in accordance with Section 26 05 53.
- E. Install breaker circuit directory.
- F. Ground and bond switchboards in accordance with Section 26 05 26.
- G. Coordinate interconnection of metering to building management system contractor and assist with all required programming and configuration of the power meter.
- H. Service Switchboards:
 - 1. Identification in accordance with Section 26 05 53.
 - 2. Labeling & Identification:
 - a. Indicate the maximum available fault current at the equipment, including the date the fault current calculation was performed. Label shall include warning for "Arc Flash Hazard" and requirement for "PPE protection".
 - b. Indicate locations of sources and feeders for all services to the building (generator and fire pump).

3. Installation of ERMS maintenance lockable selector switch and blue indicating light onto compartment door of the main circuit breaker. Installation of the IO module and the IFE module in accordance with manufactures recommendations.
 - a. Set point for the ERMS instantaneous is based on manufactures recommendations. For Square D Power Pact circuit breaker (Basis of design) the default programmed setting to the instantaneous (li) set point is $2 \times I_n$.

3.3 FIELD QUALITY CONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.1.
- D. Above testing shall be documented in writing and furnished as a part of the O&M manuals, and provided to CX agent prior to closeout.

3.4 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Adjust operating mechanisms for free mechanical movement.
- C. Tighten bolted bus connections.
- D. Adjust circuit breaker trip and time delay settings to values as indicated on Drawings or as instructed by Architect/Engineer.

3.5 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Touch up scratched or marred surfaces to match original finish.

END OF SECTION

SECTION 262416 - PANELBOARDS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes distribution and branch circuit panelboards.
- B. Selective Coordination:
 - 1. Fusible branch circuit panelboards overcurrent protective devices shall be selectively coordinated with all supply side (fed from both the normal and emergency source) overcurrent protective devices. Provide recommended fuses from a single manufacturer to maintain published minimum ampere coordination ratios. Provide integral type 2 surge protection built into the panelboard where available. Consult manufacturer for coordination ratios for other types of fuses.
- C. Related Sections:
 - 1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 2. Section 26 05 53 - Identification for Electrical Systems.
 - 3. Section 26 05 73 – Overcurrent Protective Device Coordination Study.
 - 4. Section 01 90 00 – Building Commissioning Requirements.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
 - 1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
 - 2. UL 248 – Low-Voltage Fuses.
 - 3. NEMA FU 1 – Low Voltage Cartridge Fuses.
- B. National Electrical Manufacturers Association:
 - 1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
 - 2. NEMA FU 1 - Low Voltage Cartridge Fuses.
 - 3. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
 - 4. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
 - 5. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
 - 6. NEMA PB 1 - Panelboards.
 - 7. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.
- C. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- D. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.
- E. Underwriters Laboratories Inc.:
 - 1. UL 67 - Safety for Panelboards.
 - 2. UL 1283 - Electromagnetic Interference Filters.
 - 3. UL 1449 - Transient Voltage Surge Suppressors.

1.5 SUBMITTALS

- 1. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes and with built type 2 surge protection (SPD).
- B. Product Data: Submit catalog data showing specified features of standard products.
- C. Main disconnect ratings (if applicable):
 - 1. Voltage and ampacity ratings of the disconnect.
 - 2. Voltage, ampacity, and interrupting ratings of fuses.
- D. Branch device ratings including:
 - 1. Voltage, ampacity, and interrupting ratings of fused branch device.
- E. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:

1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements.
- B. Operation and Maintenance Data: Submit spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.7 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.

- B. Fusible branch circuit panelboards shall be listed to UL 67.

1.9 MAINTENANCE MATERIALS

- A. Furnish two of each panelboard key. Panelboards keyed alike.
- B. Furnish 20% or minimum of three fuses of each rating and type of fuse installed.
- C. Furnish a minimum of one spare fuse cabinet or as indicated on the drawings.

PART 2 PRODUCTS

2.1 DISTRIBUTION PANELBOARDS

- A. Manufacturers:
 - 1. General Electric.
 - 2. Square D.
 - 3. Eaton/Cutler Hammer
 - 4. Substitutions: Not permitted.
- B. Product Description: NEMA PB 1, circuit breaker type panelboard.
- C. Panelboard Bus: Copper current carrying components, ratings as indicated on Drawings. Furnish copper ground bus in each panelboard.
- D. Panelboard shall have built in integral SPD protection for 480Y 3 phase L-N=1200, L-G=1200, N-G=1200, L-L=2000 and 208Y 3 phase shall have L-N=600, L-G=600, N-G=600, L-L =1000.
- E. Minimum integrated short circuit rating: Calculated based on primary transformer available SCR.
- F. Molded Case Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Furnish circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.
- G. Circuit Breaker Accessories: Trip units and auxiliary switches as indicated on Drawings.
- H. Enclosure: NEMA PB 1, Type 1 cabinet box.
- I. Cabinet Front: Surface door-in-door type, fastened with concealed trim clamps, hinged door with flush lock, metal directory frame, finished in manufacturer's standard gray enamel.
- J. Provide fully rated (100%) main circuit breakers in Panelboards where indicated.

2.2 BRANCH CIRCUIT PANELBOARDS

- A. Manufacturers:

1. General Electric.
 2. Square D.
 3. Eaton/Cutler Hammer.
 4. Substitutions: Not permitted.
- B. Product Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.
- C. Panelboard Bus: Copper current carrying components, ratings as indicated on Drawings. Furnish copper ground bus in each panelboard.
- D. Minimum Integrated Short Circuit Rating: Calculated based on primary transformer available SCR and as indicated on plans.
- E. SPD Devices: Provide integral panel mounted surge protective device modules within all 208/120 volt branch power panelboards.
1. IEEE C62.41 surge protective device.
 2. 200 kA short circuit current rating.
 3. Minimum current rating per phase: 120 kA.
- F. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Class A ground fault interrupter circuit breakers as indicated on Drawings. Do not use tandem circuit breakers.
- G. Enclosure: NEMA PB 1, Type 1.
- H. Cabinet Box: 6 inches deep, 20 inches wide for 240 volt and less panelboards.
- I. Cabinet Front: Flush cabinet front with concealed hinge, metal directory frame, and flush lock keyed alike. Finish in manufacturer's standard gray enamel.

2.3 FUSIBLE BRANCH CIRCUIT PANELBOARDS

- A. Manufacturers:
1. Fusible Panelboards shall be Cooper Bussmann™ Quik-Spec™ Coordination Panelboards type QSCP.
 2. Substitutions will be accepted only if the below requirements are met and written approval is provided from the engineer:
 - a. The electrical contractor supplies a written request to the engineer three weeks prior to the project bid date
 - b. The electrical contractor provides product documentation to prove complete compliance with specification and all pertinent codes and standards requirements as specified in this section.
- B. Panelboard overcurrent protective device interrupting ratings shall be fully rated for the maximum available fault current and have a UL Listed interrupting rating of 300kA and CSA Certified interrupting rating of 200kA with SPD. SPD protection for 480V, 3-phase

shall have L-N=600, L-G=600, N-G=600, L-L =1000 and for 480Y L-N=1200, L-G=1200, N-G=1200, L-L=2000.

C. Construction:

1. Panelboard circuits 100A and less shall incorporate overcurrent protection and branch-circuit rated disconnecting means into a single integrated component.
2. Interiors shall be factory assembled.
3. Panelboard shall be equipped with a six-space spare fuse compartment for storing replacement branch circuit fuses. Spare fuse compartment shall be located behind locking panel door.
4. Bus bars shall be tin-plated copper with sufficient cross sectional area to meet UL 67 temperature rise requirements.
5. 200A/400A rated neutrals shall be standard.
6. Main lug conductor terminations:
 - a. MLO terminations shall be rated for 60/75°C, Cu-Al
 - b. Main disconnect terminations shall be rated for 75°C, Cu Only
7. NEMA 1 panelboards shall be field convertible for top or bottom incoming feed.

D. Main Disconnect:

1. Permanently installed lockout means shall be provided on the main disconnect for lockout tagout procedures.
2. Main disconnect shall be quick-make, quick-break type.

E. Branch Fused Disconnects:

1. Device shall have visible circuit ON/OFF indication with colored and international symbol markings.
2. Device shall provide open fuse indication via permanently installed neon indicating light.
3. Device shall be UL and cUL Listed 600Vac/200kA or 125Vdc/100kA voltage/short-circuit current rating, load-break disconnect with amp ratings and number of poles as indicated on the panelboard schedule.
4. Fuse and disconnect assembly shall be a finger-safe component with trim installed.
5. Fuse and disconnect shall be mechanically interlocked so as not to allow fuse removal while fuse terminals are energized.
6. No special tools shall be required for fuse removal.
7. Devices shall have bolt-on style bus connectors.
8. Device housing shall be clearly marked with device amperage.
9. Permanently installed lockout means shall be provided on the device for lockout tagout procedures. Permanently installed means for locking device in the ON position shall also be provided.
10. Device shall provide fuse amp rating rejection at the following ampacities to ensure continued circuit protection at the specified circuit rating: 15A, 20A, 30A, 40A, 50A, 60A, 70A, 90A & 100A.

F. Main and Branch Circuit Overcurrent Protection

1. All overcurrent protective devices shall have a minimum UL Listed interrupting rating of 300kA and CSA Certified interrupting rating of 200kA.

2. Branch circuit overcurrent protection shall be 600Vac UL Listed minimum 300kA IR and CSA Certified minimum 200kA IR finger-safe fuse with Class J* performance characteristics.
 3. Main overcurrent protective devices shall be 600Vac UL Listed minimum 300kA IR and CSA Certified minimum 200kA IR Class J time-delay fuses or Class J performance fuses.
 4. Where panelboard main fuses are installed, fuses in panelboard branch circuits shall selectively coordinate with main fuses for all overcurrents up to 200kA.
- G. Panelboard Bus: Copper current carrying components, ratings as indicated on Drawings. Furnish copper ground bus in each panelboard.
- H. Minimum Integrated Short Circuit Rating: Calculated based on primary transformer available SCR and as indicated on plans.
- I. Enclosure:
1. NEMA 1 enclosures shall be surface or flush mount as indicated in associated schedules or drawings.
 2. Boxes shall be a nominal 20 inches wide and 5-³/₄ inches deep with wire bending space per the National Electrical Code.
 3. Panelboard trim shall be supplied with lockable door covering all disconnect handles.
 4. Panelboard trim shall be dead-front construction covering all energized parts.
 5. Door-in-door type trim shall be provided for NEMA 1 enclosures where it is specified in the associated schedules or drawings.
 6. Front trim shall be lockable. All lock assemblies shall be keyed alike with like NEMA rated enclosures.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install panelboards in accordance with NEMA PB 1.1.
- B. Install panelboards plumb.
- C. Install recessed panelboards flush with wall finishes.
- D. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.
- E. Install filler plates for unused spaces in panelboards.
- F. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes to balance phase loads.
- G. Install engraved plastic nameplates in accordance with Section 26 05 53.

- H. Install labeling indicated power supply origin of source feeding panelboard in accordance with Section 26 05 53.
- I. Install a permanent label indicating the panelboard or transformer where the power supply to the panel originates.
- J. Ground and bond panelboard enclosure according to Section 26 05 26. Connect equipment ground bars of panels in accordance with NFPA 70.
- K. Define each lighting control circuit breaker, relay load type and assign to required zone, input and/or schedule.

3.2 FIELD QUALITY CONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform circuit breaker inspections and tests listed in NETA ATS, Section 7.6.
- D. Perform switch inspections and tests listed in NETA ATS, Section 7.5.
- E. Perform controller inspections and tests listed in NETA ATS, Section 7.16.1.
- F. Above testing shall be documented in writing and furnished as a part of O&M manuals, and provided to CX agent prior to closeout.

3.3 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.
- B. Measure steady state load currents at each panelboard feeder; rearrange circuits in panelboard to balance phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION

SECTION 262726 - WIRING DEVICES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes wall switches; wall dimmers; receptacles; multioutlet assembly; and device plates and decorative box covers.
- B. Related Sections:
 - 1. Section 26 05 33 - Raceway and Boxes for Electrical Systems: Outlet boxes for wiring devices.
 - 2. Section 26 05 34 - Floor Boxes for Electrical Systems: Service fittings for receptacles installed on floor boxes.
 - 3. Section 26 05 34 - Floor Boxes for Electrical Systems: Poke-through receptacles.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA WD 1 - General Requirements for Wiring Devices.
 - 2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's catalog information showing dimensions, colors, and configurations.
- B. Samples: Submit two samples of each wiring device and wall plate illustrating materials, construction, color, and finish.
- C. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.7 QUALIFICATIONS

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

1.8 EXTRA MATERIALS

- A. Furnish two of each style, size, and finish wall plate.

PART 2 PRODUCTS

2.1 RECEPTACLES

- A. Manufacturers:
 - 1. Hubbell Wiring Products.
 - 2. Leviton.
 - 3. Bryant.
 - 4. Pass and Seymour.
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: NEMA WD 1, General-duty general use receptacle.
- C. Device Body: Color by Architect
- D. Configuration: NEMA WD 6, type as indicated on Drawings.
- E. Convenience Receptacle: Type 5-20R.
- F. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.
- G. Specification grade device.

2.2 OUTDOOR WEATHER PROOF COVERING.

- A. Manufacturers:
 - 1. Hubbell Wiring Products.
 - 2. Leviton.
 - 3. Bryant.
 - 4. Pass and Seymour.
 - 5. Substitutions: Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify outlet boxes are installed at proper height.
- B. Verify wall openings are neatly cut and completely covered by wall plates.

- C. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

- A. Clean debris from outlet boxes.

3.3 INSTALLATION

- A. Install devices plumb and level.
- B. Install receptacles with grounding pole on top.
- C. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor.
- D. Install weatherproof receptacle cover, in outdoor areas.
- E. Connect wiring devices by wrapping solid conductor around screw terminal. Install stranded conductor for branch circuits 10 AWG and smaller. When stranded conductors are used in lieu of solid, use insulated crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under device screws.
- F. Provide GFCI type receptacles for all 20A, 125V receptacles on roof with weatherproof cover.

3.4 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate locations of outlet boxes provided under Section 26 05 33 to obtain mounting heights as specified and as indicated on drawings.
- B. Install convenience receptacle above 36 inches to 48 inches above roof deck.

3.5 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects.
- B. Verify each receptacle device is energized.
- C. Test each receptacle device for proper polarity.
- D. Test each GFCI receptacle device for proper operation.

3.6 ADJUSTING

- A. Adjust devices and weatherproof to be level.

END OF SECTION

SECTION 262813 - FUSES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes fuses and spare fuse cabinet.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA FU 1 - Low Voltage Cartridge Fuses.

1.5 DESIGN REQUIREMENTS

- A. Select fuses to provide appropriate levels of short circuit and overcurrent protection for the following components: wire, cable, bus structures, and other equipment. Design system to maintain component damage within acceptable levels during faults.
- B. Select fuses to coordinate with time current characteristics of other overcurrent protective elements, including other fuses, circuit breakers, and protective relays. Design system to maintain operation of device closest to fault operates.

1.6 FUSE PERFORMANCE REQUIREMENTS

- A. General Purpose Branch Circuits: Class RK1 (time delay).
- B. Motor Branch Circuits: Class RK1 (time delay).

1.7 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit data sheets showing electrical characteristics, including time-current curves.
- C. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.8 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual sizes, ratings, and locations of fuses.

1.9 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile

Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings”, where applicable.

2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.10 QUALIFICATIONS

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

1.11 MAINTENANCE MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two fuse pullers.

1.12 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for extra materials.
- B. Furnish three spare fuses of each Class, size, and rating installed.

PART 2 PRODUCTS

2.1 FUSES

- A. Manufacturers:
 1. Bussman.
 2. Gould Shawmut.
 3. Little Fuse.
 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Dimensions and Performance: NEMA FU 1, Class as specified or as indicated on Drawings.
- C. Voltage: Rating suitable for circuit phase-to-phase voltage.
- D. Main Service Switches Larger than 600 amperes: Class L (time delay).
- E. Motor Load Feeder Switches: Class RK1 (time delay).
- F. Other Feeder Switches Larger than 600 amperes: Class L time delay.

- G. Other Feeder Switches: Class RK1 (time delay).
- H. General Purpose Branch Circuits: Class J (non-time-delay).
- I. Motor Branch Circuits: Class RK1 (time delay).

2.2 SPARE FUSE CABINET

- A. Manufacturers:
 - 1. Bussman.
 - 2. Gould Shawmut.
 - 3. Little Fuse.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Wall-mounted sheet metal cabinet with shelves, suitably sized to store spare fuses and fuse pullers specified.
- C. Doors: Hinged, with hasp for Owner's padlock.
- D. Finish: Gray enamel.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install fuse with label oriented so manufacturer, type, and size are easily read.
- B. Install spare fuse cabinet as indicated on Drawings or as directed by Owner.

END OF SECTION

SECTION 262819 - ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes fusible and nonfusible switches.
- B. Related Sections:
 - 1. Section 01 90 00 – Building Commissioning Requirements.
 - 2. Section 26 28 13 - Fuses.
 - 3. Section 26 05 53 – Identification for electrical systems.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA FU 1 - Low Voltage Cartridge Fuses.
 - 2. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- B. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit switch ratings and enclosure dimensions.
- C. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of enclosed switches and ratings of installed fuses.

1.7 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.

3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

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

PART 2 PRODUCTS

2.1 FUSIBLE SWITCH ASSEMBLIES

- A. Manufacturers:
 1. General Electric.
 2. Square D.
 3. Siemens.
 4. Eaton/Cutler Hammer.
 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: NEMA KS 1, Type HD, enclosed load interrupter knife switch. Handle lockable in OFF position.
- C. Fuse clips: Designed to accommodate NEMA FU 1, Class R fuses.
- D. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
 1. Interior Dry Locations: Type 1.
 2. Exterior Locations: Type 3R.
- E. Furnish switches with entirely copper current carrying parts.

2.2 NONFUSIBLE SWITCH ASSEMBLIES

- A. Manufacturers:
 1. General Electric.
 2. Square D.
 3. Siemens.
 4. Eaton/Cutler Hammer.
 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: NEMA KS 1, Type HD enclosed load interrupter knife switch. Handle lockable in OFF position.
- C. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
 1. Interior Dry Locations: Type 1.
 2. Exterior Locations: Type 3R.
- D. Furnish switches with entirely copper current carrying parts.

2.3 SWITCH RATINGS

- A. Switch Rating: Horsepower rated for AC or DC as indicated on Drawings.
- B. Short Circuit Current Rating: UL listed for 200,000 rms symmetrical amperes when used with or protected by Class R or Class J fuses (30-600 ampere switches employing appropriate fuse rejection schemes).

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install enclosed switches plumb. Provide supports in accordance with Section 26 05 29.
- B. Height: 5 feet to operating handle.
- C. Install fuses for fusible disconnect switches. Refer to Section 26 28 13 for product requirements.
- D. Install engraved plastic nameplates in accordance with Section 26 05 53.
- E. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.2 FIELD QUALITY CONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.5.

END OF SECTION

SECTION 262826 - ENCLOSED TRANSFER SWITCHES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes transfer switches in individual enclosures.
- B. Related Sections:
 - 1. Section 01 90 00 – Building Commissioning Requirements.
 - 2. Section 26 05 53 – Identification for Electrical Systems.
 - 3. Section 26 32 13 – Engine Generators.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA ICS 10 - Industrial Control and Systems: AC Transfer Switch Equipment.
- B. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

- C. Underwriters Laboratories Inc.:
 - 1. UL 1008 - Transfer Switch Equipment.

1.5 SUBMITTALS

- A. Product Data: Submit catalog sheets showing voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short circuit ratings, dimensions, and enclosure details.
- B. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of enclosed transfer switches.
- C. Operation and Maintenance Data: Submit routine preventative maintenance and lubrication schedule. List special tools, maintenance materials, and replacement parts.

1.7 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.

2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.

1.9 MAINTENANCE SERVICE

- A. Section 01 70 00 - Execution and Closeout Requirements: Maintenance service.
- B. Furnish service and maintenance of transfer switches for one year from Date of Substantial Completion.

PART 2 PRODUCTS

2.1 AUTOMATIC TRANSFER SWITCH

- A. Manufacturers:
 1. Asco.
 2. Russelectric.
 3. Onan.
 4. Kohler.
 5. Generac.
 6. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: NEMA ICS 10, automatic transfer switch.
- C. Configuration: Electrically operated, mechanically held transfer switch.
- D. Rating: State voltage and current rating and number of poles or "as indicated on drawings".
- E. Interrupting Capacity: 100 percent of continuous rating.
- F. Withstand Current Rating: 93kA rms symmetrical amperes, when used with molded case circuit breaker.
- G. Product Features:
 1. Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, switch position.
 2. Test Switch: Mount in cover of enclosure to simulate failure of normal source.
 3. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate source to normal source.

4. Transfer Switch Auxiliary Contacts: 2 normally open.
5. Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 95 percent.
6. Alternate Source Monitor: Monitor alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent.
7. In-Phase Monitor and Time Delay Neutral: Inhibit transfer until source and load are synchronized.
8. Switched Neutral: Non-Overlapping contacts.

H. Automatic Sequence of Operation:

1. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.
2. Time Delay To Start Alternate Source Engine Generator: 0 to 60 seconds, adjustable (refer to paragraph 10).
3. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.
4. Time Delay Before Transfer to Alternate Power Source: 0 to 60 seconds, adjustable (refer to paragraph 10).
5. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.
6. Time Delay Before Transfer to Normal Power: 0 to 60 seconds, adjustable; bypass time delay in event of alternate source failure.
7. Time Delay Before Engine Shut Down: 0 to 15 minutes, adjustable, of unloaded operation.
8. Engine Exerciser: Start engine every 30 days; run for 20 minutes before shutting down. Bypass exerciser control when normal source fails during exercising period.
9. Alternate System Exerciser: Transfer load to alternate source during engine exercising period.
10. Required emergency systems transfer switch and generator shall be configured in accordance with NFPA 70 to ensure emergency power is available within 10 seconds of failure of the normal supply. The Contractor shall coordinate starting and stabilization time with the generator supplier and set all time delays to ensure the required 10 second maximum time period is met.

I. Enclosure:

1. Enclosure: ICS 10, Type 1.
2. Finish: Manufacturer's standard enamel.

2.2 SOURCE QUALITY CONTROL

- A. Furnish shop inspection and testing of each transfer switch.
- B. Make completed transfer switch available for inspection at manufacturer's factory prior to packaging for shipment. Notify Owner at least seven days before inspection is allowed.
- C. Allow witnessing of factory inspections and tests at manufacturer's test facility. Notify Owner at least seven days before inspections and tests are scheduled.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install engraved plastic nameplates in accordance with Section 26 05 53.

3.2 FIELD QUALITY CONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.22.3.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Section 01 40 00 - Quality Requirements: Manufacturers' field services.
- B. Check out transfer switch connections and operations and place in service.

3.4 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Adjust control and sensing devices to achieve specified sequence of operation.

3.5 DEMONSTRATION AND TRAINING

- A. Demonstrate operation of transfer switch in bypass, normal, and emergency modes.
- B. Provide a minimum of 2 hours instruction to Owner & personnel by manufacturer's authorized representative.

END OF SECTION

SECTION 262913 - ENCLOSED CONTROLLERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes manual and magnetic motor controllers in individual enclosures.
- B. Related Sections:
- C. Related Sections:
 - 1. Section 01 90 00 – Building Commissioning Requirements.
 - 2. Section 26 28 13 - Fuses.
 - 3. Section 26 05 53 – Identification for electrical systems.
 - 4. Section 26 28 13 - Fuses.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
 - 2. NEMA FU 1 - Low Voltage Cartridge Fuses.

3. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
4. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
5. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
6. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

- B. International Electrical Testing Association:
1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
- C. Test Reports: Indicate field test and inspection procedures and test results.
- D. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations and ratings of enclosed controllers.
- C. Operation and Maintenance Data: Submit Replacement parts list for controllers.

1.7 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

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

PART 2 PRODUCTS

2.1 MANUAL MOTOR CONTROLLER

- A. Manufacturers:
 - 1. General Electric.
 - 2. Square D.
 - 3. Eaton/Cutler Hammer.
 - 4. Cerus Industrial.
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller with overload element, red pilot light, 1 NO and 1 NC auxiliary contact, and toggle operator.
- C. Enclosure: NEMA ICS 6, to meet conditions of installation.

2.2 FRACTIONAL-HORSEPOWER MANUAL CONTROLLER

- A. Manufacturers:
 - 1. General Electric.
 - 2. Square D.
 - 3. Eaton/Cutler Hammer.
 - 4. Cerus Industrial.
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, red pilot light, and toggle operator.
- C. Enclosure: NEMA ICS 6, to meet conditions of installation.

2.3 FULL-VOLTAGE NON-REVERSING CONTROLLERS

- A. Manufacturers:
 - 1. General Electric.
 - 2. Square D.
 - 3. Eaton/Cutler Hammer.
 - 4. Cerus Industrial.
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower.
- C. Control Voltage: 120 volts, 60 Hertz.
- D. Overload Relay: NEMA ICS 2; bimetal (electronic preferred).
- E. Product Features:
 - 1. Auxiliary Contacts General: NEMA ICS 2, 2 each, field convertible contacts in addition to seal-in contact.
 - 2. Cover Mounted Pilot Devices: NEMA ICS 5, heavy duty type.
 - 3. Pilot Device Contacts: NEMA ICS 5.
 - 4. Pushbuttons: Shrouded type.
 - 5. Indicating Lights: LED type.
 - 6. Selector Switches: Rotary type.
 - 7. Relays: NEMA ICS 2.
 - 8. Control Power Transformers: 120 volt secondary, in each motor starter. Furnish fused primary and secondary, and bond unfused leg of secondary to enclosure.
- F. Combination Controllers: Combine motor controllers with disconnect in common enclosure, using fusible switch conforming to NEMA KS 1, enclosed knife switch with externally operable handle. Fuse clips: Designed to accommodate NEMA FU 1, Class R fuses. Obtain IEC Class 2 coordinated component protection.

- G. Enclosure: NEMA ICS 6, to meet conditions. Fabricate enclosure from [steel finished with manufacturer's standard gray enamel.
 - 1. Interior Dry Locations: Type 1.
 - 2. Exterior Locations: Type 3R.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install enclosed controllers plumb. Provide supports in accordance with Section 26 05 29.
- B. Height: 5 feet to operating handle.
- C. Install fuses for fusible switches. Refer to Section 26 28 13 for product requirements.
- D. Select and install overload heater elements in motor controllers to match installed motor characteristics.
- E. Install engraved plastic nameplates. Refer to Section 26 05 53 for product requirements and location.
- F. Neatly type label and place inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place label in clear plastic holder.

3.2 FIELD QUALITY CONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.16.1.

END OF SECTION

SECTION 263213 - ENGINE GENERATORS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes engine generator set, exhaust silencer and fittings, fuel fittings and day tank, remote control panel, battery, and charger.
- B. Required emergency systems transfer switch and generator shall be configured in accordance with NFPA 70 to ensure emergency power is available within 10 seconds of failure of the normal supply. The Contractor shall coordinate transfer switch time delays with the enclosed transfer switch supplier based on generator starting and stabilization time to ensure the required 10 second maximum time period is met.
- C. Related Sections:
- D. Related Sections:
 - 1. Section 01 90 00 – Building Commissioning Requirements.
 - 2. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 3. Section 26 05 53 - Identification for Electrical Systems.
 - 4. Section 26 28 26 - Enclosed Transfer Switches.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 2. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
 - 3. NEMA ICS 10 - Industrial Control and Systems: AC Transfer Switch Equipment.
 - 4. NEMA MG 1 - Motors and Generators.
- B. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- C. National Fire Protection Association:
 - 1. NFPA 30 - Flammable and Combustible Liquids Code.
 - 2. NFPA 110 - Standard for Emergency and Standby Power Systems.

1.5 SYSTEM DESCRIPTION

- A. Description: Engine generator assembly and accessories to provide source of power for Level 1 and 2 applications in accordance with NFPA 110.
- B. Capacity: 600 kW, at elevation of 500 feet above sea level, standby rating using specified engine cooling scheme.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate electrical characteristics and connection requirements. Include plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, electrical diagrams including schematic and interconnection diagrams.
- C. Product Data: Submit data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, and day tank.
- D. Test Reports: Indicate results of performance testing.
- E. Manufacturer's Field Reports: Indicate inspections, findings, and recommendations.
- F. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).

- c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.7 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit instructions and service manuals for normal operation, routine maintenance, oil sampling and analysis for engine wear, and emergency maintenance procedures.

1.8 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of project.
- B. Supplier: Authorized distributor of specified manufacturer with minimum three years experience.

1.10 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish one year manufacturer warranty.

1.11 MAINTENANCE SERVICE

- A. Section 01 70 00 - Execution and Closeout Requirements: Maintenance service.
- B. Furnish service and maintenance of engine generator for one year from Date of Substantial Completion, and provide optional five year parts and labor maintenance agreement offering.

1.12 MAINTENANCE MATERIALS

- A. Furnish one set of tools required for preventative maintenance of engine generator system. Package tools in adequately sized metal tool box.
- B. Furnish two of each fuel, oil and air filter element.

PART 2 PRODUCTS

2.1 ENGINE

- A. Manufacturers:
 - 1. Atlantic/Detroit Diesel.
 - 2. Cummins/Onan.
 - 3. Caterpillar.
 - 4. Generac.
 - 5. Substitutions: Section 26 04 00.
- B. Product Description: Water-cooled in-line or V-type, four-stroke cycle, compression ignition diesel internal combustion engine.
- C. Rating: Sufficient to operate under 10 percent overload for one hour in ambient of 90 degrees F at elevation of 500 feet.
- D. Fuel System: No. 2 fuel oil.
- E. Engine speed: 1800 rpm.
- F. Safety Devices: Engine shutdown on high water temperature, low oil pressure, overspeed, and engine overcrank. Limits as selected by manufacturer.
- G. Engine Starting: DC starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer's instructions. Furnish remote starting

control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel.

- H. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F, and suitable for operation on 120 volts AC.
- I. Radiator: Radiator using glycol coolant, with blower type fan, sized to maintain safe engine temperature in ambient temperature of 110 degrees F. Radiator air flow restriction 0.5 inches of water maximum.
- J. Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil cooler, fuel transfer pump, fuel priming pump, gear-driven water pump. Furnish fuel pressure gage, water temperature gage, and lube oil pressure gage on engine/generator control panel.
- K. Mounting: Furnish unit with suitable spring-type vibration isolators and mount on structural steel base.
- L. Sub Base Tank: Provide with external, double wall sub base tank to store full fuel supply. Tank shall be sized for code required run time at full load and fuel flow rating, for 48 hours. Provide with tank full of fuel. Refill tank upon completion of operational start up and all testing.

2.2 GENERATOR

- A. Manufacturers:
 - 1. Detroit Deisel.
 - 2. Onan.
 - 3. Kohler.
 - 4. Generac.
 - 5. Substitutions: Section 01 60 00 - Product Requirements {01600 - Product Requirements}.
- B. Rating: 600 kW, at 0.8 power factor, 480Y/277 volts, 60 Hz at 1800 rpm.
- C. Insulation Class: F.
- D. Temperature Rise: 105 degrees C Continuous.
- E. Enclosure: NEMA MG1, open drip proof.
- F. Voltage Regulation: Furnish generator mounted volts per hertz exciter-regulator to match engine and generator characteristics, with voltage regulation plus or minus 1 percent from no load to full load. Furnish manual controls to adjust voltage droop, voltage level (plus or minus 5 percent) and voltage gain.

2.3 GOVERNOR

- A. Product Description: Electronic governor to maintain engine speed within 0.5 percent, steady state, and 5 percent, no load to full load, with recovery to steady state within 2 seconds following sudden load changes. Equip governor with means for manual operation and adjustment.

2.4 ACCESSORIES

- A. Exhaust Silencer: Critical type silencer, with muffler companion flanges and flexible stainless steel exhaust fitting, sized in accordance with engine manufacturer's instructions.
- B. Batteries: Heavy duty, diesel starting type lead-acid storage batteries, 170 ampere-hours minimum capacity. Match battery voltage to starting system. Furnish cables and clamps.
- C. Battery Tray: Treated for electrolyte resistance, constructed to contain spillage.
- D. Battery Charger: Current limiting type designed to float at 2.17 volts for each cell and equalize at 2.33 volts for each cell. Furnish overload protection, full wave rectifier, DC voltmeter and ammeter, and 120 volts AC fused input.
- E. Line Circuit Breaker: NEMA AB 1, fully rated, molded case circuit breaker on generator output with integral thermal and instantaneous magnetic trip in each pole. Furnish battery voltage operated shunt trip, connected to open circuit breaker on engine failure. Unit mount in enclosure to meet NEMA 250, Type 1 requirements. Provide additional, fully rated load circuit breakers as indicated on project plans and specifications.
- F. Emergency Power Off (EPO): Provide a red, EPO mushroom head push button for emergency off operation at the enclosure.
- G. Engine-Generator Control Panel: NEMA 250, Type 1 generator-mounted control panel enclosure with engine and generator controls and indicators. Furnish provision for padlock and the following equipment and features:
 - 1. Frequency Meter: 45-65 Hz. range, 3.5 inch dial.
 - 2. AC Output Voltmeter: 3.5 inch dial, 2 percent accuracy, with phase selector switch.
 - 3. AC Output Ammeter: 3.5 inch dial, 2 percent accuracy, with phase selector switch.
 - 4. Output voltage adjustment.
 - 5. Push-to-test indicator lamps, one each for low oil pressure, high water temperature, overspeed, and overcrank.
 - 6. Engine start/stop selector switch.
 - 7. Engine running time meter.
 - 8. Oil pressure gage.
 - 9. Water temperature gage.
 - 10. Auxiliary Relay: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.
 - 11. Additional visual indicators and alarms in accordance with NFPA 110.

12. Remote Alarm Contacts: Factory wire SPDT contacts to terminal strip for remote alarm functions in accordance with NFPA 110.

- H. Remote Annunciator Panel: Flush mounted panel with painted finish and RS-485 communications with the engine generator. Furnish alarm horn, and indicators and alarms as follows:
 1. High battery voltage (alarm).
 2. Low battery voltage (alarm).
 3. Low fuel (alarm).
 4. System ready.
 5. Anticipatory-high water temperature.
 6. Anticipatory-low oil pressure.
 7. Low coolant temperature.
 8. Switch in off position (alarm).
 9. Overcrank (alarm).
 10. Emergency stop (alarm).
 11. High water temperature (alarm).
 12. Overspeed (alarm).
 13. Low oil pressure (alarm).
 14. Line power available.
 15. Generator power available.
 16. Lamp test and horn silence switch.

- I. Generator Access Platform: Prefabricated Code compliant aluminum working platform along both sides of generator. Platform shall include:
 1. 42" wide platform with OSHA compliant railings.
 2. OSDHA/ADA compliant stair risers with railings (both sides).
 3. Adjustable leg height to set platform at base of enclosure, above fuel tank.
 4. Manufacturers:
 - a. REDD Team.
 - b. C.A.P. (Compliant Accesss Products, LLC)
 - c. Substitutions: Section 01 60 00 - Product Requirements {01600 - Product Requirements}.

- J. Weather-protective Enclosure: Reinforced steel housing allowing access to control panel and service points, with lockable doors and panels. Furnish with fixed louvers, fuel tank, battery rack, silencer, stainless steel hardware, and emergency power off button. Housing shall attenuate sound pressure produced by generator, as measured 25 feet from assembly, to a level of 70 dBA maximum.

2.5 SOURCE QUALITY CONTROL

- A. Provide shop inspection and testing of completed assembly.

- B. Make completed engine-generator assembly available for inspection at manufacturer's factory prior to packaging for shipment. Notify Owner and Architect/Engineer at least seven days before inspection is allowed.

- C. Allow witnessing of factory inspections and tests at manufacturer's test facility. Notify Architect/Engineer at least seven days before inspections and tests are scheduled.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install engraved nameplates in accordance with Section 26 05 53.
- B. Ground and bond generator and other electrical system components in accordance with Section 26 05 26.

3.2 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.22.
- C. Perform NFPA 110 emergency power system testing including full load testing and full load transfer.
- D. Above testing shall be documented in writing and furnished as a part of the O&M manuals, and provided to CX agent prior to closeout.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Prepare and start up engine-generator assembly.
- B. Submit written start up checklist and readings for all measurable conditions.

3.4 ADJUSTING

- A. Adjust generator output voltage and engine speed to meet specified ratings.

3.5 CLEANING

- A. Clean engine and generator surfaces. Replace oil and fuel filters with new.

3.6 DEMONSTRATION AND TRAINING

- A. Furnish 2 hours of instruction each for two persons, to be conducted at project site with manufacturer's representative.
- B. Describe loads connected to emergency and standby system and restrictions for future load additions.
- C. Simulate power outage by interrupting normal source, and demonstrate system operates to provide emergency and standby power.

END OF SECTION

SECTION 264100 - FACILITY LIGHTNING PROTECTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes air terminals, interconnecting conductors, grounding, and bonding for lightning protection.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. Lightning Protection Institute:
 - 1. LPI 175 - Standard of Installation.
- B. National Fire Protection Association:
 - 1. NFPA 780 - Standard for the Installation of Lightning Protection Systems.
- C. Underwriters Laboratories Inc.:
 - 1. UL 96 - Lightning Protection Components.
 - 2. UL 96A - Installation Requirements for Lightning Protection Systems.

1.5 SYSTEM DESCRIPTION

- A. Description: Conductor system protecting entire building and having UL Master Label.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects. Include terminal, electrode, and conductor sizes, and connection and termination details.
- C. Product Data: Submit catalog sheets showing dimensions and materials of each component, and include indication of listing in accordance with UL 96.
- D. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.
- E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
- F. Certificate of Compliance: Submit certificate from Underwriter's Laboratories indicating approval of lightning protection systems.
- G. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.7 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors.

1.8 QUALITY ASSURANCE

- A. Perform Work in accordance with NFPA 780.
- B. Perform Work in accordance with UL 96A and furnish Master Label.
- C. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in lightning protection equipment with minimum five years documented experience and a member of Lightning Protection Institute.
- B. Installer: Authorized installer of manufacturer with minimum five years documented experience and certified by Lightning Protection Institute.
- C. Inspection Agency: Underwriter's Laboratories, Inc. (UL).

1.10 PRE-INSTALLATION MEETINGS

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

1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.12 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate Work with roofing and exterior and interior finish installations.

PART 2 PRODUCTS

2.1 COMPONENTS

- A. Manufacturers:
 - 1. Erico.
 - 2. Hager.
 - 3. Alltec
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Listing: UL 96.
- C. Air Terminals:
 - 1. Material: Copper.
 - 2. Configuration: Solid.
 - 3. Use adhesive base for single-ply roof installations.
 - 4. Air Terminal for Chimney: Lead-coated copper.
 - 5. Grounding Rods: Solid copper.
 - 6. Ground Plate: Copper.
 - 7. Conductors:
 - a. Material: Copper.
 - b. Configuration: Cable.
- D. Connectors and Splicers: Bronze.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with UL 96A.
- B. Connect conductors using mechanical connectors.
- C. Conceal interior conductors within building finishes. Conceal exterior conductors where practical.
- D. Bond exterior metal bodies on building to lightning protection system, and provide intermediate level interconnection loops 60 feet on center.

3.2 FIELD QUALITY CONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Perform inspection and testing in accordance with UL 96A.

END OF SECTION

SECTION 265100 - INTERIOR LIGHTING

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes interior luminaires, lamps, ballasts, and accessories.
- B. Related Sections:
 - 1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
 - 3. Section 26 56 00 - Exterior Lighting.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI C82.11 - American National Standard for Lamp Ballast-Line Frequency Fluorescent Lamp Ballast.
 - 2. ANSI C82.4 - American National Standard for Ballasts-for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type).

- B. International Engineering Society of North America:
 - 1. IESNA LM-79: Approved Method- Electrical and Photometric Measurements of Solid-State Lighting Products.
 - 2. IESNA LM-80: Approved Method for Measuring Lumen Maintenance of LED light Sources.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate dimensions and components for each luminaire not standard product of manufacturer.
- C. Product Data: Submit dimensions, ratings, and performance data:
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include emergency lighting units, including batteries and chargers.
 - 5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
 - 6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA LM-79 and IESNA LM-80.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - b. Testing Agency Certified Data: Photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
 - c. TM-21 report for L70 rating at color temperature specified.
- D. Shop Drawings: For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
- E. Samples: Submit two color chips 3 x 3 inch in size illustrating luminaire finish color where indicated in luminaire schedule.

- F. Qualification Data: For testing laboratory providing photometric data for luminaires.
1. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
 - a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 3. Product Test Reports: For each luminaire, for tests performed by a qualified testing agency.
 4. Sample warranty.
- G. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 QUALITY ASSURANCE

- A. High Performance Building Requirements:
1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles

shall be documented in accordance with the High Performance Building Requirements of this Section.

3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.7 QUALIFICATIONS

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

1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.9 MAINTENANCE MATERIALS

- A. Furnish two of each plastic lens type.
- B. Furnish twelve replacement lamps for each fluorescent or HID lamp type installed.
- C. Furnish two of each ballast and LED driver type.

PART 2 PRODUCTS

2.1 INTERIOR LUMINAIRES

- A. Manufacturers:
 1. Manufacturers represented by Apex Lighting.
 2. Manufacturers represented by Reflex Lighting.
 3. Manufacturers represented by Lighting Affiliates.
 4. Manufacturers represented by Illuminate/Vanguard Lighting.
- B. Substitutions:
 1. Substitutions: Section 26 04 00 - Product Requirements and as follows:
 - a. Approved equals to the basis of design fixture shall be accepted for review with the proposed substitute fixture meeting the following minimum requirements:
 - 1) Be of the same general size, style and shape, including but not limited to lens construction and shading.
 - 2) Be of equal or better quality and construction.
 - 3) Be supplied with all required accessories to match the specified fixture.
 - 4) Be supplied with all remote drivers, power supplies and cabling lengths to meet specified performance and control.
 - 5) Provide the same or better distribution, efficiency, source lumen output, and L70 lumen depreciation metric.
 - b. Provide point-by-point photometric calculations at the request of the Engineer for evaluation.

- c. The basis of design fixture listed in the Lighting Fixture Schedule lists part numbers, specifications, options, accessories and source output available at the time of design. Substitutions shall meet these requirements as scheduled.
 - d. The evaluation of an approved equal shall be at the sole discretion of the Architect and Engineer.
- C. Product Description: Complete interior luminaire assemblies, with features, options, and accessories as scheduled.
- D. Performance requirements:
- 1. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
 - 2. Luminaire requirements
 - a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - b. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
 - c. Recessed Fixtures: Comply with NEMA LE 4.
 - d. Bulb shape complying with ANSI C79.1.
 - e. Lamp base complying with ANSI C81.61.
 - f. CRI of minimum 80.
 - g. LED lamp life, minimum of 50,000 hours.
 - h. TM-21 L70 lumen depreciation metric calculated at color temperature listed.
 - i. Internal ballast/driver.
 - j. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

2.2 MATERIALS

- A. Metal Parts:
- 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
 - 4. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
 - 5. Diffusers and Globes:
 - a. Refer to Interior Light Fixture Schedule for types.
 - b. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - c. Glass: Annealed crystal glass unless otherwise indicated.

- d. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- 6. Housings:
 - a. Extruded-aluminum housing and heat sink unless otherwise indicated.
 - b. Powder-coat finish unless otherwise indicated, color selection by Architect.
- 7. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - a. Label shall include the following lamp characteristics:
 - 1) "USE ONLY" and include specific lamp type.
 - 2) Lamp diameter, shape, size, wattage, and coating.
 - 3) CCT and CRI for all luminaires.

B. METAL FINISHES

- 1. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.3 LUMINAIRE FIXTURE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage minimum.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

2.4 FLUORESCENT BALLASTS

- A. Manufacturers:
 - 1. General Electric Co.
 - 2. Universal Lighting Technologies.
 - 3. Philips Electronic North America / Advance.
 - 4. Osram Sylvania.

5. Substitutions: Section 26 04 00.

B. Product Description: Electronic ballast instant start (program start where controlled by occupancy sensors) by Certified Ballast Manufacturers, Inc. to comply with ANSI C82.1, suitable for lamps specified, with voltage to match luminaire voltage.

2.5 HIGH INTENSITY DISCHARGE (HID) BALLASTS

A. Manufacturers:

1. General Electric Co.
2. Universal Lighting Technologies.
3. Philips Electronic North America / Advance.
4. Osram Sylvania.
5. Substitutions: Section 26 04 00.

B. Product Description: ANSI C82.4, metal halide lamp ballast, suitable for lamp specified, with voltage to match luminaire voltage.

2.6 FLUORESCENT DIMMING BALLASTS AND CONTROLS

A. Manufacturers:

1. Lutron.
2. Advance Transformer.
3. Universal Lighting Technologies.
4. Substitutions: Section 26 04 00.

B. Product Description: Electrical assembly of control unit and ballast to furnish smooth dimming of fluorescent lamps.

C. Ballast: Selected by dimming system manufacturer as suitable for operation with control unit and suitable for lamp type and quantity specified for luminaire.

2.7 FLUORESCENT LAMPS

A. Manufacturers:

1. General Electric Co.
2. Philips Electronics North America.
3. Osram/Sylvania.
4. Substitutions: Section 26 04 00.

2.8 HID LAMPS

A. Manufacturers:

1. General Electric Co.
2. Philips Electronics North America.
3. Osram/Sylvania.
4. Substitutions: Section 26 04 00.

2.9 LED DRIVERS

A. Manufacturers:

1. eldoLED
2. Lutron.
3. General Electric Co.
4. Philips Electronics North America.
5. Osram/Sylvania.
6. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: LED dimming driver.

1. 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers
2. Digital (DALI Low Voltage Controlled) Dimming Drivers
3. Digital Multiplex (DMX Low Voltage Controlled) Dimming Drivers

C. General:

1. LED dimming shall be equal in range and quality to a commercial grade incandescent dimmer. Quality of dimming to be defined by dimming range, freedom from perceived flicker or visible stroboscopic flicker, smooth and continuous change in level (no visible steps in transitions), natural square law response to control input, and stable when input voltage conditions fluctuate over what is typically experience in a commercial environment. Demonstration of this compliance to dimming performance will be necessary for substitutions or prior approval.
2. Ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.
3. Driver must limit inrush current.
 - a. Base specification: Meet or exceed NEMA 410 driver inrush standard of 430 Amps per 10 Amps load with a maximum of 370 Amps² – seconds.
 - b. Preferred Specification: Meet or exceed 30mA²s at 277VAC for up to 50 watts of load and 75A at 240us at 277VAC for 100 watts of load.
4. Withstand up to a 1,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A.
5. No visible change in light output with a variation of plus/minus 10 percent line voltage input.
6. Total Harmonic Distortion less than 20% percent and meet ANSI C82.11 maximum allowable THD requirements at full output. THD shall at no point in the dimming curve allow imbalance current to exceed full output THD.
7. Driver must support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance:
 - a. Adjustment of forward LED voltage, supporting 3V through 55V.
 - b. Adjustment of LED current from 200mA to 1.05A at the 100 percent control input point in increments of 1mA
 - c. Adjustment for operating hours to maintain constant lumens (within 5 percent) over the 50,000 hour design life of the system, and deliver up to 20 percent energy savings early in the life cycle.

8. Driver must be able to operate for a (+/- 10%) supply voltage of 120V through 277VAC at 60Hz.
9. Driver should be UL Recognized under the component program and shall be modular for simple field replacement. Drivers that are not UL Recognized or not suited for field replacement will not be considered.
10. Driver shall include ability to provide no light output when the analog control signal drops below 0.5 V, or the DALI/DMX digital signal calls for light to be extinguished and shall consume 0.5 watts or less in this standby. Control deadband between 0.5V and 0.65V shall be included to allow for voltage variation of incoming signal without causing noticeable variation in fixture to fixture output.

D. Light Quality

1. Over the entire range of available drive currents, driver shall provide step-free, continuous dimming to black from 100 percent to 1 percent and 10% relative light output where indicated, or 100 – 10% light standard. Driver shall respond similarly when raising from 1% to 100%
 - a. Driver must be capable of configuring a linear or logarithmic dimming curve, allowing fine grained resolution at low light levels
2. Drivers to track evenly across multiple fixtures at all light levels, and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range.
3. Driver and luminaire electronics shall deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10). At all points within the dimming range from 100-1 percent luminaire shall have:
 - a. LED dimming driver shall provide continuous step-free, flicker free dimming similar to incandescent source.
 - b. Base specification: Flicker index shall less that 5% at all frequencies below
 - c. 1000 Hz.
 - d. Preferred specification: Flicker index shall be equal to incandescent, less that 1% at all frequencies below 1000 Hz.

E. Control Input

1. 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers
 - a. Must meet IEC 60929 Annex E for General White Lighting LED drivers
 - b. Connect to devices compatible with 0 to 10V Analog Control Protocol, Class 2, capable of sinking 0.6 ma per driver at a low end of 0.3V. Limit the number of drivers on each 0-10V control output based on voltage drop and control capacity.
 - c. Must meet ESTA E1.3 for RGBW LED drivers
2. Digital (DALI Low Voltage Controlled) Dimming Drivers
 - a. Must meet IEC 62386
3. Digital Multiplex (DMX Low Voltage Controlled) Dimming Drivers
 - a. Must meet DMX / RDM: USITT DMX512A and ANSI E1.20 (Explore & Address)

- b. Capable of signal interpolation and smoothing of color and intensity transitions
- F. *Driver: Selected by dimming system* manufacturer as suitable for operation with control unit and suitable for LED source type and quantity specified for luminaire.

2.10 LED FIXTURES

- A. Refer to light fixture schedule.
- B. Minimum allowable efficacy of 80 lumens per watt.
- C. Integral junction box with conduit fittings.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install suspended luminaires using pendants supports. Install pendant length required to suspend luminaire at indicated height.
 - 1. Suspended Luminaire Support:
 - a. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - b. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box, heavy-duty swivel hangers and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - c. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
 - d. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- B. Support luminaires independent of ceiling framing.
- C. Where remote ballasts are required, mount ballasts in remote locations as per the manufacturers' recommendations and per ballast requirements, at no additional cost.
- D. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.
- E. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.
- F. Exposed Grid Ceilings: Support surface-mounted luminaires on grid ceiling directly from building structure.
- G. Install recessed luminaires to permit removal from below.

- H. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
- I. Install clips to secure recessed grid-supported luminaires in place.
- J. Install wall-mounted luminaires at height as indicated on Drawings and as scheduled.
- K. Install accessories furnished with each luminaire.
- L. Connect luminaires to branch circuit using flexible conduit, except for emergency lighting which shall be in conduit completely.
- M. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- N. Install specified lamps in each luminaire.
- O. Ground and bond interior luminaires in accordance with Section 26 05 26.

3.2 FIELD QUALITY CONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.3 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Aim and adjust luminaires as indicated on Drawings.

3.4 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Remove dirt and debris from enclosures.
- C. Clean photometric control surfaces as recommended by manufacturer.
- D. Clean finishes and touch up damage.

3.5 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Protecting finished work.
- B. Relamp luminaires having failed lamps at Substantial Completion.

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State Project No.s: 014-0034 EA / 014-0035 BE-EA

3.6 SCHEDULES

A. Refer to Drawings.

END OF SECTION

SECTION 265200 - EMERGENCY LIGHTING

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes emergency exit signs and egress marking systems.
- B. Related Sections:
 - 1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.5 SYSTEM DESCRIPTION

- A. Emergency lighting to comply with requirements.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit dimensions, ratings, and performance data.
- C. Samples: Submit two color chips 3 x 3 inch in. size illustrating unit finish color.
- D. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.7 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

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

1.9 EXTRA PRODUCTS

- A. Provide (6) universal exit signs complete with all labor and materials required for installation as directed by the Local Authority Having Jurisdiction.

1.10 MAINTENANCE MATERIALS

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

PART 2 PRODUCTS

2.1 EXIT SIGNS

- A. Manufacturers:
 - 1. Manufacturers represented by Apex Lighting.
 - 2. Manufacturers represented by Lighting Affiliates.
 - 3. Manufacturers represented by Reflex Lighting.
 - 4. Manufacturers represented by Illuminate/Vanguard lighting.
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Exit sign fixture.
- C. Housing: Extruded aluminum.
- D. Face: Translucent plastic face with red letters on white or clear background. Provide with international symbol of accessibility at level of exit, accessible exits as indicated on the Drawings.
- E. Letters and Directional Arrows: Universal type for field adjustment sized so that they are clearly visible at a distance of 40 feet as required by local codes.
- F. Mounting: As indicated on Drawings and universal, for field adjustment.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install suspended exit signs using pendants supported from swivel hangers. Install pendant length required to suspend sign at indicated height.
- B. Install surface-mounted exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.

- C. Install wall-mounted exit signs at height as indicated on Drawings or as directed by the Authority Having Jurisdiction.
- D. Install accessories furnished with each exit sign and egress marking system component.
- E. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within unit.
- F. Install specified lamps in each exit sign.
- G. Ground and bond exit signs in accordance with Section 26 05 26.

3.2 FIELD QUALITY CONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Operate each unit after installation and connection. Inspect for proper connection and operation.

3.3 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Position exit sign directional arrows as indicated on Drawings and as directed by the Authority Having Jurisdiction.

3.4 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Protecting finished work.
- B. Relamp exit signs having failed lamps at Substantial Completion.

3.5 SCHEDULES

- A. See Drawings.

END OF SECTION

SECTION 265600 - EXTERIOR LIGHTING

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes exterior luminaries, poles, and accessories.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Section 26 05 19 – Electrical Power Conductors and Cables
 - 2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
 - 3. Section 26 51 00 – Interior Lighting.
 - 4. Section 33 71 19 – Electrical Underground Ducts and Handholes
 - 5. Section 33 79 00 – Site Grounding

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI C82.1 - American National Standard for Lamp Ballast-Line Frequency Fluorescent Lamp Ballast.
 - 2. ANSI C82.4 - American National Standard for Ballasts-for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type).

3. ANSI O5.1 - Wood Poles, Specifications and Dimensions.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Requirements: Submittal procedures.
- B. Shop Drawings: Indicate dimensions and components for each luminaire not standard Product of manufacturer.
- C. Product Data: Submit dimensions, ratings, and performance data.
- D. Samples: Submit two color chips 3 x 3 inch in size illustrating luminaire finish color where indicated in luminaire schedule.
- E. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.

3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

1.9 COORDINATION

- A. Section 01 31 00 – Project Management, Coordination, and Commissioning: Coordination and project conditions.
- B. Furnish bolt templates and pole mounting accessories to provider of pole foundations.

1.10 MAINTENANCE MATERIALS

- A. Section 01 77 00 - Contract Closeout: Spare parts and maintenance products.
- B. Furnish two of each lamp or LED array installed.
- C. Furnish two ballasts and LED drivers of each lamp type installed.

PART 2 PRODUCTS

2.1 LUMINAIRES

- A. Product Description: Complete exterior luminaire assemblies, with features, options, and accessories as scheduled.
- B. Refer to Section 01 60 00 - Product Requirements for product options.
- C. Refer to Section 26 51 00 – LED product requirements.

2.2 FLUORESCENT BALLASTS

- A. Manufacturers:
 1. General Electric Co.
 2. Magnetek Inc.
 3. Philips Electronic North America.
 4. Advance.
 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Suitable for lamps and environmental conditions specified, with voltage to match luminaire voltage.

2.3 LED FIXTURES AND DRIVERS

- A. Refer to Light Fixture Schedules.
- B. Refer to Section 26 51 00 for LED fixture and driver product requirements.

2.4 HIGH INTENSITY DISCHARGE (HID) BALLASTS

- A. Manufacturers:
 - 1. General Electric Co.
 - 2. Magnetek Inc.
 - 3. Philips Electronic North America.
 - 4. Advance.
 - 5. Holophane.
 - 6. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: ANSI C82.4, metal halide lamp ballast, suitable for lamp and environmental conditions specified, with voltage to match luminaire voltage.

2.5 FLUORESCENT LAMPS

- A. Manufacturers:
 - 1. General Electric Co.
 - 2. Philips Electronics North America.
 - 3. Osram/Sylvania.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: All lamps shall have mercury content less than 90 picograms per lumen hour.

2.6 HID LAMPS

- A. Manufacturers:
 - 1. General Electric Co.
 - 2. Philips Electronics North America.
 - 3. Osram/Sylvania.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: All lamps shall have mercury content less than 90 picograms per lumen hour.

2.7 METAL POLES

- A. Manufacturers:
 - 1. Refer to Light Fixture Schedule on Civil Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 31 00 - Project Management, Coordination, and Commissioning: Coordination and Project conditions.
- B. Verify foundations are ready to receive fixtures.

3.2 INSTALLATION

- A. Attach stem and pendent fixtures to swivel type attachment box. Provide independent seismic restraint of each fixture.
- B. Install lamps in each luminaire.
- C. Bond and ground luminaries, metal accessories and metal poles in accordance with Section 26 05 26.

3.3 FIELD QUALITY CONTROL

- A. Section 01 77 00 - Contract Closeout: Field inspecting, testing, adjusting, and balancing.
- B. Operate each luminaire after installation and connection. Inspect for improper connections and operation.

3.4 ADJUSTING

- A. Section 01 77 00 - Contract Closeout: Testing, adjusting, and balancing.
- B. Aim and adjust luminaries to provide illumination levels and distribution as indicated on Drawings.

3.5 CLEANING

- A. Section 01 77 00 - Contract Closeout: Final cleaning.
- B. Clean photometric control surfaces as recommended by manufacturer.
- C. Clean finishes and touch up damage.

3.6 PROTECTION OF FINISHED WORK

- A. Section 01 77 00 - Contract Closeout: Protecting finished work.
- B. Re-lamp luminaries having failed lamps at Substantial Completion.

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State Project No.s: 014-0034 EA / 014-0035 BE-EA

3.7 SCHEDULES

A. See Drawings.

END OF SECTION

SECTION 27 0526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Wire.
 - 2. Mechanical connectors.
 - 3. Exothermic connections.
- B. Related Sections:
 - 1. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 2. Division 1 Section 013329 - General LEED® Requirements
 - 3. Division 1 Section 017419 - Waste Management and Disposal
 - 4. Division 1 Section 018113 - LEED® Product Requirements

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. Building Industry Consulting Service International, Inc.
 - 1. BICSI TDM Manual - Telecommunications Distribution Methods Manual.

- B. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.
- C. Telecommunication Industry Association/Electronic Industries Alliance:
 - 1. TIA/EIA 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications.

1.5 SYSTEM DESCRIPTION

- A. Communications grounding systems use the following elements as grounding electrodes:
 - 1. Building grounding electrode.
- B. Do not use the following elements as grounding electrodes:
 - 1. Building plumbing system.

1.6 PERFORMANCE REQUIREMENTS

- A. Grounding System Resistance: 10 ohms maximum.

1.7 SUBMITTALS

- A. Section 01 33 00 - Submittal Requirements: Requirements for submittals.
- B. Product Data: Submit data on grounding electrodes and connections.
- C. Test Reports: Indicate overall resistance to ground and resistance of each electrode.
- D. Manufacturer's Installation Instructions: Submit for active electrodes.
- E. Manufacturer's Certificate: Certify meet or exceed specified requirements.
- F. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and

coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.8 CLOSEOUT SUBMITTALS

- A. Section 01 77 00 - Contract Closeout: Requirements for submittals.
- B. Project Record Documents: Record actual locations of components and grounding electrodes.

1.9 QUALITY ASSURANCE

- A. Provide grounding, surge protection and lightning protection of telecommunications system in accordance with latest version of Grounding, Bonding and Electrical Protection chapter of the BICSI TDM Manual, TIA/EIA 607, and NFPA 70.
- B. Maintain one copy of each document on site.
- C. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.10 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.
- B. Installer: Company specializing in performing work of this section with minimum three years experience approved by manufacturer.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

- C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.12 COORDINATION

- A. Section 01 31 00 - Project Management, Coordination, and Commissioning: Requirements for coordination.
- B. Complete grounding and bonding of building reinforcing steel prior concrete placement.

PART 2 PRODUCTS

2.1 WIRE

- A. Material: Stranded copper.
- B. Grounding Conductor: Copper conductor bare.
- C. Bonding Conductor: Copper conductor bare.

2.2 MECHANICAL CONNECTORS

- A. Manufacturers:
 - 1. Copperweld, Inc.
 - 2. Erico, Inc.
 - 3. O-Z Gedney Co.
 - 4. Thomas & Betts, Electrical
 - 5. Substitutions: Section 01 60 00 - Product Requirements
- B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

2.3 EXOTHERMIC CONNECTIONS

- A. Manufacturers:
 - 1. Cadweld, Erico, Inc.
 - 2. Copperweld, Inc.
 - 3. ILSCO Corporation.
 - 4. O-Z Gedney Co.
 - 5. Thomas & Betts, Electrical.
 - 6. Substitutions: Section 01 60 00 - Product Requirements
- B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

PART 3 EXECUTION

3.1 PREPARATION

- A. Remove paint, rust, mill oils, surface contaminants at connection points.

3.2 INSTALLATION

- A. Install in accordance with BICSI TDM Manual, TIA/EIA 607, and NFPA 70.
- B. Provide grounding/bonding for each communication rack using #4 AWG THHN, rated for 90 degrees C, insulated, copper stranded conductor. Terminate to copper communication grounding Bar in each telecommunications room.
- C. Bond main telecommunications grounding system to building grounding electrode system at main electrical service entrance location with #3/0 AWG THHN, rated for 90 degrees C, insulated, copper stranded conductor.
- D. Routing of grounding conductor shall be as short and direct as practical.
- E. Install routing of bonding conductors with minimum number of bends and splices. Use sweeping bends.
- F. Install bonding connections with listed bolts, crimp pressure connectors, clamps, or lugs.
- G. Within each MDF/IDF room, provide ground bar mounted to isolating stand offs, with pre-drilled holes for accepting cable spade lugs. Each ground bus shall connect to the next with #3/0 AWG insulated green wire, and the final termination shall be at the main demarc location.
- H. Position busbars near associated equipment and insulate from supports.
- I. Construct busbars of copper, 4 inches x 8 inches by 1/4 inch thick with pilot holes for ground lug.
- J. Bond backbone cabling at each sheath opening.
- K. Ground/bond data cabinets, racks, cable trays.
- L. Conduit stub/sleeves shall be installed with ground bushings and form a continuous bonded surface.
- M. Install ground from each piece of equipment to grounding bar via an insulated cable no smaller than 6 AWG stranded copper wire. Install proper grounding lug on cable where connecting to racks and grounding bar.
- N. Label grounding conductors and grounding bus bars in accordance with BICSI guidelines.
- O. Permanently attach equipment and grounding conductors prior to energizing equipment.

3.3 FIELD QUALITY CONTROL

- A. Section 01 45 00 - Quality Control: Field inspecting, testing, adjusting, and balancing.
- B. Visually inspect from each bus bar to main grounding electrode service location.
- C. Test in accordance with BICSI TDM Manual, TIA/EIA 607, and NFPA 70.
- D. When improper grounding is found, check entire project and correct. Perform retest.

END OF SECTION

SECTION 270529 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Conduit supports.
 - 2. Formed steel channel.
 - 3. Spring steel clips.
 - 4. Sleeves.
 - 5. Mechanical sleeve seals.
 - 6. Equipment bases and supports.
- B. Related Sections:
 - 1. Section 03 30 00 - Cast-In-Place Concrete: Product requirements for concrete for placement by this section.
 - 2. Division 07 Section – Penetration Firestopping.
 - 3. Section 26 05 29 - Hangers and Supports for Electrical Systems.
 - 4. Section 27 10 00 – Structured Cabling.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. ASTM International:
 - 1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 3. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
 - 4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
- B. FM Global:
 - 1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.
- C. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.
- D. Underwriters Laboratories Inc.:
 - 1. UL 263 - Fire Tests of Building Construction and Materials.
 - 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
 - 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
 - 4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
 - 5. UL - Fire Resistance Directory.

1.5 PHASE 2 SUPPORT REQUIREMENTS

- A. All communications systems including equipment, conduit, junction boxes and accessories being hung from above shall not be supported from the existing "space truss" roof structure unless noted otherwise. Systems shall be supported from new framing only. Refer to structural drawings for locations of new framing. Provide supplemental framing as required.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
- C. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
- D. Design Data: Indicate load carrying capacity of trapeze hangers and hangers and supports.
- E. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.

- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- G. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.7 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.
- B. Installer: Company specializing in performing work of this section with minimum three years experience, approved by manufacturer.

1.9 PRE-INSTALLATION MEETINGS

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

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

PART 2 PRODUCTS

2.1 CONDUIT SUPPORTS

- A. Manufacturers:
 - 1. Allied Tube & Conduit Corp.
 - 2. Electroline Manufacturing Company.
 - 3. O-Z Gedney Co.
 - 4. Thomas and Betts
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.
- C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.
- D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.
- E. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.
- F. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.

2.2 FORMED STEEL CHANNEL

- A. Manufacturers:
 - 1. Allied Tube & Conduit Corp.
 - 2. B-Line Systems.
 - 3. Midland Ross Corporation, Electrical Products Division.
 - 4. Unistrut Corp.
 - 5. Substitutions: Section 01 60 00 - Product Requirements

- B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.3 SPRING STEEL CLIPS

- A. Manufacturers:
 1. Allied Tube & Conduit Corp.
 2. B-Line Systems
 3. Midland Ross Corporation, Electrical Products Division.
 4. Unistrut Corp.
 5. Substitutions: Section 01 60 00 - Product Requirements
- B. Product Description: Mounting hole and screw closure.

2.4 SLEEVES

- A. Sleeves for conduit, cable tray, raceway or cable through Non-fire Rated Floors: 18 gage thick galvanized steel.
- B. Sleeves for conduit, cable tray, raceway or cable through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
- C. Sleeves for conduit, cable tray, raceway, or cable through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.
- D. Fire-stopping Insulation: Glass fiber type, non-combustible.

2.5 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
 1. Thunderline Link-Seal, Inc.
 2. NMP Corporation.
 3. PSI Link-Seal.
 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify openings are ready to receive sleeves.

- C. Verify openings are ready to receive firestopping.

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
- B. Remove incompatible materials affecting bond.
- C. Obtain permission from Architect/Engineer before using powder-actuated anchors.
- D. Do not drill or cut structural members.

3.3 INSTALLATION - HANGERS AND SUPPORTS

- A. Anchors and Fasteners:
 - 1. Concrete Structural Elements: Provide precast inserts and expansion anchors.
 - 2. Steel Structural Elements: Provide beam clamps, spring steel clips, and welded fasteners.
 - 3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
 - 4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.
 - 5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
 - 6. Sheet Metal: Provide sheet metal screws.
 - 7. Wood Elements: Provide wood screws.
- B. Inserts:
 - 1. Install inserts for placement in concrete forms.
 - 2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.
- C. Install conduit and raceway support and spacing in accordance with NEC.
- D. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
- E. Install multiple conduit runs on common hangers.
- F. Supports:
 - 1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
 - 2. Install surface mounted cabinets and panelboards with minimum of four anchors.
 - 3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.

4. Support vertical conduit at every floor.

3.4 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment. Refer to Section 03 30 00.
- B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of formed steel channel. Brace and fasten with flanges bolted to structure.

3.5 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with adjustable interlocking rubber links.
- B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.
- C. Set sleeves in position in forms. Provide reinforcing around sleeves.
- D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- E. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- G. Install chrome plated steel escutcheons at finished surfaces.

3.6 FIELD QUALITY CONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

3.7 CLEANING

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

3.8 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 270533 - CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.
- B. Related Sections:
 - 1. Division 07 Section – Penetration Firestopping.
 - 2. Section 26 05 03 - Equipment Wiring Connections.
 - 3. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
 - 4. Section 26 05 34 - Floor Boxes for Electrical Systems.
 - 5. Section 26 05 36 - Cable Trays for Electrical Systems.
 - 6. Section 27 05 26 - Grounding and Bonding for Communications Systems.
 - 7. Section 27 05 29 - Hangers and Supports for Communications Systems.
 - 8. Section 27 05 36 - Cable Trays for Communications Systems.
 - 9. Section 27 05 53 - Identification for Communications Systems.
 - 10. Section 27 10 00 – Structured Cabling.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
 - 2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
- B. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
 - 3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 4. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
 - 5. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.5 SYSTEM DESCRIPTION

- A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.
- B. Underground More than 5 feet outside Foundation Wall: Provide thickwall Schedule 40/80 nonmetallic conduit. Provide cast metal boxes or nonmetallic handhole.
- C. Underground within 5 feet from Foundation Wall: Provide rigid steel conduit. Provide cast metal or nonmetallic boxes.
- D. In or Under Slab on Grade: Provide thickwall Schedule 40/80 nonmetallic conduit. Provide rigid steel conduit sweeps.
- E. Outdoor Locations, Above Grade: Provide rigid steel conduit. Provide cast metal outlet, pull, and junction boxes.
- F. Wet and Damp Locations: Provide rigid steel conduit, electrical metallic tubing. Provide cast metal outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.
- G. Concealed Dry Locations: Provide electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- H. Exposed Dry Locations: Provide electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- I. Existing Gymnasiums and Natatorium: Existing recessed backboxes and concealed conduits can be reused for devices shown on the technology drawings in the same vicinity. Provide recessed backboxes in infill areas at columns in these spaces. Do not

install exposed conduit or raceways below 12 ft. AFF in these spaces without prior approval from the Architect and Engineer.

1.6 DESIGN REQUIREMENTS

- A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

1.7 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit for the following:
1. Liquidtight flexible metal conduit.
 2. Nonmetallic conduit.
 3. Nonmetallic tubing.
 4. Raceway fittings.
 5. Conduit bodies.
 6. Surface raceway.
 7. Wireway.
 8. Pull and junction boxes.
 9. Handholes.
- C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
- D. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer

literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.8 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents:
 - 1. Record actual routing of conduits larger than 2 inch.
 - 2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.9 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- C. Protect PVC conduit from sunlight.

1.11 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate installation of outlet boxes for equipment connected under Section 26 05 03.
- C. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 PRODUCTS

2.1 METAL CONDUIT

- A. Manufacturers:
 - 1. Allied Tube and Conduit.

2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Rigid Steel Conduit: ANSI C80.1.

C. Fittings and Conduit Bodies: NEMA FB 1; all steel fittings.

2.2 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Manufacturers:

1. Carlon Electrical Products.
2. Anamet Electrical.
3. Allied Tube and Conduit.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Interlocked steel construction with PVC jacket.

C. Fittings: NEMA FB 1.

2.3 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:

1. Allied Tube and Conduit.
2. Western Tube and Conduit.
3. Wheatland Tube Company.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: ANSI C80.3; galvanized tubing.

C. Fittings and Conduit Bodies: NEMA FB 1; steel, compression (damp locations), and set screw type.

2.4 SURFACE METAL RACEWAY

A. Manufacturers:

1. Hubbell Wiring Devices.
2. Thomas & Betts Corp.
3. The Wiremold Co.
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.

C. Size: as indicated on drawings.

D. Finish: Manufacturers standard finish as selected by Architect.

- E. Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories; match finish on raceway.

2.5 OUTLET BOXES

- A. Manufacturers:
 - 1. Erico Products.
 - 2. Raco.
 - 3. Thomas & Betts Corp.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
 - 1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
 - 2. Concrete Ceiling Boxes: Concrete type.
- C. Cast Boxes: NEMA FB 1, Type FD, cast fer alloy. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.
- D. Wall Plates for Finished Areas: As specified in Section 26 27 26.
- E. Wall Plates for Unfinished Areas: Furnish gasketed cover.

2.6 PULL AND JUNCTION BOXES

- A. Manufacturers:
 - 1. Carlon Electrical Products.
 - 2. Hubbell Wiring Devices.
 - 3. Thomas & Betts Corp.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- C. Hinged Enclosures: As specified in Section 26 27 16.
- D. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
 - 1. Material: Galvanized cast iron.
 - 2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.
- E. Concrete Composite Handholes: Die-molded, concrete composite hand holes:
 - 1. Cable Entrance: Pre-cut 6 inch x 6 inch cable entrance at center bottom of each side.
 - 2. Cover: Concrete composite, weatherproof cover with nonskid finish.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 EXISTING WORK

- A. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces.
- B. Remove concealed abandoned raceway to its source.
- C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets when raceway is abandoned and removed. Install blank cover for abandoned outlets not removed.
- D. Maintain access to existing boxes and other installations remaining active and requiring access. Modify installation or provide access panel.
- E. Extend existing raceway and box installations using materials and methods compatible with existing electrical installations, or as specified.
- F. Clean and repair existing raceway and boxes to remain or to be reinstalled.

3.3 INSTALLATION

- A. Ground and bond raceway and boxes in accordance with Section 26 05 26.
- B. Fasten raceway and box supports to structure and finishes in accordance with Section 26 05 29.
- C. Identify raceway and boxes in accordance with Section 26 05 53.
- D. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.4 INSTALLATION - RACEWAY

- A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.
- B. Arrange raceway supports to prevent misalignment during wiring installation.
- C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

- D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29; provide space on each for 25 percent additional raceways.
- E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports
- F. Do not attach raceway to ceiling support wires or other piping systems.
- G. Construct wireway supports from steel channel specified in Section 26 05 29.
- H. Route exposed raceway parallel and perpendicular to walls.
- I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.
- J. Route conduit under slab from point-to-point.
- K. Maintain clearance between raceway and piping for maintenance purposes.
- L. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.
- M. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- N. Bring conduit to shoulder of fittings; fasten securely.
- O. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.
- P. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
- Q. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install factory elbows for bends in metal conduit larger than 2 inch size.
- R. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.
- S. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.
- T. Install suitable pull string or cord in each empty raceway except sleeves and nipples.
- U. Install suitable caps to protect installed conduit against entrance of dirt and moisture.
- V. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.

W. Close ends and unused openings in wireway.

3.5 INSTALLATION - BOXES

- A. Install wall mounted boxes at elevations to accommodate mounting heights as specified in section for outlet device.
- B. Coordinate communications device locations with furniture plan and receptacle locations to accommodate the intended purpose prior to rough-in.
- C. Adjust box location up to 10 feet prior to rough-in to accommodate intended purpose.
- D. Orient boxes to accommodate wiring devices oriented as specified in Section 271343.
- E. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- F. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- G. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- H. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic rated walls.
- I. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- J. Install stamped steel bridges to fasten flush mounting outlet box between studs.
- K. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- L. Install adjustable steel channel fasteners for hung ceiling outlet box.
- M. Do not fasten boxes to ceiling support wires or other piping systems.
- N. Support boxes independently of conduit.
- O. Install gang box where more than one device is mounted together. Do not use sectional box.
- P. Install gang box with plaster ring for single device outlets.

3.6 INTERFACE WITH OTHER PRODUCTS

- A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with Division 07 Section "Penetration Firestopping".

- B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket.
- C. Locate outlet boxes to allow luminaires positioned as indicated on Drawings.
- D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.7 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Adjust flush-mounting outlets to make front flush with finished wall material.
- C. Install knockout closures in unused openings in boxes.

3.8 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Clean interior of boxes to remove dust, debris, and other material.
- C. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes cable tray.
- B. Related Sections:
 - 1. Division 07 Section – Penetration Firestopping.
 - 2. Section 27 05 26 - Grounding and Bonding for Communications Systems.
 - 3. Section 27 05 29 - Hangers and Supports for Communications Systems.
 - 4. Section 27 05 53 - Identification for Communications Systems.
 - 5. Section 27 10 00 – Structured Cabling.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. ASTM International:
 - 1. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 2. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

- B. National Electrical Manufacturers Association:
 - 1. NEMA FG 1 - Nonmetallic Cable Tray Systems.
 - 2. NEMA VE 1 - Metal Cable Tray Systems.
 - 3. NEMA VE 2 - Metal Cable Tray Installation Guidelines.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate tray type, dimensions, support points, and finishes.
- C. Product Data: Submit fittings and accessories.
- D. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
- E. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual routing of cable tray and locations of supports.

1.7 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience, and with service facilities within 100 miles of Project.

1.9 PRE-INSTALLATION MEETINGS

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

PART 2 PRODUCTS

2.1 METAL LADDER-TYPE CABLE TRAY

- A. Manufacturers:
 - 1. B-Line Systems.
 - 2. Chalfant.
 - 3. Thomas and Betts.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: NEMA VE 1, Class 20C ladder type tray.
- C. Material: Aluminum.
- D. Finish: Galvanized to ASTM A123/A123M; galvanize after fabrication..
- E. Inside Width: 18 inches or as indicated on Drawings.
- F. Inside Depth: 5 inches or indicated on Drawings.
- G. Straight Section Rung Spacing: 9 inches on center.
- H. Inside Radius of Fittings: 24 inches.

- I. Furnish manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.

2.2 WARNING SIGNS

- A. Engraved Nameplates: 1/2 inch black letters on yellow laminated plastic nameplate, engraved with: WARNING! DO NOT USE CABLE TRAY AS WALKWAY, LADDER, OR SUPPORT. USE ONLY AS MECHANICAL SUPPORT FOR CABLES AND TUBING!

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install metal cable tray in accordance with NEMA VE 2.
- B. Support trays and fasten to structure and finishes in accordance with Section 26 05 29. Install supports at each connection point, at end of each run, and at other points to maintain spacing between supports of 10 ft. maximum.
- C. Install expansion connectors where recommended by manufacturer or as indicated on Drawings.
- D. Install firestopping in accordance with Section 07 84 00 to sustain ratings when passing cable tray through fire-rated elements.
- E. Ground and bond metal cable tray in accordance with Section 26 05 26.
 - 1. Provide continuity between tray components.
 - 2. Use anti-oxidant compound to prepare aluminum contact surfaces before assembly.
 - 3. Install 2 AWG bare copper equipment grounding conductor through entire length of tray; bond to each component.
 - 4. Make connections to tray using mechanical, compression or exothermic connectors.
- F. Install warning signs at 50 feet centers along cable tray, located to be visible.

END OF SECTION

SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Nameplates.
 - 2. Labels.
 - 3. Wire markers.
 - 4. Conduit markers.
- B. Related Sections:
 - 1. Section 09 90 00 - Painting and Coating: Execution requirements for painting specified by this section.
 - 2. Section 26 05 53 - Identification for Electrical Systems.
 - 3. Section 27 10 00 – Structured Cabling.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

- B. Product Data:
 - 1. Submit manufacturer's catalog literature for each product required.
 - 2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.
- C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.
- D. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of tagged devices; include tag numbers.

1.6 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles

shall be documented in accordance with the High Performance Building Requirements of this Section.

3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept identification products on site in original containers. Inspect for damage.
- C. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- D. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Install labels only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

PART 2 PRODUCTS

2.1 NAMEPLATES

- A. Manufacturers:
 1. Seton.
 2. Brady.
 3. Ideal Industries
 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Laminated three-layer plastic with engraved white letters on black contrasting background color.
- C. Letter Size:
 1. 1/8 inch high letters for identifying individual equipment and loads.
 2. 1/4 inch high letters for identifying grouped equipment and loads.
- D. Minimum nameplate thickness: 1/8 inch.

2.2 LABELS

- A. Manufacturers:
 1. Seton.

2. Brady.
3. Ideal Industries
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Labels: Embossed, pre-printed adhesive tape, with 3/16 inch white letters on black background.

2.3 WIRE MARKERS

A. Manufacturers:

1. Seton.
2. Brady.
3. Ideal Industries
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Description: Cloth tape or, split sleeve type wire markers.

C. Legend:

1. Control Circuits: Control wire number as indicated on shop drawings.
2. Work area data drop cables:
 - a. Coordinate with Owner's IT representative. Drops shall be labeled with room number and sequential lettering starting with "A" for all drops in room.
3. Work area voice drop cables:
 - a. Coordinate with Owner's IT representative. Drops shall be labeled with room number and letter "V" and sequential numbering starting with "1" for multiple voice drops in room drops in room (ex. xxxV1, xxxV2...etc.).

2.4 CONDUIT AND RACEWAY MARKERS

A. Manufacturers:

1. Seton.
2. Brady.
3. Ideal Industries
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Description: Nameplate fastened with straps.

C. Color:

1. Voice System: Blue lettering on white background.
2. Data System: White lettering on black background.

D. Legend:

1. Voice system: VOICE.
2. Data System: TELECOMMUNICATIONS.
3. Audiovisual Systems: AV

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Section 09 90 00 for stencil painting.

3.2 INSTALLATION

- A. Install identifying devices after completion of painting.
- B. Nameplate Installation:
 - 1. Install nameplate parallel to equipment lines.
 - 2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners.
 - 3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners.
 - 4. Secure nameplate to equipment front using screws.
 - 5. Install nameplates for the following:
 - a. Equipment racks and cabinets.
- C. Label Installation:
 - 1. Labeling procedures shall meet TIA/EIA 568B Series standard and BICSI Standards and shall be pre-approved by the Architect.
 - 2. Permanently label, using pre-printed labels, all cables and terminations.
 - a. Patch panels and cross-connect blocks, numerically from top to bottom.
 - b. Patch panel port with work area outlet label.
 - c. Cable segments.
 - 3. Install label parallel to equipment lines.
 - 4. Use industry standard TIA/EIA and BICSI color codes.
- D. Wire Label Installation:
 - 1. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.
 - 2. Install labels at data outlets identifying patch panel and port designation as specified.
- E. Conduit Marker Installation:
 - 1. Install conduit marker for each conduit longer than 10 feet.
 - 2. Conduit Marker Spacing: 20 feet on center.

END OF SECTION

SECTION 2710 00 - STRUCTURED CABLING

PART 1 GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.
- B. Attention is directed Section 26 0400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 SECTION INCLUDES

- A. Horizontal data/VOIP cabling and infrastructure.
- B. Fiber optic backbone.
- C. IT rack hardware and power distribution.
- D. Patch panels.

- E. Analog telephone cabling.

1.5 RELATED SECTIONS

- A. Carefully examine all of the Contract Documents for requirements that affect the work of this section. Other specification sections that directly relate to the work of this section include, but are not limited to the following:
 1. Section 27 0526 – Grounding and Bonding for Communication Systems
 2. Section 27 0529 – Hangers and Supports for Communication Systems
 3. Section 27 0533 – Conduits and Backboxes for Communication Systems
 4. Section 27 0536 – Cable Tray for Communications Systems

1.6 REFERENCES

- A. All wire and components supplied and installed shall meet the requirements of the following and all sub-referenced documents:
 1. The National Electrical Code, Article 800.
 2. Underwriters Laboratories (UL).
 3. EIA/TIA 568-B.
 4. EIA/TIA 569.
 5. BICSI TDMM

1.7 SYSTEM DESCRIPTION

- A. Service entrance from Telecommunications Utility Company.
- B. Service entrance pathway: Empty raceway, boxes, etc. from utility pole to telecommunications demarcation point.
- C. WAN fiber optic pathway: Empty raceway, boxes, etc. from telecommunications demarcation point to main server rack in MDF. Entrance wiring by utility company.
- D. Backbone pathway: Conform to TIA/EIA 569 using conduit, sleeves, J-Hooks, and other methods indicated on drawings.
- E. Horizontal pathway: Conform to TIA/EIA 569 using conduit, sleeves, J-Hooks, and other methods indicated on drawings.
- F. Backbone wiring: Complete from point of utility Co. termination in MDF to each IDF using unshielded voice backbone and optical fiber communications backbone cables.
- G. Horizontal wiring: Complete from rack in MDF or IDF to each outlet using unshielded horizontal cables as indicated on drawings.
- H. Network equipment racks, cabinets, and accessories.
- I. Fireproofing of penetrations, grout, sleeve seals and openings for pathways.
- J. Testing, certification, and warranty for all cabling.

- K. Record drawings and documentation.
- L. Operation and Maintenance Instruction Manuals.
- M. Training for work and equipment of this section.

1.8 SUBMITTALS

- A. Section 01 3300 – Submittal Procedures: Submittal procedures.
- B. Product Data: Submit manufacturer’s product data, installation instructions, use limitations and recommendations for each material used.
- C. Authorizations: The vendor must submit, with this bid, proof of any manufacturer's authorizations that may be required to sell, install and configure proposed cable and hardware.
- D. Warranty Information: Refer to section 1.10.
- E. Field Quality Control Reports.
- F. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor’s or subcontractor’s work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer’s letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product’s VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.9 CLOSEOUT SUBMITTALS

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

- B. Project Record Documents: Record actual locations and sizes of pathways and outlets.

1.10 QUALITY ASSURANCE

- A. High Performance Building Requirements:
1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.11 WARRANTY

- A. Provide a warranty for one (2) year against defects in material and workmanship on all components, equipment, software, systems, cabling, etc. as specified herein. Warranty shall start at time of substantial completion or beneficial use, whichever comes sooner. Any failure due to defective material, equipment, installation, or workmanship that may develop over the course of the warranty period shall be corrected at no expense to the Owner, including all materials, labor, travel and expenses.
- B. Data Cabling Warranty: provide a manufacturer's data cabling twenty-five (25) year mission critical warranty for voice and data structured cabling system.
1. The Contractor shall provide documented proof that he/she is authorized and certified and in good standing with the manufactures to provide this warranty.
 2. The contractor shall provide a written 25-year warranty from the manufacturer at substantial completion of the project.
 3. The warranty shall include connecting hardware products and installed cable as part of the data cabling system warranty.
 4. The data cabling system shall include:
 - a. Work area outlets.
 - b. Horizontal cable.
 - c. Backbone cable.
 - d. The connecting hardware in the horizontal cross-connect.
 - e. The equipment patch cord at the work area outlet.
 - f. The patch cord at the horizontal cross-connect.
 5. The manufacturer's warranty shall guarantee that the data cabling system shall be free from defects in materials and workmanship for the duration of the warranty.

1.12 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum THREE YEARS documented experience.

- B. UL Compliance: The communication system supplied shall be listed by Underwriters' Laboratories under the UL Standard 1459 for Telephone Appliances and Equipment. A copy of the UL listing card for the proposed system shall be included with the contractor's submittal.
- C. FCC Approval: The system shall be approved for direct interconnection to the telephone utility under Part 68 of FCC rules and regulations. Systems that are not FCC approved or that utilize intermediary devices for connection, shall not be considered. Provide FCC registration number of the system being proposed as part of the submittal process.
- D. Installer: Company specializing in installing products specified in this section with minimum three years documented experience, and with service facilities within 50 miles of project.
 - 1. Evidence of ability: Furnish training certifications. Certified training shall be industry recognized at least equal to:
 - a. Building Industry Consulting Service international, Inc (BICSI).
 - b. Ortronics Certified installer.
 - c. Hubbell Certified installer.
 - d. Leviton Certified Installer.
- E. Provide a full time, on-site Project manager to supervise the project.
- F. Testing Agency: Company member of International Electrical Testing Association and specializing in testing products specified in this section with minimum three years documented experience.

1.13 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 – Administrative Requirements: pre-installation meeting.
- B. Convene minimum THREE WEEKS prior to commencing work of this section.

1.14 EXTRA MATERIALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish ten single gang 4-port face plates.
- C. Furnish ten communications outlet jacks of each type.
- D. Furnish 2-48 port patch panels.
- E. Furnish 2-horizontal wire managers.
- F. Furnish five of each length and type of patch cords.

1.15 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials and products in unopened, factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from all possible damage. Sequence deliveries to avoid delays, but minimize on-site storage.

1.16 COORDINATION

- A. Coordinate the installation of cable and equipment with other construction activities and the work of other sections.
- B. Pre-installation Conference: Conduct conference at project site to comply with requirements in Section 01 1100.
- C. Coordinate with utility company, relocation of overhead or underground lines interfering with construction.
- D. Contact utility company regarding charges related to service installation. Include utility charges in this contract.
- E. Utility charges for service installation paid by Owner and are not part of this contract.

PART 2 PRODUCTS

2.1 FIBER OPTIC BACKBONE CABLE

- A. Manufacturers:
 - 1. Leviton
 - 2. Mohawk
 - 3. Corning
 - 4. Substitutions: See Division 1 – Product Requirements.
- B. Provide quantity of multi-mode and single-mode strands as indicated on drawings.
- C. All cabling shall meet or exceed Commercial Building Telecommunications Cabling Standard ANSI/TIA/EIA 586-B.
- D. Description:
 - 1. Multi-mode fiber optic cable shall be TIA type OM4, with 50/125 nominal core/cladding diameter.
 - 2. All fiber strands not installed in conduit and innerduct shall be encased within aluminum or steel spirally wrapped armor in an interlocking configuration. The cable shall then be covered with a plenum or riser rated jacket to prevent snags during installation. Where specified, plenum rated fiber optic cables installed in innerduct are acceptable.
 - 3. Fiber cables shall have color-coded buffered fibers, per TIA/EIA-568B, for easy identification. The fiber shall comply with ANSI/EIA/TIA-492AAAA. Fiber cable installed within buildings (riser) is to be sheathed in flame retardant outer

jacket and be OFNR rated. Each cabled fiber shall meet the graded performance specifications as follows:

Wavelength (nm)	Max. Atten. (dB/km)	Max. Transmission Capacity (MHz-km)
Multi-mode		
850	3.0	2000
1300	1.0	500

- E. All fiber optic cabling run underground shall be loose-tube, gel-filled type (including fiber in raceway).

2.2 FIBER OPTIC PATCH PANELS AND CONNECTORS

- A. Manufacturers:
1. Corning
 2. Ortronics
 3. Leviton
 4. Substitutions: See Division 1 – Product Requirements.
- B. Fiber optic patch panels shall be capable of terminating all strands of the fiber optic cables installed in an IDF or the MDF.
- C. Patch panels shall be rack mounted, EIA 19” wide, drawer type with integral cable management. Patch panels shall be pre-loaded with duplex SC couplings.
- D. Height (in rack units) of each fiber optic patch panel shall be minimum 1U unless otherwise noted in the drawings.
- E. Provide fiber optic connectors. Fiber optic modular connectors/couplings shall be NRTL listed and TIA/EIA compliant, type “LC” terminations. Connectors and couplings shall be able to withstand a minimum of 2,000 mating cycles without any transmission degradation. Maximum optical loss budget shall not exceed 0.75 dB per termination and 1.5 dB per mated pair.
- F. Fiber optic connectors shall be terminated by the following methods:
1. Hot melt.
 2. Heat Cured Epoxy.
 3. UV Cured Epoxy.
 4. Anaerobic.
- G. Fiber Optic Patch Cables:
1. Provide TIA/EIA 568B Series standard performance tested patch cables. Patch cables shall be factory pre-connectorized, two-strand, tight buffer. Patch cables connectors shall be provided by the same manufacturers as the fiber optic connectors and couplings.
 2. Fiber Optic patch cables shall be with "LC" to “LC” and/or “SC” to “LC” type connectors as required.

3. Provide tested and certified measured fiber optic patch cables as follows:
 - a. Multi-mode: (2) ten foot patch cables for each strand terminated.
 - b. Coordinate color of cable jacket with the Town Network Telecommunications Manager.

2.3 HORIZONTAL CABLE

- A. Manufacturers:
 1. General Cable
 2. Belden
 3. Hubbell NextSpeed
 4. Mohawk
 5. Substitutions: See Division 1 – Product Requirements.
- B. Product Description: Unshielded, twisted pair 23AWG wire (UTP) with suitable insulation and sheath material to meet or exceed EIA /TIA 568C.0 or equivalent. Cables shall adhere to the EIA/TIA Category 6 specifications.
- C. All horizontal cabling shall be communications riser cable type (CMR).
- D. Jacket Color:
 1. Data cabling: Yellow
 2. Voice cabling: Blue
 3. CCTV Camera cabling: Purple
 4. Wireless access point cabling: Orange
 5. AV system cabling: Green
- E. Provide 9” of slack on outlet boxes behind each faceplate.
- F. Pulling tension: The cable pulling tension shall not exceed 25 ft/lbs as indicated in TIA/EIA-568-A.
- G. Supports: All Horizontal cabling shall be supported via J-Hooks from telecom room to work station. J-Hooks shall be manufactured by:
 1. Cooper B-Line
 2. Caddy
 3. Chatsworth
- H. Analog Telephone: Provide an analog telephone system (POTS) as follows:
 1. Provide and terminate copper pair backbone cabling at each IDF/MDF for emergency telephone/fax backup. Quantity of copper pairs as indicated on drawings.
 2. Backbone cabling between MDF and IDF shall be sized to accommodate quantity of jacks terminating in IDF backboard. Backbone shall be minimum 50-pair.
 3. Terminate copper pairs in analog patch panels indicated on rack elevations.
 4. Provide cable jacket. Provide CMR or CMP rated cable for riser applications.

5. Provide EIA/TIA Cat. 6 UTP cabling from patch panels to “analog” work stations, as indicated on drawings.

2.4 PATCH PANELS AND TERMINATIONS FOR HORIZONTAL CABLE

- A. Manufacturers:
 1. Hubbell
 2. Ortronics
 3. Panduit
 4. Substitutions: See Division 1 – Product Requirements.
- B. Product Description: TIA/EIA 568 19 inch, Cat. 6 rated, rack-mounted panels with 110-type terminations.
- C. Panels shall be 48 port, 2U, or 24 port 1U, UL Cat. 6 type with integral printed circuit board, color coding, 110-type IDC terminations, and 8-position jacks.
- D. Each port shall include a color coded identification label.
- E. Wireless access point panels shall be 24 port, 1U, Cat. 6A type, metal with integrated grounding tabs.
- F. Provide horizontal wire management above and below each patch panel. Provide rear cable management bar with strain-relief brackets behind each patch panel.
- G. Patch Cords: Supply patch cords which meet the following specification and are of the same TIA/EIA category rating and manufacturer as the workstation cabling:
 1. 4- unshielded twisted pairs
 2. 24 AWG stranded conductors
 3. Thermoplastic Dielectric
 4. EIA/TIA 568B Category 6
 5. Provide patch cables as follows:
 - a. Ten foot and seven foot patch cables. Provide one of each for each cable terminated for the project. Provide the following jacket colors for patch cables:
 - 1) Data cabling: Yellow
 - 2) Voice cabling: Blue
 - 3) CCTV Camera cabling: Purple
 - 4) Wireless access point cabling: Orange
 - 5) AV system cabling: Green
- H. Connecting Blocks: 110-style IDC for category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies.
- I. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

2.5 ANALOG/POTS CABLING

- A. Copper building entrance protection. Use Circa-brand protection boxes, no manufacturer substitutions. Typical model used in the CDF is 1880ECA1-XXX (sized appropriately), but other models by Circa may be substituted in order to interface directly with rack-mounted patch panels and distribution (examples include 1900A1-100K and RMP100BET).
- B. Cables must meet all applicable codes and environmental requirements for the type of installation (OSP, riser, plenum, etc.).
- C. Copper Cabling:
 - 1. OSP cable must be suitable for that purpose, possessing weather- and water-proofing features and meeting RUS PE-39 or RUS PE-89 specifications.
 - 2. Install copper backbone cabling in conduit. Direct buried cable is not acceptable.
 - 3. Final termination of copper in the equipment rooms must be in a rack-mounted panel with 8P8C connectors allowing for direct connection to the horizontal cabling patch panels using standard 8P8C cords. See Panduit VP25344KBLY and VP50384KBLY as examples, and coordinate building entrance protection to interface with selected equipment.

2.6 RACK HARDWARE

- A. Manufacturers:
 - 1. Hubbell
 - 2. Chatsworth
 - 3. Tripp-Lite
 - 4. Great Lakes
 - 5. Ortronics/Legrand
 - 6. Substitutions: See Division 1 – Product Requirements.
- B. Equipment Racks: Free standing equipment racks shall be seven feet high, EIA 19” wide, open bay as indicated on drawings. Racks shall include the following features:
 - 1. 2 or 4 post supports, as indicated on drawings.
 - 2. Universal, 10-32 threaded hole pattern on the front and rear flanges, and mounting holes on both sides of the rack for wire management.
 - 3. Shelves for electronic equipment rated load carrying capacity of 125% of each piece of equipment.
 - 4. Mounting brackets to support equipment installed in the racks.
 - 5. Hook and loop Velcro cable strain-relief system on rear of rack to support horizontal and backbone cable.
 - 6. Hook and loop Velcro cable strain-relief system on front of rack for dressing patch cables and cross-connect wiring.
 - 7. Bonding and grounding cables for all equipment not directly bolted to equipment rack.
 - 8. Grounding bus bar with terminals for #6 copper minimum bonding cables.
 - 9. Provide all hardware and accessories required to properly support rack from the top and bottom and assemble rack in place.

- C. Swing-out Equipment Rack: Swing-out equipment racks shall be 85 ½”H high (44 RU), EIA 19” wide, open bay as indicated on drawings. Racks shall include the following features:
1. 2 post with full depth top and base supports for securing to wall and floor, all welded construction.
 2. Swing-out front.
 3. Universal, 10-32 threaded hole pattern on the front flanges, and mounting holes on both sides of the rack for wire management.
 4. Mounting brackets to support equipment installed in the racks.
 5. Hook and loop Velcro cable strain-relief system on rear of rack to support horizontal and backbone cable.
 6. Hook and loop Velcro cable strain-relief system on front of rack for dressing patch cables and cross-connect wiring.
 7. Bonding and grounding cables for all equipment not directly bolted to equipment rack.
 8. Grounding bus bar with terminals for #6 copper minimum bonding cables.
 9. Provide all hardware and accessories required to properly support rack from the wall and floor and assemble rack in place.
 10. Adjust rack depth to 27”.
- D. Equipment Cabinets: Cabinets shall be seven feet high, 24 inches wide and 31.5 inches deep. Cabinets shall include the following features:
1. 4 post supports.
 2. Welded construction (steel or aluminum) with full hinge doors and keyed locks (all cabinets keyed alike). Color as approved by Architect. Front door shall include vision panel, rear-door shall include louvers for ventilation.
 3. Integral EIA four (4) post equipment rack with, 10-32 threaded hole pattern for mounting of equipment.
 4. Adjustable front and rear mounting rails specifically designed to support equipment installed in the rack.
 5. Hook and loop Velcro cable strain-relief system on rear of rack to support horizontal and backbone cable.
 6. Hook and loop Velcro cable strain-relief system on front of rack for dressing patch cables and cross-connect wiring.
 7. Integral fans and louvers to adequately ventilate the equipment within the cabinets. Maintain to be no greater the 88 degrees F in warmer months.
 8. Bonding and grounding cables for all equipment not directly bolted to equipment rack.
 9. Grounding bus bar with terminals for #6 copper minimum bonding cables.
 10. Surge protected PDU, rated for 20A/120V/1P.
 11. Provide all hardware and accessories required to properly support rack from the top and bottom and assemble rack in place.

- E. Wall-Mounted Cabinets: Cabinets shall be 26 inches wide and 26 inches deep. Height shall be a minimum of 18RU, or as indicated on drawings. Wall mounted cabinets shall include the following features:
1. Capable of housing EIA-standard 19-inch rack equipment, with a maximum depth of 24.5 inches.
 2. Double-hinged construction. The user shall be able to swing the back of the cabinet outward to access equipment from behind.
 3. Load rating of at least 250 pounds.
 4. Welded construction (steel or aluminum) with full hinge doors and keyed locks (all cabinets keyed alike). Color as approved by Architect. Front door shall include vision panel, rear-door shall include louvers for ventilation.
 5. Vented side and front panels.
 6. Integral EIA four (4) post equipment rack with, 10-32 threaded hole pattern for mounting of equipment.
 7. Adjustable front and rear mounting rails specifically designed to support equipment installed in the rack.
 8. Hook and loop Velcro cable strain-relief system on rear of rack to support horizontal and backbone cable.
 9. Hook and loop Velcro cable strain-relief system on front of rack for dressing patch cables and cross-connect wiring.
 10. Bonding and grounding cables for all equipment not directly bolted to equipment rack.
 11. Grounding bus bar with terminals for #6 copper minimum bonding cables.
 12. Surge protected PDU, rated for 20A/120V/1P.
 13. Provide all hardware and accessories required to properly support rack from the top and bottom and assemble rack in place.
- F. Cable Management:
1. Provide horizontal cable management above and below each patch panel, and in locations shown on drawings. Horizontal management shall be sized 2U high with 6" fingers.
 2. Provide 6" single sided, vertical cable management on both sides of each rack, and in locations shown on drawings.
 3. Provide 6" rear cable management bar located behind each patch panel, and in locations shown on drawings.

2.7 UNINTERRUPTIBLE POWER SUPPLIES

- A. Manufacturer:
1. Tripp-Lite
 2. APC (basis of design)
 3. Eaton
 4. Substitutions: See Division 1 – Product Requirements.
- B. Uninterruptable power supplies shall be APC Smart-UPS #SMX3000RMLV2U with external battery pack and custom 6-foot power cord or approved equal.
1. Output Power: 2700 watts/3000VA.
 2. Nominal output voltage: 120V, 60 HZ nominal.
 3. Nominal input voltage: 120V, single phase.

4. Output connection receptacles:
 - a. (3) 5-15R
 - b. (3) 5-20R
 - c. (1) L5-30R
- C. External Battery Pack: APC #SMX120RMBP2U with maintenance-free, leak-proof, sealed lead-acid batteries.
- D. Refer to drawings and rack elevations for quantities.

2.8 POWER DISTRIBUTION

- A. Manufacturer:
 1. Tripp-Lite (basis of design)
 2. APC
 3. Eaton
 4. Substitutions: See division 1 – Product Requirements.
- B. Product Description:
 1. Provide rack mounted vertical and horizontal power distribution units as indicated on drawings.
 2. All PDU's shall be powered via owner-provided UPS at bottom of rack, unless otherwise noted.
- C. Vertical PDU:
 1. All vertical power distribution units shall meet or exceed the following general requirements:
 - a. 5-20P input plug. Contractor shall provide all necessary adapters to convert input plug to L5-20P if only twistlock outlets are available in UPS. Input cord shall be at least 10 feet long.
 - b. 120VAC input.
 - c. 2.4KW nominal load capacity.
 - d. Twenty-eight(28) NEMA 5-20R outlets.
 - e. 60" height.
 - f. Unit shall be metered, using a Digital LED display to show the total current draw of connected equipment in amps.
 - g. PDU's shall be surge protected.
 2. Vertical power distribution units shall be mounted directly to each side of rack, as indicated in drawings. Provide all necessary mounting hardware.
 3. Vertical power distribution units shall be Tripp-Lite model PDUMV20 or equal.
- D. Horizontal PDU:
 1. All horizontal power distribution units shall meet or exceed the following general requirements:
 - a. 5-20P input plug. Contractor shall provide all necessary adapters to convert input plug to L5-20P if only twistlock outlets are available in UPS. Input cord shall be at least 10 feet long.
 - b. 120VAC input.
 - c. 2.4KW nominal load capacity.

- d. Twelve(12) NEMA 5-20R outlets.
 - e. 1U width.
 - f. Unit shall be metered, using a Digital LED display to show the total current draw of connected equipment in amps.
 - g. PDU's shall be surge protected.
2. Horizontal power distribution units shall be mounted within rack, as indicated in drawings. Provide all necessary mounting hardware.
 3. Horizontal power distribution units shall be Tripp-Lite model PDUMH20 or equal.

2.9 WORK AREA OUTLET

- A. Product Description: Assembly consisting of faceplate and modular connectors that meet or exceed TIA/EIA-568B, Category 6 standard.
- B. Manufacturers:
 1. Hubbell.
 2. Leviton.
 3. Ortronics.
 4. Substitutions: See Division 1 – Product Requirements.
- C. Each Work Area outlet shall consist of the following:
 1. Single or double gang thermoplastic faceplate equipped with front-loading modules with the number of voice and data jacks indicated on the Drawings and Specifications.
 2. Provide faceplate with clear plastic window on the top and bottom of the faceplate for labeling.
 3. Faceplate Color selection by Architect.
 4. Provide blank-off modules for all empty positions.
 5. Category 6 Modular Jacks: jacks shall meet or exceed Category 6 requirements for connecting hardware as specified in TIA/EIA-568B.2 standard and shall be front loading, 110 style, 8-pin IDC, and modular (RJ45) type. Each jack shall be color coded as indicated on drawings.
 6. Cat. 6 jacks shall be Hubbell HXJ6 or equal.
- D. Modular Jack Color:
 1. Data: Yellow
 2. Phone: Blue
 3. Wireless access Points: Orange
 4. CCTV Surveillance Cameras: Purple
 5. AV Systems: Green
 6. Coordinate all colors and icon requirements with the Owner prior to purchase.

2.10 BACKBOARDS

- A. Material: Class “A” fire retardant plywood.
- B. Size: 3/4" thick. Width and Height as indicated on drawings.

- C. Provide backboards for all utility demarcation equipment.
- D. Paint with (2) two coats of grey paint.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Rated Stairs: Penetrations into stairs are NOT permitted except for items serving that stair.
- B. Wiring Method:
 - 1. Install all required telecommunications conduits, sleeves, and back boxes. Conduits, sleeves and boxes shall be installed in accordance with Section 270533.
 - 2. Install cables in raceways, conduits and interstitial spaces above suspended ceilings.
 - 3. Conceal wiring except in unfinished spaces.
 - 4. Wire shall not be subjected to pulling tensions greater the maximum specified by the manufacturer
 - 5. Wire bend radius shall not be less than the manufacturer's minimum of one (1) inch.
 - 6. Support cables that are not in raceway or conduit at intervals no greater than 60 inches with supports designed for high-speed twisted pair wire ("J" hooks)
- C. Riser Cables:
 - 1. Install multimode and single mode fiber optic cable through the ceilings and riser conduit as indicated on the attached cable plates. The fiber shall be run in innerduct for its entire length. Cables shall be terminated as follows:
 - 2. Multi/Single Mode Fiber: Mount LC type terminators in a 19" rack mounted enclosure at both ends.
- D. Horizontal Cables:
 - 1. Mount new station jacks on the specified plate, flush or surface mounted, as construction requires.
 - 2. STATION IDENTIFICATION:
 - a. All labeling standards shall be confirmed with and approved by owner's IT staff prior to performing work. It is the responsibility of the contractor to coordinate with owner's staff.
 - b. Each work station outlet jack and corresponding patch panel port shall be marked with the same, unique label.
 - 3. Mark the plate with standard nomenclature as required by the configuration. Mark the outlet plainly and neatly with its station identification, as indicated in above paragraph. The station identification shall also be marked inside the outlet plate on the backing plate of the outlet, and shall match the ID used at the patch panel port. Make the outlet marking using the Panduit system or equal, except for the inside marking which may be by indelible marker. Place exposed marking on outlet plates under a transparent window for protection. Label cable

with permanent marker compliant with EIA/TIA 606, six (6) inches back from the termination at both ends.

4. At the station end, terminate 4-pair UTP cables on 8-pin modular jacks according to TIA/EIA 568B terminating specifications.
5. At the telecom room, terminate all 4-pair UTP cables (voice & data) onto panel mounted 8-pin modular connectors that meet the TIA/EIA Category 6 specification. Provide sufficient patch jacks (ports) at each telecom closet to terminate the cables from all of the stations served by that closet. Mark the voice and data patch terminating jacks with its associated station identification in ascending sequential order. Mark patch panel using the Panduit system or equal. Match the patch panels into the supplied equipment racks.
6. Analog Line (Emergency Line) Connection:
 - a. Coordinate with Telephone provider. Telephone provider shall terminate phone service at DEMARC. Contractor shall extend, punch down and make final connections to the specific locations listed below for complete service.
 - b. Provide patch panels as indicated in above PART 2. Terminate all cables within these panels.
 - c. The Contractor is responsible for establishing an analog metallic connection to each analog line, locations shown on drawings.

3.2 TESTING, HORIZONTAL CABLING

- A. Horizontal cabling testing shall be conducted from the jack at the outlet in the Work Area to the Patch Panel on which the cables are terminated.
- B. Baseline accuracy of the test equipment must exceed TIA Level III, as indicated by independent laboratory testing. Test adapter cable must be approved by the manufacturer of the test equipment.
- C. All horizontal cables must be tested with a Level 3 Fluke DTX Networks Cable Tester.
- D. Testing of the Permanent Link shall be performed. However, contractor shall warrant performance based on channel performance and provide patch cords that meet channel performance criteria. All cabling not tested strictly in accordance with these procedures shall be retested at no cost to the Owner.
- E. Horizontal station cables shall be free of shorts within the pairs, and be verified for continuity, pair validity, and polarity, and Wire Map (Conductor Position on the Modular Jack). Any defective, split or miss-positioned pairs must be identified and corrected.
- F. Testing of the Cabling Systems rated at TIA Category 6 and above shall be performed to confirm proper functioning and performance.
- G. Testing of the Transmission Performance of station cables (Category 6 shall include):
 1. Length
 2. Attenuation
 3. Pair to Pair NEXT
 4. ACR

5. PSNEXT Loss
 6. Return Loss
 7. Pair to Pair ELFEXT Loss (Equal Level Far End Cross-Talk)
 8. PSEFEXT Loss
 9. Propagation Delay
 10. Delay Skew
 11. Return Loss
- H. The maximum length of horizontal cable shall not exceed 90 meters, which allows 10 meters for equipment and patch cables.
- I. Cables shall be tested to the maximum frequency defined by the EIA/TIA 568B standards covering that performance category. Test records shall verify a “PASS” on each cable and display the specified parameters – comparing test values with standards based “templates” integral to the unit.
- J. Any “Pass*” or “Warning” test results shall be considered a “FAIL” for the channel or permanent link under test. In order to achieve an overall “Pass Condition”, the test result for each individual test parameter shall be “PASS”.
- K. All data shall indicate the worst-case result, the frequency at which it occurs, the limit at that point, and the margin. These tests shall be performed in a swept frequency manner from 1MHz to the highest relevant frequency, using a swept frequency interval consistent with TIA and ISO requirements. Information shall be provided for all pairs or pair combinations. And in both directions when required by the appropriate standards.

3.3 TESTING, FIBER OPTIC CABLING

- A. Tests after Installation
1. Upon completion of a cable installation and termination, the Fiber Optic cabling shall be tested to include Optical Attenuation (“Insertion Loss” Method).
- B. Optical Attenuation Testing
1. Optical Attenuation shall be measured on all terminated optical fibers, in both directions of transmission, using the “Insertion Loss” method. Measurement shall be inclusive of the optical connectors and couplings installed at the system endpoints. Access jumpers shall be used at both transmit and receive ends to ensure an accurate measurement of connector losses.
 2. Field test instruments for fiber cabling shall meet the requirements of ANSI/TIA/EIA-526-14A. The light source shall meet the launch requirements of ANSI/EIA/TIA-455-50-B.3, Method A. This launch condition shall be achieved either within the field test equipment or by use of an external mandrel wrap (as described in clause 11 of ANSI/TIA/EIA-568-B.1) with Category 1 light source.
 3. Field test instruments for single mode fiber cabling shall meet the requirements of ANSI/EIA/TIA-526-7.
 4. The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.

5. The fiber optic launch cables and adapters must be of high quality and the cables shall not show excessive wear resulting from repetitive coiling and storing of the tester interface adapters.
6. Testing of multi-mode fiber cable:
 - a. Link attenuation shall be tested in accordance with TIA/EIA 525-14A. Reference measurements shall be made in accordance with method B or equivalent. Optical loss shall be measured at 850 and 1300 nm. Loss shall be measured on each fiber, from each direction.
 - b. Maximum optical loss calculations for each cable at each wavelength shall include a maximum of two connector/terminations at a value of $\leq 0.5\text{dB}$ for each connector.
 - c. Link length optically measured cabling shall meet the following criteria:

<u>Wavelength</u>	<u>Attenuation (dB/km)</u>
850 nm	≤ 3.0
1300 nm	≤ 1.0

7. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests detailed in the following section.
 - a. Performance Test Parameters
 - 1) The link attenuation shall be calculated by the following formulas specified in ANSI/TIA/EIA standard 568-B.1
 - 2) $\text{Link Attenuation} = \text{Cable_Attn} + \text{Connector_Attn} + \text{Splice_Attn}$
 - 3) $\text{Cable Attn (dB)} = \text{Attenuation Coefficient (dB/km)} * \text{Length (Km)}$
 - 4) The values for Attenuation_Coefficient are listed in the table
 - 5) $\text{Connector_Attn (dB)} = \text{number_of_connector_pairs} * \text{connector_loss (dB)}$
 - 6) Maximum allowable mated connector_loss = 0.70 DB
 - 7) $\text{Splice_Attn (dB)} = \text{number of splices (S)} * \text{splice_loss (dB)}$
 - 8) Maximum allowable splice_loss = 0.2dB
 - 9) Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
 - 10) Test equipment shall measure the link length and automatically calculates the link loss based on the above formulas is preferred.
 - 11) The above link test limits attenuation are based on the use of the One Reference Jumper Method specified by ANSI/TIA/EIA-526-14A, Method B and ANSI/TIA/EIA-526-7, Method A.1. The user shall follow the procedures established by these standards or application notes to accurately conduct performance testing.
 - 12) The backbone link shall be tested in two directions at both operating wavelengths to account for attenuation deltas associated with wavelength.
 - 13) Backbone links shall be tested in accordance with ANSI/EIA/TIA-526-14A.

- 14) Because backbone length and the potential number of splices vary depending upon site conditions, the link attenuation equation shall be used to determine limit (acceptance) values.
8. Test reports shall include the following information:
 - 1) Actual measured and allowable attenuation at specified wavelengths.
 - 2) Number of mated connectors and splices (if any).
 - 3) Actual length and maximum allowable length.
 - 4) Tester manufacturer, model, serial number, and software version.
 - 5) Circuit ID number and project name.
 - 6) Pass/Fail indication of each link and overall indication.
 - 7) Date and time of test.

3.4 DOCUMENTATION

- A. At the completion of the project and prior to system acceptance provide the following documentation:
 1. As-built floor plans that show the final location and identification of the telecom outlets. Submit the floor plans in printed form and as AutoCAD 2000 files (Original AutoCAD files will be made available).
 2. Test results for each strand of fiber optic cable installed. This should be supplied in a page per strand printed format and in machine-readable (computer file) format. If the machine-readable file requires special software for reading, a single-user version of that software shall be provided as well.
 3. Test results for each pair of copper riser cabling installed and the installed cable length.
 4. Test results for each UTP station cable installed. This should be supplied in a page per cable printed format and in machine-readable (computer file) format. If the machine-readable file requires special software for reading, a single-user version of that software will be provided as well.
 5. Test results for each coaxial riser and horizontal cable installed. Documentation indicating successful testing and length for each cable shall be bound and provided by the vendor.
 6. Cross connection documentation for the voice station cable (cut sheets) which detail the station number, telecom room, and riser pair number for each installed cross connection.

END OF SECTION

SECTION 274100 - AUDIO VIDEO SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to the work specified in this Section.
- B. Coordinate work of this Section with work of other Sections as required to properly execute the Work and as necessary to maintain satisfactory progress of the work of other Sections.

1.2 SCOPE OF SPECIFICATION

- A. The following terms are defined for this specification section:
 - 1. “Owner” or “End User” is the Francis Walsh Intermediate School (FWIS).
 - 2. “Architect” is the Design Architect & Architect of Record for the project: Antinozzi Associates.
 - 3. “Systems” are the audio and video systems.
 - 4. “Designer” or “Systems Designer” is the designer of the audio and video systems: Jaffe Holden.
 - 5. “Electrical Engineer” is the designer of the Electrical Pathway & Wiring Systems: Consulting Engineering Services.
 - 6. “Contractor” or “Systems Contractor” is the specialty contractor working under the General Contractor, responsible for the installation of the audio and video systems.
- B. This specification covers all Systems as described below for the project. The objective is to provide professional systems, installed, acceptance tested, and ready for use.
- C. The written specification and large format AV drawings shall be collectively referred to herein as the Contract documents. System features which are mentioned in one part may not be shown in the others. In case of conflict between the written specification and the drawings, Contractor must seek clarification from the Systems Designer. In the event that the Contractor fails to obtain such clarification, the interpretation of the Systems Designer will prevail.

1.3 CONTRACTOR RESPONSIBILITY

- A. Specification drawings are detailed only to the extent necessary to show design intent and signal flow. It is understood and agreed by the Contractor that the work herein described shall be complete in every detail to supply a complete working system.

- B. Equipment not mentioned herein nor shown on drawings but necessary to meet this requirement shall be provided without claim for additional payment.

1.4 SUMMARY DESCRIPTION

- A. Appendix A contains the Summary Systems Description.
- B. Specific products to meet the system requirements described in Appendix A will be called out in the contract documents.

1.5 SCOPE OF WORK

- A. Furnish all materials, labor and any engineering services to provide complete and professionally installed Systems in working order as described herein. Labor furnished shall be specialized and experienced in Systems installation. The Project Engineer shall hold a current CTS-D certification, and the Lead Installer/Installation Supervisor shall hold a current CTS-I.
- B. Furnish all back boxes and enclosures.
- C. Deliver to the job site all back boxes which are to be installed by others.
- D. Furnish and install all wire and cable.
- E. Contractor to provide initial DSP and control system programming prior to acceptance testing, one full set of programming changes and adjustments, prior to handover to the Owner, and one additional set of changes and adjustments during the initial warranty period, as part of the base scope of work.
- F. Furnish any additional items, not specifically mentioned herein, to meet system requirements as specified, without claim for additional payment. Such items may include hardware, transformers, line/distribution amplifiers and other devices for proper installation, interface, isolation or gain structure.
- G. Furnish shop drawings and receive approval, prior to fabrication and installation.
- H. Perform initial adjustments and verification tests. Submit verification test report.
- I. Participate in acceptance tests and perform final adjustments.
- J. Provide up to 3 training sessions of four hours each to the Owner.
- K. Provide any manufacturer required commissioning and/or training and properly coordinate schedule with the manufacturer for their staff to attend. Coordinate schedule and training syllabus with owner and consultant
- L. Provide system documentation including copies of all relevant drawings and equipment manuals.

- M. Provide maintenance services for the specified period from the date of acceptance.
- N. Guarantee all equipment and components for the specified period from the date of acceptance.
- O. Requirements and materials that apply to the work of others related to the Systems are listed to define and establish Systems requirements.
- P. Work scope does not include the AC power system except as shown in the drawings.
- Q. Coordination with the Electrical Contractor is required to assure correct Systems conduit routing, Systems backbox locations, and clean power circuit locations as specified in Division 26 - Electrical.
- R. See Work Scope Summary Table at the end of Part One (Paragraph 1.12).

1.6 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include complying with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, June 2017.

1.7 SUBMITTALS

- A. Pre-Bid Submittals
 - 1. All Contractors submitting bids for the Systems specified herein must be qualified by the Systems Designer.
 - 2. Not later than ten (10) days prior to the bid date, Contractor shall submit to the Systems Designer for approval, brochures containing a statement of the Contractor's qualifications. At minimum, this submittal shall include the following:
 - a. A list of Systems of comparable size and scope to that described herein, completed by the Contractor in the last five (5) years. Indicate the project name and address,

- year of completion, and the name and phone number of a person to contact who is a representative of the Owner or User.
- b. A personal resume of formal education and experience, and a copy of the current CTS-I certificate of the staff member who would act as Leader for the Project. A personal resume of formal education and experience, and a copy of the current CTS-D certificate of the staff member who would act as Project Engineer.
 - c. A description of the Contractor's capabilities and facilities for rack assembly, shop fabrication, repair, and servicing of Systems
 - d. A description of the Contractor's capabilities and facilities for generating CAD (or other high quality graphics) documentation for the Shop Drawings and As-Built Drawings
3. The following Contractors have submitted the required qualifications and have been approved to bid:
- a. Masque Sound
21 E. Union Ave.
East Rutherford, NJ 07073
Contact: Arno Miller
Phone: 201-939-8666
Email: arnomiller@masquesound.com
 - b. North American Theatrix
60 Industrial Drive
Southington, CT 06489
Contact: Gary Peck
Phone: 860-863-4112
Email: gpeck@natheatrix.com
 - c. Professional Audio Designs
11707-B West Dearbourn Ave
Wauwatosa, WI 53226
Contact: Kim Leonard
Phone: 414-476-1011
Email: kim@proaudiodesigns.com
 - d. Sound Associates
979 Saw Mill River Road
Yonkers, NY 10710
Contact: Phillip Peglow
Phone: 914-963-3452
Email: ppeglow@soundassociates.com

B. Bid Submittals:

1. Contractors shall examine all drawings and read all divisions of this specification in order to avoid omissions and duplications and to ensure a complete job. No allowances shall be made for failure to read and understand these documents. Discrepancies between drawings and specifications or obvious omissions shall be referred to the Systems Designer for clarification before the bid date. Where discrepancies occur and pre-bid instructions have not been obtained, the contractor agrees to abide by the Systems Designer's decision.
2. Bid proposals shall include all work and all equipment as specified, as well as any other equipment and materials to be used in assembling the system.
3. Requests for clarification of specification intent shall be made, in writing, not later than ten (10) days prior to bid date.
4. No portion of the work herein may be assigned or sub-contracted to others unless the following requirements have been satisfied:
 - a. The names of any proposed sub-contractors shall have been disclosed in the bid proposal.

- b. A statement of qualifications for each sub-contractor shall have been included with the bid proposal.
- c. All terms of this contract, including bidding and qualification requirements, shall apply to the sub-contractor.
- 5. The bid submittals shall include the following:
 - a. The total Contract price
 - b. The total price for any Add-Alternates
 - c. An itemized list of all equipment and materials to be used in assembling the system
 - d. Unit pricing for all items on the specified equipment list
 - e. Lot pricing for miscellaneous items not on the specified equipment list
 - f. A breakdown of the number of staff hours allotted for:
 - (a). Preparation of submittals, shop drawings, and system documentation
 - (b). On site coordination meetings and supervision
 - (c). In shop engineering, fabrication, and assembly
 - (d). On site fabrication, assembly, and installation
 - (e). On site verification and acceptance testing

Shop Drawing Submittals:

6. Within sixty (60) days after contract award, submit detailed shop drawings to the Architect for approval. All shop drawings shall be marked with the related drawing number when submitted. Do not begin installation or fabrication without the approval of the Architect and Systems Designer.
7. Review of shop drawings shall not constitute final approval of system function. Said review does not in any way relieve the Contractor from the responsibility of furnishing material or performing work as required by the Contract documents.
8. Failure of the Contractor to submit shop drawings in ample time for evaluation shall not entitle the Contractor to an extension of contract time, and no claim for extension by reason of such default will be allowed.
9. At minimum, the Shop Drawings shall include electronically bound copies of the following:
 - a. Table of Contents
 - b. Itemized list of all equipment and materials to be used in assembling the system
 - c. Catalog cut sheets or data sheets for each listed item
 - d. One-line signal flow diagrams for all sound reinforcement and auxiliary systems showing point to point wiring interconnection of all equipment with wire run numbers and patch bay designations. Show all transformers, switches, relays, control circuits, and modifications to equipment. Show all equipment items which are required for realization of the functions described herein.
 - e. A complete list of all wire run numbers along with the termination location of each end of each wire run
 - f. Detailed 3-wire schematic diagrams for any custom circuitry
 - g. Detailed 3-wire schematic diagrams for typical connections between audio lines, patch bays, and rack mounted equipment
 - h. Drawings of all items which are to be custom fabricated or modified. Drawings shall be of scale suitable for use in fabrication. They shall show materials, finishes and panel/control markings. Submit samples of lettering/label size and typeface to be employed on custom plates, panels and other equipment.
 - i. Full size drawings illustrating the physical layout and labeling of patch bays
 - j. Mechanical drawings of all assemblies, major sub-assemblies, racks, and enclosures
 - k. Mechanical drawings showing proposed mounting details of all loudspeakers and associated rigging, and interface with adjacent architecture.
 - l. Provide a detailed written plan for EDID and HDCP management for all video signals and interconnections between video devices.
 - m. Submit a Work Scope plan that lists all actions required to complete the work in this section. The Work Scope plan must include a complete schedule of all activities, particularly activities that require coordination with other trades, Architect, Owner, and Systems Designer, and must reference all relevant documents related to each activity. Critical path must be identified, and all key moments relating to procurement and installation must be identified. All points of coordination must be vetted with the other affected parties prior to submittal to the Owner for review. The

Work Scope plan must be submitted to the Owner 10 days prior to material purchase and fabrication.

- n. For the ease of drawing review the following guidelines must be adhered to:
- 1). Plot styles should be utilized so that color is only used for emphasis of specific line types.
 - 2). Drawings should be in black and white but if color is used the drawings must still be legible with all design information easily seen, when printed black and white.
 - 3). The paper size for all AV drawings must match that of all other construction drawings. All drawings must be legible at ½ size.
 - 4). CAD drawings should be delivered as PDF prints. Provide DWG files upon request.
 - 5). All revisions of drawings in drawing packages must include a revision number and date, with all changed drawings clearly indicated, with changes clouded and tagged with the revision number. Drawings that have not changed from previous releases should not be marked as revised. Already revised drawings should have revision clouds and tags removed from the previous revision so that current revisions are clear to see.
- o. Document release must be simultaneous unless a tiered release is authorized by the Systems Designer. If utilizing a tiered document release system, each release must be a full release of documents within each tier, within the context of the entirety of this scope of work. The required order for tiered review is:
- (a). Equipment and Panel Locations, and Conduit Riser (possibly provided by others per the Work Scope Table in this section)
 - (b). Complete project equipment list and Product data sheets
 - (c). Product data sheets must not be web page captures of specifications, unless there is no other recourse.
 - (d). Product data sheets with multiple options or part numbers must clearly be marked with the selection to be used for this project. All options must be called out. Anything the Contractor is not supplying that is shown on the sheet must be called out as an exclusion.
- p. Single-line drawings, Panel details, Rack elevations, and Patchbay layouts
- 1). Patchbay layouts must conform to the guidelines for Patchbay layouts included in this specification and on large format drawings.
 - 2). Panel drawings must indicate each panel and its engraving individually (if two 'AA' panels exist, for instance, they must have individual panel drawings showing the connector numbering and other engraving specific to that panel at that location)
 - 3). All custom rack panels must have a panel drawing as part of this submittal.

- q. Rigging and Mounting Details, Control system and DSP system GUI mockup, functional control narrative, initial DSP programming, other equipment and software configuration files.
- 10. All drawings shall be produced on AutoCAD or similar computer drafting/graphics program. All submittal drawings must be engineered and drafted to represent actual fabrication and installation drawings and details. All details that are graphically unclear must be properly noted to clarify intent. Copies of the Contract Drawings are not acceptable as submittal drawings and will be rejected.
- 11. The use of electronic files from other sources (e.g., architectural backgrounds, Systems Designer's drawings, etc.) will not release the Contractor of responsibility to supply Shop Drawings that represent a completely engineered, coordinated, and functional solution. The Contractor has final responsibility to provide systems that meet or exceed all requirements of the contract documents.

C. Substitutions:

- 1. Subsequent to Contract award, substitutions may be permitted, but only with the express written permission of the Systems Designer. The proposed substitutes must be equivalent to the specified products in quality, performance, construction, function and conformance to system objectives.
- 2. It is the responsibility of the Contractor to prove, to the satisfaction of the Systems Designer, that the proposed substitution is equal to the specified product, as demonstrated by submission of the following:
 - a. List of advantages to the Owner
 - b. Cost savings
 - c. Printed specifications or laboratory test data
 - d. Previous field experience
- 3. The Contractor shall list the unit price of each item proposed for substitution and indicate which specified items are to be deleted.
- 4. If the Systems Designer determines that the proposed product is not equal to the specified project, the Contractor shall supply the product specified in the Contract documents.
- 5. Where substitute materials or methods are approved, the Contractor shall make all adjustments to contingent work necessary to accommodate the substituted equipment, without claim for additional payment.
- 6. In the event that one or more of the products specified herein is unavailable, the Contractor shall make recommendations to the Systems Designer as to what substitutions are available to meet the intent of the specification.
- 7. The Systems Designer reserves the right to substitute new products which become available subsequent to the issuance of the Contract Documents, provided that:
 - a. The Contractor has not yet purchased the originally specified equipment.
 - b. The substitute equipment shall not materially increase the Contractor's costs.

8. Selected items of the systems are subject to rapid technology changes. Items that have a high likelihood of needing re-evaluation prior to installation are highlighted or otherwise called out, in the equipment list. The Contractor shall not purchase these items without 30 days prior notice to the Systems Designer.

D. Samples:

1. Submit samples of substitute equipment to the Systems Designer as required to prove equivalency to items specified.
2. Submit samples of custom work, finishes or other materials as required by the Architect or Systems Designer to verify appearance and quality. All panels within direct view of the public may require a custom finish. Provide the Architect with a list of any panels that meet this criteria so that they may specify custom finishes. A sample of every type of finish specified other than standard finish as detailed in this specification must be provided to the Architect for approval.
3. Costs for shipping samples shall be the responsibility of the Contractor
4. Submit samples of any and all GUI (Graphic User Interface) designs for all system soft wares to the Systems Designer for markup or approval. Re-submit as necessary until all are approved.
5. Submitted samples will not be returned.

E. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:

1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).
5. High Performance Building Requirements:

- a. Adhesives or sealants used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113 “Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings”, where applicable.
 - b. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Submittal Requirements of this Section.
 - c. Materials that contain recycled content shall be documented in accordance with the High Performance Building Submittal Requirements of this Section.
- F. Progress Reports must be submitted to the Owner every two weeks. The progress report will include:
1. Work Scope Plan updates and any schedule changes
 2. Overall Project Status
 3. Work Completed by percentage complete
 4. Work planned for the next two week period
 - a. Call out any coordination requirements for each item.
 5. Procurement report
 - a. Percentage by dollar value of equipment that has been procured to date
 - b. Procurement problems or concerns to be addressed by others
 6. RFI/Submittal List
 - a. List outstanding RFI’s and Submittals, showing the assigned document number and the date it was submitted.
 - b. Highlight in Yellow any items that are overdue but are not affecting schedule or project quality.
 - c. Highlight in red any items that are overdue AND are affecting schedule and/or project quality.
- G. Written Guarantee (See Paragraph 1.9)
- H. Verification Test Report (See Paragraph 3.13)
- I. System Documentation and Operation Manuals (See Paragraph 3.15)

3.2 JOB CONDITIONS

- A. Keep the job adequately staffed at all times. Unless illness, loss of personnel or other circumstances beyond the control of the Contractor intervene, keep the same individual in charge throughout.
- B. Cooperate with all appropriate parties in order to achieve well-coordinated progress with the overall construction completion schedule and satisfactory final results.

- C. Watch for conflicts with work of other contractors on the job and execute, without claim for extra payment, moderate moves or changes as are necessary to accommodate other equipment or to preserve acoustic performance, symmetry, and pleasing appearance.
- D. Immediately report to the Architect and Systems Designer, any design or installation irregularities, particularly architectural elements that interfere with the intended coverage angles of loudspeakers, so that appropriate action may be taken.
- E. Do all cutting, patching and painting for proper and finished installation of the system and repair any damage done as a result of such installation. Clean up and dispose of trash from all Systems work areas.

3.3 QUALITY ASSURANCE

- A. Parts listed shall be complete, type numbers accurate and equipment furnished shall conform to manufacturer's specifications.
- B. All materials shall be new and shall conform to applicable provisions of Underwriters Laboratories and the American Standards Association.
- C. Procure and pay for all permits, licenses and inspections and observe any requirements stipulated therein. Conform in all trades with all local regulations and codes.
- D. Comply with federal, state and local labor regulations and applicable union regulations.
- E. Installation shall conform to latest federal, state and local electrical and safety codes or those of other authorities having jurisdiction. Where conflicts exist, most stringent code or regulation shall apply.
- F. Government Standards: The Systems Contractor is to comply with all government regulations, standards, and laws that apply to the installation and use of the AV equipment and/or other scope of work specified in this section. The following agencies have laws and rules that apply.
 - 1. Federal Communications Commission (FCC): FCC rules are located in Title 47 of the Code of Federal Regulations. The following is a partial list of the FCC regulations that apply to equipment specified in this section of work:
 - a. Part 15: Radio frequency devices
 - b. Part 22: Public mobile services.
 - c. Part 24: Personal communications services.
 - d. Part 25: Satellite communications.
 - e. Part 27: Wireless communications service.
 - f. Part 51: Interconnection.
 - g. Part 74: Experimental radio, special broadcast, and other program distribution services.
 - h. Part 95: Personal radio services.

2. Occupational Safety and Health Administration (OSHA) – Follow all applicable standards for health and safety particularly sound pressure level exposure.
3. ANSI Standards: American National Standards Institute (ANSI) standards cover safety, fabrication, assembly, installation, rigging, equipment handling, and testing.
4. Contributing Organizations – The Organizations listed below have published standards used to establish the technical references to be followed under this scope of work.
 - a. Acoustical Society of America (ASA) (ASC S1)
 - b. Alliance for Telecommunications Industry (ATIS) (ASC T1)
 - c. American Society of Safety Engineers (ASSE) (ASC A1264)
 - d. Audio Engineering Society (AES) (ASC S4)
 - e. Electronics Industry Alliance (EIA) (CEMA)
 - f. Entertainment Services and Technology Association (ESTA) (ASC E1)
 - g. Institute of Electrical and Electronics Engineers (IEEE) (ASC C136) (802.1)
 - 1) IEEE 802.1AS: This standard specifies the protocol and procedures used to ensure that the synchronization requirements are met for time sensitive applications, such as audio and video, across Bridged and Virtual Bridged Local Area Networks consisting of LAN media where the transmission delays are fixed and symmetrical.
 - 2) IEEE 802.1QAT: This standard specifies protocols, procedures and managed objects, usable by existing higher layer mechanisms, that allow network resources to be reserved for specific traffic streams traversing a bridged local area network. It identifies traffic streams to a level sufficient for bridges to determine the required resources and provides a mechanism for dynamic maintenance of those resources.
 - 3) IEEE 802.1QAV: This standard allows bridges to provide guarantees for time-sensitive (i.e. bounded latency and delivery variation), loss-sensitive real-time audio video (AV) data transmission (AV traffic). It specifies per priority ingress metering, priority regeneration, and timing-aware queue draining algorithms. This standard uses the timing derived from IEEE 802.1AS. Virtual Local Area Network (VLAN) tag encoded priority values are allocated, in aggregate, to segregate frames among controlled and non-controlled queues, allowing simultaneous support of both AV traffic and other bridged traffic over and between wired and wireless Local Area Networks (LANs). Bridges are increasingly used to interconnect devices that support audio and video streaming application. This standard will specify enhancements to bridge relay function to provide performance guarantees to allow for time-sensitive traffic in a local area network and harmonize delay jitter and packet loss for wired (e.g., IEEE 802.3 - "Standard for Information Technology - Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications"), wireless (e.g., IEEE Std 802.11 - "Standard for Information Technology - Telecommunications and information exchange between systems - Local and Metropolitan networks - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer

- (PHY) specifications"), and mixed wired/wireless L2 networks. Most if not all entertainment media going forward is in digital
- 4) form. Audio and video streaming and interactive applications over bridged LANs need to be enhanced to have comparable real-time performance of legacy out-of-band analog media distribution. There is significant vendor and end-user interest and market opportunity to consolidate layer 2 solution for both computer networking (e.g. internet access) and audio video services (e.g. home consumer electronics, professional A/V applications, etc) in mixed wired and wireless environments. The use of such consolidated network will realize operational and equipment cost benefits. This standard defines a set of enhancements to the Virtual Bridged LAN (802.1Q - "Standards for Local and Metropolitan Area Networks - Virtual Bridged Local Area Networks"). This will enable end-to-end quality of service guarantee agreement for audio and video streaming negotiated over SRP protocol to be realized in a bridged LAN, while interoperating with existing 802.1D - "Standard for Local and Metropolitan Area Networks: Media Access Control (MAC) Bridges" and Q bridges. There is currently no interoperability among bridges that support Audio and Video streaming, nor generally accepted means of achieving such service guarantees in a bridged LAN.
 - 5) IEEE 802.3 – 2008: A revision of base standard incorporating the 802.3an/ap/aq/as amendments, two corrigenda and errata. Link aggregation was moved to 802.1AX.
 - 6) IEEE 802.3AZ: Energy Efficient Ethernet is scheduled for release in September 2010.
 - 7) IEEE 802.3bd: Defines a MAC Control Frame to support 802.1Qbb Priority-based Flow Control.
 - h. International Cable Engineers Association (ICEA) Formerly IPCEA
 - i. International Standards Organization (ISO)
 - j. National Electrical Manufacturer's Association (NEMA) (ASC C119)
 - k. National Fire Protection Associations (NFPA)
 - l. National Safety Council (NSC) (ASC A10)
 - m. Photographic and Imaging Manufacturer's Association (PIMA)
 - n. Society of Motion Picture and Television Engineers (SMPTE)
 - o. Telecommunications Industry Association (TIA)
 - p. Underwriters Laboratories (UL) (ASC C101) (CE)
 - q. NTSC
 - r. National Association of Broadcasters (NAB) – System technical standards for video and RF compliance are listed in the most recent edition of the NAB Handbook
5. Safety Standards – Contractor will adhere to the following Safety Standards for all work identified in Division 27 41 00 and as part of the General and Supplementary sections of the Division-1 Specifications.
- s. ANSI A14.2-2000: Safety Requirements for Portable Metal Ladders
 - t. ANSI A14.7-2000: Safety Requirements for Mobile Ladder Stands and Mobile Work Platforms.
 - u. ANSI C2-2002: National Electrical Safety Code

- v. ANSI Z136.1-2000: Safe Use of Lasers and laser systems
 - w. ANSI Z136.2-1997: Safe Use of Optical Fiber
 - x. ANSI Z359.1-1992 (R1999): Safety Requirements for Personal Fall Arrest Systems, Subsystems, and Components.
 - y. ANSI/PIMA IT7.101-1999: Recommended Practice for the Safe Handling and Operating of Audiovisual Equipment.
 - z. IEEE 142-1991: Grounding of Industrial and Commercial Power System's
 - aa. UL 514A: Scrub Water exclusion from AV Floor Boxes
 - bb. UL 1419-1995: Standard for Safety for Professional Video and Audio Equipment in accordance with the National Electrical Code, ANSI/NFPA 70
 - cc. UL 1492-1994: Standard for Safety for Audio-Video Products and Accessories
 - dd. UL 1651-1997: Standard for Safety for single and multiple Optical Fiber Cable
 - ee. UL 1667-1996: Audiovisual Systems Safety Standard for Tall AV Institutional Carts for use with Audio, Video, etc.
 - ff. ANSI E1.1-1999: Construction and Use of Wire Rope Ladders to prevent most injuries
 - gg. ANSI A10.8-2001: Safety Requirements for Scaffolding
 - hh. ANSI A10.42-2000: Rigging Qualifications and Responsibilities
6. Applicable Performance Standards – Execute all Division work in accordance with the following standards:
- a. ANSI S4.48-1992 (R1998): Recommended Practice for the Application of Connectors, Part 1, XLR-Type polarity, and gender
 - b. ANSI S4.55-1997: Recommended Practice for conservation of the Polarity of Audio Signals
 - c. ANSI S4.56-1997: Recommended Practice for the subjective evaluation of Loudspeakers
 - d. ANSI S12.2-1995 (R1999): Criteria for Evaluating Room Noise
 - e. ANSI T1.217-1991 (R1998): Integrated Services Digital Network (ISDN) Management –Primary Rate Physical Layer
 - f. ANSI T1.522-2000: Quality of Service (QOS) for Business Multimedia Conferencing. Specifies classes of Service for conferencing on IP Networks
 - g. AES15: ANSI S4.49: AES Recommended practice for Sound Reinforcement System's –Communications Interface PA-422.
 - h. AES-R1-1997 AES project report for professional audio: Specifications for audio on high capacity media
 - i. AES14-1992 (r1998) AES standard for professional audio equipment -- Application of connectors, part 1, XLR-type polarity and gender
 - j. AES24-1-1999, (Revision of AES24-1-1995) AES standard for sound system control - Application protocol for controlling and monitoring audio devices via digital data networks
 - k. AES26-2001 (Revision of AES26-1995) AES recommended practice for professional audio -- Conservation of the polarity of audio signals
 - l. ANSI/TIA/EIA 606-1993: Standard for the Telecommunications Infrastructure of Commercial Buildings
 - m. ANSI/TIA/EIA 607-1994: Commercial Building Grounding and Bonding Requirements for Telecommunications
 - n. IEEE 149-1979 (R1990): Test Procedure for Antennas

- o. IEEE 1100-1999: Powering and Grounding Sensitive Electronic Equipment
- p. NEMA 250-2001: Enclosures for Electrical Equipment
- q. SMPTE 292M: SMPTE 292M defines the base 1.485Gbps HD-SDI. Note: This standard can handle all HD formats except 1920*1080 @ 50P and 60P.
- r. SMPTE 372M: Uncompressed Dual-Link HD-SDI for 50P & 60P
- s. SMPTE 424M: 2.97 Gbps HD-SDI for 50P & 60P
- t. TIA/EIA-568-B: Digital audio over Cat5 audio cable
- u. UL 1047-1999: Isolated Power System's Equipment
- v. UL 1581-1998: Reference Standard for Electrical Wires, Cables, and Flexible Cords
- w. UL 1682-1998: Standard for Safety for Plugs, Receptacles, and Cable Connectors, of the Pin and Sleeve Type up to 800 Amperes and up to 600 volts ac or dc.
- x. UL 467-1998: Grounding and Bonding Equipment
- y. UL 813-1999: Commercial Audio Equipment and accessories for use in commercial enterprises... this standard was originally listed for public review in the October 13, 1995 issue of Standards Action. It is being resubmitted owing to substantive changes in the text.
- z. ANSI/TIA/EIA-568-A: Commercial Building Telecommunications Cabling
- aa. ANSI/TIA/EIA-569-A: Commercial Building Standard for Telecommunications Pathways and Spaces
- bb. ANSI/TIA/EIA-607: Commercial Building Grounding and Bonding Requirements for Telecommunications
- cc. ANSI/TIA/EIA TSB-72: Centralized Optical Fiber Cabling Guidelines
- dd. ANSI/TIA/EIA-526-14A: Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
- ee. ANSI/TIA/EIA-526-7 Measurement of Optical Power Loss of Installed Single mode Fiber Cable Plant
- ff. ANSI/IEEE C-2 National Electrical Safety Code how to install cabling in accordance with the most recent edition of BICSI® publications:
- gg. BICSI Telecommunications Distribution Methods Manual
- hh. BICSI Cabling Installation Manual

3.4

3.5 GUARANTEE AND SERVICE

- A. All systems and components shall be guaranteed free of defects in materials and workmanship for a period of one (1) year (or to the length of the Manufacturer's warranty if longer) from the date of acceptance and shall be repaired or replaced within forty-eight (48) hours following report of such defects by the owner.
- B. The Contractor shall be available on call and on eight (8) hour notice during the first month following acceptance of the system, to assist the Owner's representatives in any problems which may arise during the initial period of operation. If corrective measures on-site are required they will be performed within 12 hours of the determination of a need for a site visit.

- C. If, during the Guarantee period, any component is out of service for more than seven (7) consecutive days due to unavailability of parts or service, Contractor shall supply and install an identical new component. If an identical component is not available, Contractor will substitute equivalent equipment, with the approval of the Owner.
- D. During the course of the Guarantee period, the Systems Contractor will provide the Owner with a 24 hour service phone number for emergency calls. A service engineer will respond to all emergency calls within one (1) hour. The personnel answering this call must be fully qualified to troubleshoot problems and propose solutions. A qualifying emergency event is defined as an event that may cause severe hardship or cause the systems to be inoperable or unusable for a scheduled class or event.
- E. During the course of the Guarantee period, the Contractor shall provide a minimum of three (3) service visits to the site for inspection and adjustment of equipment. Contractor shall submit proposed schedule for these visits and shall notify Owner and Systems Designer in writing at least one month in advance of each visit.
- F. During the course of the guarantee period, the Systems Contractor will supply the Owner with any published updates of manufacturer provided operating programs for any and all software-controlled equipment that are issued to correct "bugs". During the Guarantee period, the Owner will rely on the Systems Contractor to determine when to update the software, unless it is needed to correct a situation that renders the systems unstable, non-functional, or otherwise affects operations.
- G. Repeated device failures, defined as the failure of a device or a single type of device three or more times over three contiguous months, will be considered as a failure of a manufactured system and all items of this type shall be replaced at no charge to the Owner.
- H. At least one representative of the Systems Contractor, well versed in the installation and the operation of the systems, shall be on site in support of the Owner for the first significant public event in each space (as determined by the Owner) where the system will be used. The Contractor representative(s) for this event shall also be competent in show operations.
- I. Contractor is to coordinate ongoing remote access to AV Systems Networks for support and troubleshooting. Owner to provide the access at their discretion.

3.6 INSURANCE

- A. All equipment and materials shall be fully insured against loss or damage up until acceptance of the system by the Owner or until Owner relieves the Contractor in writing of this responsibility, whichever is earlier, regardless of the location of the equipment. All equipment is deemed to be under the control of the Systems Contractor until acceptance of the system by the Owner or until Owner relieves the Contractor in writing of this responsibility, whichever is earlier.

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11/17/2017

FRANCIS WALSH INTERMEDIATE SCHOOL/
BOARD OF EDUCATION CENTRAL OFFICES
BRANFORD, CONNECTICUT
State Project No. 014-0034 EA/014-0035 BE-EA

3.7 EXISTING CONDITIONS

- A. Visit the site prior to making a bid. No subsequent allowance will be made due to failure to thus observe and verify conditions which may affect the work. Report to the Architect and Systems Designer any discrepancies among this specification and existing conditions and similarly report obvious omissions.

B. WORK SCOPE SUMMARY TABLE

ITEMS TO BE PROVIDED AND INSTALLED	Electrical Contractor		Systems Contractor	
	Provide	Install	Provide	Install
Main Power Service Panel Boards and Circuit Breakers	x	x		
Main Power Service Conduit and Conductors	x	x		
Main Power Service Terminations		x		
Audio & Video Technical Power (AVTP) Transformers	x	x		
Transformer Conduit and Conductors	x	x		
Transformer Terminations		x		
AVTP Isolated Ground Conduit and Conductors	x	x		
Isolated Ground Terminations		x [∅]		
AVTP Distribution Panelboards and Circuit Breakers	x	x		
Distribution Panelboard Conduit and Conductors	x	x		
Distribution Panelboard Terminations		x		
AVTP Standard Load Centers and Circuit Breakers	x	x		
Standard Load Center Conduit and Conductors	x	x		
Standard Load Center Terminations		x		
AVTP Custom Sequencing Panelboards and Circuit Breakers	x	x		
Custom Sequencing Panelboard Conduit and Conductors	x	x		
Custom Sequencing Panelboard Terminations		x [∅]		
AVTP Company Switches for Portable Equipment	x	x		
Company Switch Conduit and Conductors	x	x		
Company Switch Terminations		x		
AVTP Outlet Devices for Branch Circuits delivered to Systems Equipment Racks and Devices			x	x
Equipment Rack Back Boxes and Wall Plates			x	x
Outlet Device Back Boxes	x	x		
Outlet Device Wall Plates	x	x		
Branch Circuit Conduit and Conductors	x	x		
Branch Circuit Termination		x		

WORK SCOPE SUMMARY TABLE (continued)

ITEMS TO BE PROVIDED AND INSTALLED	Electrical Contractor		Systems Contractor	
	Provide	Install	Provide	Install
Systems Equipment Racks and Devices			x	x
Metallic Conduit between Systems Devices and Systems Equipment Racks	x	x◇		
Conduit Insulation Bushings between Metallic Conduit and Systems Equipment Racks	x	x◇		
Systems Equipment Rack Cabling			x	x
Systems Equipment Rack Terminations				x
Systems Device Back Boxes and Floor Boxes		x◇	x	
Systems Device Metallic Conduit	x	x◇		
Systems Device Cabling			x	x
Systems Device Termination				x
Empty Conduit (for temporary use)	x	x		
Systems Cable Trays	x	x		
Systems Cable Sleeves	x	x		
Systems Pull Boxes	x	x		
Conduit Riser Diagram	x			

◇ Installation criteria to be provided by Systems Contractor

PART TWO - EQUIPMENT

3.1 GENERAL EQUIPMENT

- A. Whenever any equipment is specified by manufacturer and model number, it is for purposes of establishing a standard of quality, performance, construction and function.
- B. All materials and equipment shall be new and of the latest design or model offered for sale by the manufacturer.
- C. Equipment models provided shall operate at the required AC line voltage and frequency.
- D. Contractor shall provide quantities as indicated in the equipment list, detail drawings, location drawings, schedule of terminations, and as required for a complete installation.
- E. Audio & Video Wire and Cable
 - 1. All wire numbers listed in the drawings are Belden unless otherwise noted.
 - 2. THHN wire is not an allowable substitute for twisted pair stranded loudspeaker wiring.
 - 3. Approved manufacturers: Belden, Canare, Gepco, West Penn, Whirlwind
 - 4. Where conflict exists with any codes or ordinances, such codes and ordinances shall take precedence.
 - 5. Where conflict exists with electrical specifications, the higher standard or more stringent requirement shall apply.
- F. Wiring Devices
 - 1. Specifications – Duplex Receptacles: per electrical drawings
AV Technical Power Plates for receptacles must be labeled with the panel number and breaker number for the circuit(s) they are connected to (to be provided and installed by DIV. 26)
- G. Electrical Plates and Panels:
 - 1. Specifications – Rack Mount Panels
Material: 11 gauge steel or 1/8" Aluminum, minimum thickness
Finish: Black or to match adjacent equipment
Size: 19" wide, standard EIA mounting hole spacing, height as specified
 - 2. Specifications – Back Box Enclosures
Material: Code grade steel
Finish: Black or galvanized
Size: As specified
 - 3. Specifications – Plug Box and Termination Panels
Material: 11 gauge steel or 1/8" Aluminum, minimum thickness
Finish: Black (unless instructed otherwise by Architect)
Size: As specified
 - 4. Approved Manufacturers: Steel City, Raco, Hoffman, Whirlwind, Pro Co, Wireworks

H. Audio Transformers

1. All transformers shall be selected for proper interface and loading in the circuits as required by as-built conditions and per manufacturer's recommendations.

3.2 MAJOR EQUIPMENT

- A. Equipment provided shall be that specified herein or approved substitute (see Paragraph 1.6.D).
- B. Detailed performance specifications shall be those published by the manufacturer effective on the date of this document for all equipment listed below.
- C. Refer to Appendix B for Major Equipment List

3.3 DETAIL DRAWINGS

- A. The drawings herein detail custom built equipment and system details.
- B. Furnish all materials and labor to provide complete and finished work even though not specifically shown on the drawings.
- C. Detail drawings are located in large format AV drawings.

PART THREE - EXECUTION

3.1 AUDIO SYSTEM REQUIREMENTS

- A. Requirements herein refer to materials and work which are related to or part of the Systems. Where conflict exists with other specifications concerning such work or materials, this specification takes precedence unless otherwise approved in writing by the Owner.

3.2 INSTALLATION OF SYSTEMS

- A. Locate all apparatus requiring adjustments, cleaning or similar attention so that it will be accessible for such attention. Equipment racks shall be positioned to permit full access for operation and service.
- B. Furnish and install brackets, braces and supports. All mounting hardware shall be included.
- C. All bolts and fasteners must be Grade 5 or better.
- D. All bolted attachments to have lock washers or other self-locking fasteners.

- E. Provide all required mounting brackets and framing, hardware and components, safety systems and rigging systems using the following minimum design factors (given as ratio of working load limit (WWL) : rated breaking load):
1. 5:1 – Minimum design factor for all mounting components regardless of mounting condition.
 2. 5:1-8:1 – Minimum design factor for manufacturer provided mounts & assemblies where engineered stamped documentation and destructive testing data is provided by manufacturer.
 3. 10:1 – For all hardware and connecting assemblies between manufacturer rated assemblies when equipment is hung above the general public. This includes but is not limited to wire rope, bolts, shackles, turnbuckles, beam clamps, supplemental steel provided by Systems contractor and other connecting hardware.
 4. Design factor calculations to be provided with all equipment mounting details.
 5. Systems Contractor shall coordinate required additional blocking, supplemental steel or channel strut supports with Main Contractor & specific trade contractors.
 6. All mounting systems not provided as a complete package from a single manufacturer must be engineered, approved, and have drawings stamped by a professional rigging engineer or licensed structural engineer, as approved by the Main Contractor. The engineer shall verify that the design meets or exceeds design criteria for this particular use case. Each mounting system solution must be separately engineered, verified, and stamped.
- F. All supporting structures and enclosures supplied by the Contractor not having a standard factory paint finish shall be painted. Paint specifications will be supplied by the Architect or indicated herein.
- G. Provide custom color or finish for any equipment or materials supplied which are exposed to public view. Color and finish of all such equipment or materials shall be approved in writing by the Architect. This does not exclude equipment or materials where standard colors and finishes may be specified herein.
- H. Finish of blank panels and custom assembly panels shall match adjacent equipment panels. Verify all panel colors with Architect. All color choices should be clearly indicated on panel drawing submittals, and on the panel schedule.
- I. Switches, connectors, jacks, receptacles, outlets, cables and cable terminations shall be logically and permanently marked. Custom panel nomenclature shall be engraved, etched or screened. Markings for these items are detailed in the drawings to ensure consistency and clarity. Verify any changes in working type size and/or placement with the Systems Designer prior to marking.
- J. Protect equipment and related wiring where construction conditions may cause damage or environmental conditions exceed manufacturer's specifications.
- K. The standard reference for the layout and construction of the system shall be:
Giddings, Philip. Audio Systems Design and Installation. Boston: Focal Press, 1990.

3.3 CONDUIT

- A. Review and coordinate Systems conduit installation with the electrical contractor to ensure proper operation of the Systems.
- B. All wiring shall be in conduit unless authorized by the Architect, approved by the Systems Designer, and permitted by code. Exceptions are short runs at equipment terminations where there is no means of connecting conduit to the equipment.
- C. Where installed exposed, conduits shall be parallel with or at right angles to walls or ceilings and shall be supported from walls or ceilings by means of approved galvanized iron clamps or hangers. Conduit connections to equipment racks shall be insulated.
- D. Minimum size conduit shall be 3/4 inch. All conduit shall be sized for maximum 40% fill or less if required by code.

3.4 CONDUIT SEPARATION

- A. Systems wiring is divided into wiring groups according to their nominal voltage levels (refer to Schedule of Terminations):

	Wiring Type
Group A	Microphones and other sensitive wiring (0 mV to 100 mV)
Group B	Line level wiring (100 mV to 10 V)
Group C	Loudspeaker and control wiring (10 V to 70 V)
Group D	Telephone, Category Network, video, control and digital circuits
Group E	Fiber optic cable
Group F	Spare Conduit

Note: These wiring groups must never be intermixed within a given conduit run!

- B. Minimum conduit separation between conduits carrying wiring of different groups is as follows:

	Group A	Group B	Group C	Group D	Group E
Group A	adjacent	6"	12"	12"	adjacent
Group B	-	adjacent	12"	6"	adjacent
Group C	-	-	adjacent	6"	adjacent
Group D	-	-	-	adjacent	adjacent
Group E	-	-	-	-	adjacent
Group F	12"	12"	12"	12"	adjacent

Note: Ninety degree crossings in close proximity are acceptable. Separations must be maintained until within six feet of box or gutter entry.

- C. Minimum conduit separation between conduits carrying Systems wiring and other electrical service conduit is as follows:

	Group A	Group B	Group C	Group D	Group E
Dimmer controlled lighting	24"	12"	6"	12"	adjacent
SCR controlled services	24"	12"	6"	12"	adjacent
220/440V circuits	6"	6"	adjacent	adjacent	adjacent
All other services	6"	6"	adjacent	adjacent	adjacent

Note: Heavy current demands in or long parallel runs with the above services may dictate greater separations to avoid interference in the Systems. Separations must be maintained until within six feet of box or gutter entry.

- D. Contractor must have written authorization from the Systems Designer for any conduit installation which does not conform to these requirements. The conduit separations above are based on the use of EMT conduit for all AV and other signals. The Contractor must request information on separation adjustments for each instance where a different type of conduit is used.

3.5 ELECTRICAL POWER

- A. Review and coordinate electrical power system installation including grounding with the electrical contractor to ensure proper operation of the Systems.
- B. Verify that all AC power circuits designated for Systems equipment are wired with correct polarity and isolated ground. Report in writing any discrepancies found to the Architect for corrective action.
- C. Provide distribution of electrical power within the equipment racks with a minimum of one spare AC receptacle for each four in use per branch circuit.

3.6 STEEL SUPPORTS

- A. Fabricate and install any supports so that the installation does not weaken or overload the building structure. Do not impose the weight of equipment or fixtures on supports provided for other trades or systems. No drilling or cutting of concrete beams, joists, or structural steel, nor welding to structural steel, will be permitted except as authorized, in writing, by the Architect.

3.7 BOXES

- A. With the exception of portable equipment, all boxes, conduits, cabinets, equipment and related wiring shall be held in place and the mounting shall be plumb and square.
- B. All boxes shall be securely mounted to building structure. All boxes shall be installed so that wiring contained in them is accessible. Install blanking devices or threaded plugs in all unused holes.
- C. Wiring groups and circuits shall be isolated as indicated herein. Common pull or junction boxes are not permitted except as authorized, in writing, by the Systems Designer. Refer to AV0.30 for standard detail.
- D. Clean all box interiors before installing plates, panels or covers.

3.8 WIRING METHODS AND PRACTICES

- A. Provide installation of all Systems wire and cable, ensuring proper:
 - 1. Pulling Tensions
 - 2. Quantities
 - 3. Types
 - 4. Lengths
 - 5. Routing
 - 6. Wire Group Separation
 - 7. Identification
- B. The interconnection of equipment in a rack shall use the same wire by type as specified for runs external to racks unless otherwise indicated on AV single line drawings. All wiring within racks shall be direct between devices without splices.
- C. Interconnection wire between amplifiers and loudspeaker transition panels will be type LSXFR (refer to wire types on AV0.01.)
- D. Connector polarity shall be maintained except for terminations at equipment manufactured to other standards. In the event that manufactured equipment can be ordered with, or internally set to, various standards, the equipment shall be configured as follows:
 - 1. Polarity for XLR style connector shall be: pin 2-high, pin 3-low, and pin 1-shield.
 - 2. Polarity for TRS style connector shall be: tip-high, ring-low, and sleeve-shield.
- E. Spare wire runs of each group and type shall be pulled to each termination location. The number of spares shall be ten percent of those in actual use or one, whichever is greater.
- F. Splicing of cables is not permitted between terminations of specified equipment.

- G. Do not pull wire or cable through any box fitting or enclosure where change of raceway alignment or direction occurs; do not bend conductors to less than recommended radius. Employ temporary guides, sheaves, and rollers to protect cables from excess tension, abrasion or damaging bending during installation.
- H. Provide wire pulling lubricants and pulling tensions in accordance with the wire and cable manufacturer's recommendations.
- I. All wires shall be permanently identified at each wire end by marking with self-laminating adhesive labels fully covered with clear heat shrink tubing, and a chart kept of each wire's function. This applies to wire within a rack assembly as well as wire running in conduit.
- J. Wire ends should be wrapped with heat shrink tubing. Each shield or drain wire should be covered with heat shrink to avoid unintentional connections.
- K. Use Wago or Entrelec DIN rail mounted terminal blocks for all terminal block wiring connections. Do not exceed one wire per terminal connection point. Do not cut strands from conductors to fit lugs or terminals. Spare terminal blocks, equivalent to 10% of those in actual use, shall be provided.
- L. Form, in an orderly manner, all conductors in enclosures and boxes, wire ways and wiring troughs, providing circuit and conductor identification. Tie using tie wraps of appropriate size and type. Limit spacing between ties to six (6) inches and provide circuit and conductor identification at least once in each enclosure.
- M. Provide ample service loops at each termination so that plates, panels, patch bays, and equipment can be dismantled and placed on an adjacent horizontal work surface allowing for safe service and inspection without disconnection. See standard detail drawing AV0.0x.

3.9 GROUNDING

- A. Audio system wiring shall conform to the following procedures:
 - 1. Audio equipment AC ground pins shall connect to AC isolated ground.
 - 2. Audio equipment chassis shall connect to AC isolated ground or rack frames.
 - 3. Audio rack frames shall connect to AC isolated ground bus in panelboard by means of #2 gauge (minimum) conductor.
 - 4. Audio shields between AC powered pieces of equipment, where signal shield is tied to chassis ground, shall be connected to ground at one end only. Capacitively terminate as required. See connection wiring details on AV0.0x.
 - 5. Audio signal paths between AC powered pieces of equipment shall be connected using balanced lines and/or transformer isolation as required. No unbalanced signal paths may be connected to the patch bay.
 - 6. Isolate all Systems wiring from racks, back boxes and conduit.
 - 7. Isolate all Systems racks from conduit and other conductive surfaces. Use insulated bushings for conduit connections and a dielectric plinth between racks and conductive flooring materials.

8. AC isolated ground system shall be isolated from all other facility grounds.

- B. All metallic conduit, boxes and enclosures shall be grounded in accordance with the current National Electrical Code.
- C. Metallic enclosures containing active equipment shall be grounded with due regard for the minimization of electrical noise. This may include the provision of grounding conductors separate from the AC ground.

3.10 EQUIPMENT RACKS

- A. The equipment racks shall be considered as custom assemblies and shall be assembled, wired and tested in the Contractor's shop. Assembly of racks on-site will not be permitted without written approval from the Systems Designer (except for shielded microphone and line wiring which must connect directly to the patch bays).
- B. Placement of equipment in equipment racks, as shown in the drawings, is for maximum operator convenience. Verify any changes in placement of the equipment with the Systems Designer before assembly.
- C. Racks shall be installed plumb and square without twists in the frames or variations in level between adjacent racks.
- D. All wire, cable, terminal blocks, rack mounted equipment, and active slots of card frame systems shall be clearly and logically labeled as to their function, circuit, or system. Labeling on manufactured equipment shall be by engraved plastic laminate or by thermal printer on adhesive tape, with white lettering on black background or dark background that is similar to panel finish.
- E. Provide stiffeners to custom panels to prevent panel deformation during normal plugging or switching operations.
- F. All wires and cables used in assembling custom panels and equipment racks shall be formed into harnesses which are tied and supported in accordance with accepted engineering practice.
- G. Harnessed cables shall be combed straight, tie-wrapped every six (6) to ten (10) inches, and attached to the structure as necessary. Each cable that breaks out from a harness for termination shall be provided with an ample service loop so that panels, patch bays, and equipment can be dismantled and placed on an adjacent horizontal work surface allowing for safe service and inspection without disconnecting. See standard detail drawing AV0.0x.
- H. Harnessed cables shall be formed in either a vertical or a horizontal relationship to equipment, controls, components or terminations.
- I. Cable shields shall be connected to the isolated ground system with due regard for ground loops. (See Giddings reference book, Chapter 10)

- J. All system components and related wiring shall be located with due regard for the minimization of induced electro-magnetic and electrostatic noise, for the minimization of wiring length, for proper ventilation, and to provide reasonable safety and convenience for the operator.
- K. All rack mounted equipment, with front panel controls, shall be provided with security covers to avoid tampering with preset levels. If specific security covers are not included in the equipment list, the Contractor will provide the manufacturer's security cover for each specified device or a suitable alternate.
- L. Every device shall be installed with regard for proper polarity. Absolute polarity shall be maintained through the entire Systems signal chain.
- M. Any permanently mounted electronic device must be balanced. Contractor will provide balancing transformers for unbalanced equipment connections where necessary.

3.11 VERIFICATION TESTS

- A. In general, test each point to point wire segment individually, and test any linkage of multiple point to point cables that form an end to end link.
- B. Confirm that each individual wire and cable run (whether in a rack or in conduit) is identified with a unique number. These numbers are affixed to both ends of each cable and are clearly visible. Provide a complete list of these numbers along with the termination location of each end of the wire run.
- C. Verify all circuits and extensions for correct connection, continuity and polarity. Absolute polarity must be maintained between all points in the system.
- D. Identify installed length of all copper and fiber cabling.
- E. Confirm that all system outputs are free of spurious signals including oscillations and radio frequency signals. A wide band oscilloscope shall be used to verify this condition.
- F. Confirm that the system is free of audible clicks, pops, and other noises when any operating control is activated, with or without input signal.
- G. For all microphone lines, tie lines, return lines, 70V loudspeaker and effect loudspeaker lines, confirm:
 - 1. Proper circuits appearing at each termination location
 - 2. Proper circuits appearing at each jack bay position
 - 3. Continuity of all conductors
 - 4. Proper polarity is maintained
 - 5. Absence of shorts between conductors within each circuit
 - 6. Absence of shorts between circuit conductors and conduit
 - 7. Perform a sweep test to 0.5 MHz

- H. For RF Coaxial cabling confirm:
1. Receptacles output does not exceed +15dBmv (50-400MHz)+6 dBmv minimum, above 400MHz+3dBmv minimum)
 2. For each modulated video output, tap to meet +9dBmv (+/- 3dBmv)
 3. Verify that all TV channels are visible and free of any interference or signal distortion.
 4. Frequency sweep test from 5MHz to 1000MHz.
- I. For Category Cabling:
1. Use Category 6A cable pair tester to verify compliance with TIA/EIA standards referenced above (including all current addendums.)
 2. Test each cable using the permanent link procedure for opens, shorts, reversals, crosstwists, and mis-wiring. Check NEXT, ELFEXT, Delay Skew, Return Loss, and Alien Crosstalk.
 3. Report all is-wiring found and report retests as needed.
 4. If any conductors report open or short, replace the entire wire and re-test.
- J. For Fiber cabling:
1. Using appropriate test devices and proper factory terminated jumpers, measure all fiber optic line attenuations, end to end, as required by TIA/EIA-526-14A.
 2. Optical budget may not exceed the cable performance by length plus splice and connector losses (0.03 dB for each fusion splice, 0.3dB for each mechanical splice, and/or 0.4 dB for each connector).
 3. Overall attenuation must meet TIA/EIA-568B standards. Perform attenuation tests at 850nm and 1300nm.
- K. Confirm that loudspeakers and mountings are free of buzzes and rattles when the loudspeaker is swept with sine wave tones over its rated bandwidth at one-half (1/2) its maximum rated power.
- L. For all permanently mounted loudspeaker terminations, provide impedance measurement of each pair of loudspeaker lines with all loudspeakers connected and all amplifiers disconnected. These measurements shall be documented as editable tabular data listing impedance for each 1/3 octave band from 20 Hz to 20 kHz and shall be accurate to the nearest tenth of an Ohm.
- M. For all intercom terminations, confirm proper operation by initiating and receiving audio communication and call light. For single lines connected to a matrix, test each line with each channel in the matrix. Verify that all channels are quiet and without spurious noise.
- N. For all electronic devices mounted in racks and connected to patch bays, confirm:
- O. Every input and output is balanced.
1. Proper polarity is maintained throughout the entire audio path.
 2. Tip connection of each TRS jack is connected to the positive terminal of each corresponding input or output.

- P. For all devices requiring IP addressing:
1. IP addressing scheme must make use of subnets such that all devices, regardless on which network (Audio, Video, Control, or House) they reside, have a unique IP address to eliminate the possibility of duplicate IP addresses if networks are inadvertently cross-patched.
 2. All devices must have static IP addresses.
 3. Create a spreadsheet of all devices and their IP addresses, Subnet Masks, MAC Addresses, and other pertinent IP configuration information.
 4. Coordinate all IP addressing schemes with the Owner.
- Q. If the Audio, Video, and Control network switches are dedicated to these systems and the systems do not rely on Owner furnished and configured network switches:
1. Configure network switches to operate properly and provide the proper network configurations to support the network devices and protocols used by those devices.
 2. Configure, as needed, VLANS, IGMP, QOS, and other protocols requiring configuration to provide a fully functioning and robust network system.
 3. With all networks configured and operating, and all network devices configured and operating, confirm that the networks are behaving as expected and as required.
- R. Confirm that there are no shorts between the Neutral and Isolated Ground conductors for each clean power circuit.
- S. The Contractor is responsible for the programming and configuration of all DSP systems and control systems necessary as specified in this project specification and AV large format drawings.
1. Programming and configuration must be complete and ready prior to System Designer's arrival for verification of functionality and acceptance testing.
 2. Programming for the DSP systems must contain control pages to support normal operations, and to support Acceptance Testing and System Tuning operations, as described in this specification and the large format AV drawings.
 3. Programming for the Control Systems must include all master controller code and touch panel code and graphics, working together to provide the function as described in this specification and the large format AV drawings.
- T. Test all Audio, Video, and Control system controls, including but not limited to mixing consoles, switchers, routers, touch panels, paging stations, volume controls, and source selectors for proper operation.
- U. Test proper operation of any portable controls at each designated control location (Stage Manager's rack, for example).

3.12 INITIAL ADJUSTMENT

- A. Make all adjustments and modifications so that the system is operational and fully functional including but not limited to:

1. Update all device software and firmware to the latest manufacturer's recommended release that allows for proper operation with ALL OTHER DEVICES in the systems.
2. Make all adjustments and modifications for system gain structure per recommendations of major component manufacturers.
3. Properly configure all EDID and HDCP settings to allow for proper function of all video systems.
4. Install all programming for digital mixing consoles, DSP, Control and any other software based devices in the systems, and verify that audio and video signal passes as designed through these systems. Verify that control systems function as specified. Contractor to provide initial DSP and control system programming prior to acceptance testing, one full set of programming changes and adjustments, prior to handover to the Owner, and one additional set of changes and adjustments during the initial warranty period, as part of the base scope of work.
5. Properly balance all 70 Volt loudspeaker zones to be consistent from zone to zone using amplifier settings and loudspeaker taps to adjust for differing loudspeakers or installation height.
6. Properly adjust delay and equalization for all loudspeaker systems using SIM, SMAART or other similar dual FFT type measurement devices. All testing and adjustment shall be in accordance with all manufacturer recommendations and industry standard practice. Contact the Systems Designer for further system delay and equalization requirements.
7. Capture traces showing equalization and phase response for each loudspeaker or loudspeaker cluster.
8. Capture traces showing equalization and phase response for the systems operating as a whole from 3 locations in each major seating area.
9. Equalization and timing of the loudspeaker systems shall be further adjusted as required by the Systems Designer and Owner

3.13 VERIFICATION TEST REPORT

- A. Submit written report detailing the results of Initial Adjustments and Verification Tests. Report to include, at minimum, the following:
 1. Copies of all relevant drawings, charts, test instrument data, and photographs.
 2. PDF copies of all available manufacturers' operation and service literature for each major system component.
 3. Copy of all programming files including, but not limited to: Audio DSP programming and Graphic User Interface (GUI) files, Control system Touch Panel GUI files and control system control programming files.
 4. All other documentation and results of testing and initial settings as referenced in 3.11 and 3.12 above.
 5. Written certification that the installation conforms to the requirements stated herein, is complete in all respects, and is ready for inspection, Acceptance Testing, and tuning.
 6. Prepare an InfoComm Standard Commissioning Checklist for each system in this specification.
 7. Prepare a training syllabus for Owner training (see section 3.15.)

- B. This report shall be completed and submitted to the Systems Designer for review a minimum of five (5) days prior to Acceptance Testing and final tuning.

3.14 ACCEPTANCE TESTING

- A. Refer to Specifications section (Project Commissioning Requirements) for additional system commissioning requirements. ALL commissioning requirements from (Project Commissioning Requirements) and this section must be satisfied. One does not replace the other.
- B. Acceptance Testing shall be performed by the Systems Designer during a period designated by the Architect. Contractor shall furnish a minimum of two (2) technicians for the acceptance testing period.
- C. The minimum time required for Acceptance Testing is two (2) working days of dedicated quiet for each performance venue and recording studio and two (2) days for the classroom/rehearsal room systems. Coordinate this time period so that free access, work lighting, and electrical power are available on the site.
- D. Ensure that Systems areas are in a clean and orderly condition ready for acceptance testing.
- E. Provide test equipment (meeting the following minimum specifications) on site, at all times during Acceptance Testing. Prior to Acceptance Testing, provide the Systems Designer with a listing of the specific equipment to be made available.
 - 1. Oscilloscope: 10MHz Bandwidth, Sensitivity – 1mV/cm
 - 2. Digital Multi-meter: 1% Accuracy
 - 3. Function Generator: 1MHz Bandwidth, Distortion < 1%
 - 4. Real Time Analyzer: 1/3 Octave with microphone
 - 5. SMAART Analysis package with V.8 software and a minimum of two matching test microphones (Earthworks M30 or better)
 - 6. Pink Noise Source: 20 Hz – 20 kHz Bandwidth
 - 7. Impedance Sweep Meter: 20 Hz – 20 kHz Range, 1 Ohm – 50 kOhm
 - 8. Polarity Checker: Mic, line, or loudspeaker level
 - 9. Video Test Signal Generator(s): must provide all signals, resolutions, and output formats as needed to fully test the systems.

Note: Systems Designers may choose to supply their own test equipment.

- F. Be prepared to verify the performance of any portion of the system by demonstration, listening tests and instrumented measurements.
- G. Be prepared to facilitate the visual inspection of system components and wiring, including removal of termination panels for inspection or wiring termination and wire management practices.
- H. Be prepared to demonstrate all software and control systems.

- I. Be prepared to go through the commissioning checklist and verify all items as complete.
- J. Make additional mechanical and electrical adjustments within the scope of the work and which are deemed necessary by the Systems Designer as a result of the Acceptance Tests. This may include realigning of loudspeaker systems, changes in system gain structures, grounding, filtering or interfaces.
- K. Final acceptance will be contingent upon issuance by the Systems Designer of a letter of acceptance stating that the work has been completed and is in accordance with the contract documents.
- L. Contractor will bear any costs incurred for additional Systems Designer's time and expenses due to failure to have the system functioning in accordance with specification requirements at the times scheduled for Systems Designer's Acceptance Testing and tuning.

3.15 USER TRAINING

- A. Contractor will provide in-depth training in operation and regular maintenance of all systems and on all equipment included in the scope of work contained in this specification and the AV large format drawings.
- B. Training to include (but is not limited to):
 - 1. Detailed operation of mixing consoles, video switchers and routers, computer control systems and other essential system elements.
 - 2. Maintenance and repair of system equipment, including replacement procedures for user-replaceable parts.
 - 3. Review of Operation and Maintenance Manual (See 3.16)
- C. Contractor will provide a minimum of XXX training sessions of four hours each.
- D. The first session shall take place in the presence of the Systems Designer and shall occur directly after the completion of Acceptance Testing. If the Systems Designer, Owner, and/or Architect judge any work to be deficient and/or not substantially complete at the time scheduled for training, the training will be postponed until the Systems Designer, Owner, and Architect judge the entire AV system conforms to this specification and the AV large format drawings.
- E. Contractor will bear any costs incurred for additional Systems Designer's time and expenses due to failure to have the system functioning in accordance with specification requirements at the times scheduled for User Training.

3.16 SYSTEM DOCUMENTATION

- A. Within thirty (30) days of the Acceptance Testing, prepare and submit a CD-ROM of the preliminary Operation and Maintenance manual for approval by the Systems Designer. Manual to include, at minimum, the following documents in PDF format:

1. Table of contents
 2. Written Guarantee and service policy
 3. Basic power on/off and operational procedure
 4. Copies of all shop drawings which have been updated to include any changes made during the installation process
 5. All available manufacturers' operation and service literature for each major system component
 6. One line signal flow diagram with all cable runs and patch points identified by alpha-numeric character
 7. Copy of the Verification Test report
 8. Copy of conduit riser diagram
 9. Copy of the final tuning settings as provided by the Systems Designer
- B. Systems Designer will review the above system documentation. Upon approval, Contractor shall prepare and submit to the Owner:
1. Five (5) copies of the final Operation and Maintenance manual on CD-ROM or Flash Disk
 2. Two (2) hard copies of the final Operation and Maintenance manual printed and neatly bound
- C. Provide framed copy of the as-built signal flow diagram to be mounted in the control room. This diagram shall have all cable runs and patch points identified by alpha-numeric character.

END OF SECTION 274100

AUDITORIUM

<i>ITEM</i>	<i>MFR</i>	<i>MODEL</i>	<i>QTY</i>
SIDE ARRAYS			
Loudspeaker	DNB	Ti10L	6
Amplifier 4chan	DNB	30d	2
Loudspeaker Rigging	CUS	per drawing xx	2
Termination - Side Proscenium Loudspeaker	CUS	per drawing BB	2
CENTER ARRAY			
Loudspeaker	DNB	Ti10L	3
Amplifier 4chan	DNB	30d	1
Loudspeaker Rigging Grid	CUS	per drawing xx	1
Termination - Center Proscenium Loudspeaker	CUS	per drawing BA	1
SUBWOOFER			
Loudspeaker Subs	DNB	Ti-SUB	2
FRONT FILL			
Loudspeaker	DNB	5S	8
Amplifier 4chan	DNB	10D	1
Termination - Front Fill Loudspeaker	CUS	per drawing BE	5
BACK FILL			
Loudspeaker	DNB	8S	3
Amplifier 4chan	DNB	10D	1
Loudspeaker Rigging	CUS	per drawing xx	3
Termination - Back Fill Loudspeaker	CUS	per drawing BS	3
HOUSE MIX / PROCESSING			
Console and Accessories	YAM	QL5	1
Headphones	SNY	MDR-7506	1
Console Stand	QLK	WS-550	1
Termination - House Mix/Tech Position	CUS	per drawing TJ	1
Portable Rack - Console	CUS	per drawing xx	1
EFFECTS / MONITORS			
Loudspeaker Portable	QSC	K8	4
Loudspeaker Portable	QSC	K12	4
ONSTAGE			
Loudspeaker	QSC	E10	2
Amplifier 2 channel	QSC	GXD4	1
Mounting Assembly - Yoke & Clamp	CUS	per drawing xx	2
Termination - Onstage Page Loudspeaker	CUS	per drawing BG	2
STAGE INTERFACE			
Hub - Stage Junction Rack	CUS	per drawing ZB	1
Drawer with Lock 3 RU	MAP	D3-LK	2
Console Stage Box	YAM	TIO1608	2
Gigabit Ethernet Switch 10-Port	CIS	SG300-10	3
Symnet Processor 12x8	SMX	Radius 12x8EX	1
AES Output Card	SMX	Digital Output Card	1
SD Card Recorder	DEN	DN-700R	1
Rack Panel - EtherCon Patch	CUS	per drawing xx	1
Patch Cable - EtherCon 2ft	WWD	tbd	24
Patch Cable - XLR 2ft	WWD	JHA-QMC-02F	16
Rack Panel - XLR Patch	CUS	per drawing xx	2
Microphone Sub Snake	WWD	MT16-F-M-10SSH	3
Termination - On Stage Page	CUS	per drawing BG	1
Termination - Deck	CUS	per drawing TA	3
Termination - Down Stage	Cus	per drawing TB	2

Termination - Up Stage	CUS	per drawing TC	2
Termination - Stage Apron Interface	CUS	per drawing TU	2
CONTROL BOOTH			
Hub - Systems Control Rack	CUS	per drawing ZB	2
Gigabit Ethernet Switch 10-Port	CIS	SG300-10	3
Loudspeaker	EAW	UB12Si	2
Amplifier	QSC	CX302	1
Mounting Assembly - Yoke & Clamp	CUS	per drawing xx	2
Termination - Control Booth	CUS	per drawing TK	1
Hub - Equipment Rack	MAP	per drawing ZE	1
TERMINATIONS			
Termination - Supplemental	CUS	per drawing TH	2
ADA COMPLIANT RF SYSTEMS			
RF Transmitter & Supply	LSN	LT-800-xxx	1
IR or RF Transmitter Rack Mount	LSN	LA-326	1
RF Antenna Kit	LSN	LA-122	1
RF Receiver	LSN	LR-400-xxx	26
IR or RF Headphones	LSN	LA-165	26
IR or RF Neck Induction Loop	LSN	LA-166	6
Rechargeable Batteries	LSN	LA-362	26
RF Battery Charger Case 16 units	LSN	LA-311-xx	2
Termination - Antenna	CUS	per drawing TL	1
LIVE ROOM MICROPHONE			
Microphone MS	SHU	VP88	1
Mounting Assembly - Clamp	CUS	per drawing xx	1
Termination - Live Room Microphone	CUS	per drawing TI	1
INTERCOM			
Main Speaker Station & Supply 4chan	CLC	MS-704	1
Remote Belt Pack	CLC	RS-601	8
Gooseneck Panel Mic 18inch	CLC	GM-18	2
Handset	CLC	HS-6	2
Headset Single Muff 4pin FXLR cable	BEY	DT-108 xxx	8
Call Signal Flasher	CLC	FL-7	2
Termination - Intercom Plug	CUS	per drawing CD	2
PAGE & PROGRAM / FIXED			
Symnet Processor 12x4	SMX	Express 12x4 Cobra	1
Rack Panel - Relays	CUS	as needed	1
Rack Panel - Auxiliary Systems Control	CUS	per drawing xx	1
LOBBY			
Amplifier 4chan	EXT	XPA2002	1
Loudspeaker & Xformer & Baffle Round	ATL	SD72W	8
Loudspeaker Enclosure Round	ATL	95-8	8
Termination - Lobby Loudspeaker Zone 1	CUS	per drawing BL	8
WIRED MICS			
Microphone Dynamic Cardioid	SHU	SM57-LC	8
Microphone Dynamic Cardioid Vocal	SHU	SM58-LC	8
Microphone Condenser Cardioid	SHU	SM81-LC	4
Microphone Condenser Side Cardioid	SHU	SM27-LC	4
Microphone Condenser Supercardioid Vocal	SHU	Beta 87A	4
Microphone Dynamic Supercardioid Kick	SHU	Beta 52A	2
Microphone Dynamic Cardioid Drums	SEN	e604	4
Microphone Condenser Hemi Boundary	CRN	PCC-160	5
Direct Box	WWD	DIRECT-JT	4
Direct Box	WWD	PCDI	2

WIRELESS MICS

UHF Digital Quad Receiver	SHU	ULXD4Q	6
Handheld Transmitter	SHU	ULXD2/B58	8
Bodypack Transmitter	SHU	ULXD1	16
Microphone Lavalier Omni	DPA	4060-BM	16
Battery Charger	SHU	SBC800	2
Rechargeable Battery	SHU	SB900	24
Termination - Wireless Antenna	CUS	per drawing TW	2

STANDS / CABLES / ACCESSORIES

Microphone Stand 17-25in & Boom 18-30in	KNM	25900-577-55	8
Microphone Stand 35-63in & Boom 18-30in	KNM	21090-577-55	24
Microphone Case	SKB	SKB-1200	2
Microphone Cables on Reel	WWD	JHA-LCR-20F-50	1
Microphone Cables on Reel	WWD	JHA-LCR-50F-20	1

RECORDING SYSTEM

Recording System Rack	ARG	90-V2R	1
Dante-MADI interface	YAM	Rmio-64D	1
DAW Interface	ANT	Goliath	1
DAW Computer	APL	Mac Pro	1
DAW Software	AVD	Pro Tools HD-Native	1
MAC Pro Rackmount	TBD	Rack Mac Pro	1
Studio Monitors 2.1 System with DSP	GEN	8330.LSE Triple SAM	1
Monitor	TBD	TBD	2
Monitor Mount	TBD	TBD	1
Microphones	TBD	allowance	1
SSD Disk Dock	BKM	MultiDock	1

VIDEO CAMERA SYSTEM

Recording System Rack	ARG	90-V2R	1
Camera Color PTZ HD/SD	PAN	AW-HE100	3
Camera Controller	PAN	AW-RP120	1
Video Router	BKM	Smart VideoHub 20x20	1
Sync Generator	TBD	TBD	1
Production Switcher	BKM	ATEM 2M/E	1
Switcher T-Bar remote	BKM	1 M/E Broadcast Panel	1
Computer Monitor	TBD	TBD	1
Monitor Mount	TBD	TBD	2
Monitor Loudspeaker	GEN	8010A	2
Recording Deck	BKM	Hyperdeck Studio	2
Monitor	TBD	TBD	3
Termination - Camera	CUS	per drawing TK	3

VIDEO & CINEMA PROJECTION

Projector 1080P 3DLP 20000 lumen	CTE	HS13	1
Projector Lens dVision	DPI	TBD	1
Projector Ceiling Mount Fixed	PRM	as needed	1
Motorized Screen 16:10	DRA	Paragon	1
LCD Display 55in	BENQ	ST550K	1
Termination - Video Display	CUS	per drawing TM	1
Termination - Projection	CUS	per drawing TP	1
Termination - Projection Screen	CUS	per drawing TS	1

COMPUTER CONTROL & MONITORING

Lectern	tbd	tbd	1
DM System	EXT	TBD	1
DM System	EXT	TBD	1
Termination - Touchpanel	CUS	per drawing CA	2

Software Programming	CUS	as needed	1
POWER DISTRIBUTION			
Hub - Sequencing Panelboard	CUS	per drawing ZZ	1

CAFETERIA

<u>ITEM</u>	<u>MFR</u>	<u>MODEL</u>	<u>QTY</u>
PUBLIC ADDRESS			
Loudspeaker	JBL	Control 26CT	22
Amplifier 4chan	QSC	CXD4.2Q	1
Termination - Public Address Loudspeaker	CUS	per drawing CC	22
PLAYBACK / RECORDING			
Ethernet Switch	CIS	SG300-10	1
SYSTEM INTERFACE			
Hub - Stage Junction Rack	CUS	per drawing ZC	1
Symnet Processor 12x4	SMX	Express 12x4 Cobra	1
UPS Line Interactive 2.2kVA	MAP	UPS-2200R	1
Termination - Cafeteria AV Interface	CUS	per drawing CV	2
Transmitter	EXT	DTP T UWP 332 D	1
ADA COMPLIANT RF SYSTEMS			
RF Transmitter & Supply	LSN	LT-82-xxx	1
IR or RF Transmitter Rack Mount	LSN	LA-326	1
RF Antenna Kit	LSN	LA-122	1
RF Receiver	LSN	LR-400-xxx	33
IR or RF Headphones	LSN	LA-165	33
IR or RF Neck Induction Loop	LSN	LA-166	9
RF Battery Charger Case 16 units	LSN	LA-311-xx	3
Termination - Antenna	CUS	per drawing CL	1
WIRED MICS			
Microphone Dynamic Cardioid Vocal	SHU	SM58-LC	1
WIRELESS MICS			
UHF Digital Quad Receiver	SHU	ULXD4Q	4
Handheld Transmitter	SHU	ULXD2/B58	6
Bodypack Transmitter	SHU	ULXD1	10
Microphone Lavalier Omni	DPA	4060-BM	10
Antenna Active Directional	SHU	UA870-USTV	2
Antenna & Power Distribution	SHU	UA844SWB	1
Battery Charger	SHU	SBC800	2
Battery Charger	SHU	SB900	16
Termination - Antenna	CUS	per drawing CN	2
VIDEO DISTRIBUTION			
55" Display	BNQ	ST550K	4
Termination - Video Display	CUS	per drawing CD	4
Wireless Collaboration	EXT	Sharelink	1
Network Switch	HP	2530-8	3
Blu-Ray Player	Oppo	BDP-103	1
CD/Media Player w/Bluetooth/USB/Aux inputs and RS-232C	Denon	DN-500CB	1
Streamer	Apple	Apple TV	1

GYM, AUXILLARY GYM & NATATORIUM

<u>ITEM</u>	<u>MFR</u>	<u>MODEL</u>	<u>QTY</u>	
PUBLIC ADDRESS				
Loudspeaker	JBL	Control 31	21	
Amplifier 4chan	QSC	CXD4.2Q	2	
Termination - Bleacher Loudspeaker	CUS	per drawing GD	2	
Termination - Public Address Loudspeaker	CUS	per drawing GC	19	
PLAYBACK / RECORDING				
Computer Monitor	TBD	TBD	1	
Ethernet Switch	CIS	SG300-10	3	
GYM INTERFACE				
Hub - Equipment Rack	CUS	per drawing ZG	1	
Symnet Processor 12x4	SMX	Express 12x4 Cobra	1	
UPS Line Interactive 2.2kVA	MAP	UPS-2200R	1	
Termination - Wall Interface	CUS	per drawing GB	3	
ADA COMPLIANT RF SYSTEMS				
RF Transmitter & Supply	LSN	LT-82-xxx	1	
IR or RF Transmitter Rack Mount	LSN	LA-326	1	
RF Antenna Kit	LSN	LA-122	1	
RF Receiver	LSN	LR-400-xxx	33	
IR or RF Headphones	LSN	LA-165	33	
IR or RF Neck Induction Loop	LSN	LA-166	9	
RF Battery Charger Case 16 units	LSN	LA-325-xx	3	
Termination - Antenna	CUS	per drawing GL	1	
LIVE ROOM MICROPHONE				
Microphone MS	SHU	VP88	1	
Mounting Assembly - Clamp	CUS	per drawing xx	1	
Termination - Live Room Microphone	CUS	per drawing GW	1	
WIRED MICS				
Microphone Dynamic Cardioid Vocal	SHU	SM58-LC	4	
WIRELESS MICS				
UHF Digital Quad Receiver	SHU	ULXD4Q	1	
Handheld Transmitter	SHU	ULXD2/B58	2	
Bodypack Transmitter	SHU	ULXD1	2	
Microphone Lavalier Omni	DPA	4060-BM	2	
Antenna Active Directional	SHU	UA870-USTV	2	
Battery Charger	SHU	SBC800	1	
Battery Charger	SHU	SB900	4	
Termination - Antenna	CUS	per drawing CN	2	
VIDEO DISTRIBUTION				
Moble Cart for Flat Panel Displays	TBD	TBD	1	
84" Flat Panel Display	BNQ	IFP RP840G	1	
COMPUTER CONTROL & MONITORING				
Control System	EXT	TBD	1	
Termination - Touchpanel	CUS	per drawing GF	3	
Software Programming	CUS	as needed	1	
CHORUS AND BAND ROOMS				
	<u>ITEM</u>	<u>MFR</u>	<u>MODEL</u>	<u>QTY</u>
ADA COMPLIANT IR SYSTEMS				
IR Transmitter & Supply	LSN	LT-84-xx	1	

Termination - Infrared Emitter	CUS	per drawing CA	1
PUBLIC ADDRESS			
Control System/8x7 AV Switcher/Amplifier	CST	DMPS-300	1
Loudspeaker	QSC	K12.2	2
Ceiling Loudspeaker	JBL	Control 26CT	4
Electronics Rack Assembly DWR	MAP	per drawing	1
Recording Deck	DEN	DN-700R	1
Termination - Rehearsal Room Loudspeaker	CUS	per drawing MC	6
VIDEO DISTRIBUTION			
84" Flat Panel Display	BNQ	IFP RP840G	1
Moble Cart for Flat Panel Displays	TBD	TBD	1
Termination - Display	CUS	per drawing AR	1
System HUB	MAP	per drawing ZA	1

ART CLASSROOMS 1003 AND 1006

<i>ITEM</i>	<i>MFR</i>	<i>MODEL</i>	<i>QTY</i>
ADA COMPLIANT IR SYSTEMS			
IR Transmitter & Supply	LSN	LT-84-xx	1
Termination - Infrared Emitter	CUS	per drawing AL	1
PUBLIC ADDRESS			
Classroom Audio System	LSP	Flexcat Audio System	1
VIDEO DISTRIBUTION			
70" Display with i5 slot in PC -4th generation Intel CoreTM i5-4460 (6M Cache, 3.2 GHz) Processors	BNQ	BNQRP703	1
Termination - Teacher AV Wall Interface	CUS	per drawing AX	2

GENERAL MUSIC CLASSROOM 142 AND 157

<i>ITEM</i>	<i>MFR</i>	<i>MODEL</i>	<i>QTY</i>
ADA COMPLIANT IR SYSTEMS			
IR Transmitter & Supply	LSN	LT-84-xx	1
Termination - Infrared Emitter	CUS	per drawing CA	1
PUBLIC ADDRESS			
Control System/8x7 AV Switcher/Amplifier	CST	DMPS-300	1
Loudspeaker	QSC	K12.2	2
Electronics Rack Assembly DWR	MAP	per drawing	1
Recording Deck	DEN	DN-700R	1
Termination - Rehearsal Room Loudspeaker	CUS	per drawing MC	2
VIDEO DISTRIBUTION			
70" Display with i5 slot in PC -4th generation Intel CoreTM i5-4460 (6M Cache, 3.2 GHz) Processors	BNQ	BNQRP703	1
Termination - Display	CUS	per drawing AR	1
System HUB	MAP	per drawing ZA	1

SCIENCE CLASSROOMS 2006, 2070, 2073, 3006, 3067, AND 3070

<i>ITEM</i>	<i>MFR</i>	<i>MODEL</i>	<i>QTY</i>
ADA COMPLIANT IR SYSTEMS			
IR Transmitter & Supply	LSN	LT-84-xx	1
Termination - Infrared Emitter	CUS	per drawing AL	1
PUBLIC ADDRESS			
Classroom Audio System	LSP	Flexcat Audio System	1
VIDEO DISTRIBUTION			
70" Display with i5 slot in PC -4th generation Intel CoreTM i5-4460 (6M Cache, 3.2 GHz) Processors	BNQ	BNQRP703	1

Termination - Teacher AV Wall Interface	CUS	per drawing AX	2
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SCIENCE CLASSROOMS 2009 AND 3009

<u>ITEM</u>	<u>MFR</u>	<u>MODEL</u>	<u>QTY</u>
ADA COMPLIANT IR SYSTEMS			
IR Transmitter & Supply	LSN	LT-84-xx	1
Termination - Infrared Emitter	CUS	per drawing AL	1
PUBLIC ADDRESS			
Classroom Audio System	LSP	Flexcat Audio System	1
VIDEO DISTRIBUTION			
70" Display with i5 slot in PC -4th generation Intel CoreTM i5-4460 (6M Cache, 3.2 GHz) Processors	BNQ	BNQRP703	1
Termination - Teacher AV Wall Interface	CUS	per drawing AX	2

INSTRUCTIONAL COACHING CLASSROOM 1007

<u>ITEM</u>	<u>MFR</u>	<u>MODEL</u>	<u>QTY</u>
ADA COMPLIANT IR SYSTEMS			
IR Transmitter & Supply	LSN	LT-84-xx	1
Termination - Infrared Emitter	CUS	per drawing AL	1
PUBLIC ADDRESS			
Classroom Audio System	LSP	TCA-F	1
VIDEO DISTRIBUTION			
70" Display with i5 slot in PC -4th generation Intel CoreTM i5-4460 (6M Cache, 3.2 GHz) Processors	BNQ	BNQRP703	1
Termination - Teacher AV Wall Interface	CUS	per drawing AX	2

CONFERENCE ROOMS (PER ROOM)

<u>ITEM</u>	<u>MFR</u>	<u>MODEL</u>	<u>QTY</u>
ADA COMPLIANT IR SYSTEMS			
IR Transmitter & Supply	LSN	LT-84-xx	1
Termination - Infrared Emitter	CUS	per drawing AL	1
PUBLIC ADDRESS			
Classroom Audio System - Wireless Speaker	LSP	TCA-F	1
Classroom Audio System - Media Connector	LSP	Media Connector	1
VIDEO DISTRIBUTION			
55" Display	BNQ	ST550K	1
Termination - Teacher AV Wall Interface	CUS	per drawing AX	2
AV Network Bridge	Vaddio	AV Bridge Conference	1
CONTROL SYSTEMS			
Video Switcher	EXT	Crosspoint 82 IPCP	1
Control Panel	EXT	TLP Pro 720M	1
Transmitter	EXT	DTP T UWP 332 D	2
Receiver	EXT	DTP HDMI 4K 230 Rx	2
Gigabit Ethernet Switch 10-Port	CIS	SG300-10	1
Touchpanel	EXT	TLP Pro 725T	1
Cable Cubby	EXT	Cable Cubby 700	1
Programming (total for all conference rooms)	CUS	12 Hr Allowance	1

CLASSROOMS

1001, 1058, 1008,1014, 2001, 2003, 2004, 2005, 2026, 2028,
 2078, 2077, 2076, 2075, 2074, 2010, 2011, 2012, 2014, 2069,
 2068, 2067, 2065, 2055, 3001, 3003, 3004, 3005, 3075, 3074,
 3073, 3072, 3071, 3010, 3011, 3012, 3014, 3055, 3065, 3064, 3062

<u>ITEM</u>	<u>MFR</u>	<u>MODEL</u>	<u>QTY</u>
ADA COMPLIANT IR SYSTEMS			
IR Transmitter & Supply	LSN	LT-84-xx	1
Termination - Infrared Emitter	CUS	per drawing AL	1
PUBLIC ADDRESS			
Classroom Audio System	LSP	TCA-F	1
Classroom Media Connector	LSP	Media Connector	1
VIDEO DISTRIBUTION			
70" Display with i5 slot in PC -4th generation Intel Core™ i5-4460 (6M Cache, 3.2 GHz) Processors	BNQ	BNQRP703	1
Termination - Teacher AV Wall Interface	CUS	per drawing AX	2
System wide Digital Signage			
55" Display	BNQ	ST550K	19
Mount for above	CHF	LSM1U	19
Termination - Video Display	CUS	per drawing SD	19

END OF SECTION

SECTION 275116 - PUBLIC ADDRESS SYSTEM

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Each Contractor, Subcontractor and/or supplier providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 SUMMARY

- A. Section includes amplifier and control equipment, input equipment, and reproducer equipment.
- B. Related Sections:
 - 1. Section 01 90 00 – Building Commissioning Requirements.
 - 2. Division 7 Section – Penetration Firestopping.
 - 3. Section 27 05 26 - Grounding and Bonding for Communications Systems.
 - 4. Section 27 05 33 - Conduits and Backboxes for Communications Systems.
 - 5. Section 27 05 53 - Identification for Communications Systems.

1.5 SYSTEM DESCRIPTION

- A. The Contractor shall furnish and install all equipment including, but not limited to, outlet boxes, wiring, speakers, and all other necessary equipment to provide a complete operating system as indicated with the contract documents. Provide all necessary wall plates, specialty boxes, etc.
- B. Valcom Class Connection™ ES, shall be considered as the base bid system for the purposes of setting the level of quality, features and system performance. Systems of equal demonstrated quality and performance will be considered.
- C. The intent of this specification is to maximize communications between the classroom and administrative areas while enhancing school safety and reducing maintenance and operational cost.
- D. Under this specification, the system shall provide a complete Communication System.
- E. The Communication System shall provide distribution of intercom, overhead paging, emergency paging, class change time tones, emergency tones, program material, AND on board emergency messaging.
- F. The Communication System shall feature the capability to operate a system of cameras such that visual and audible communication may be synchronized.
- G. During phased construction the existing and new public address systems will be operational. Provide the necessary equipment and wiring to bridge the two systems during construction to allow an “all call” generated from either system to broadcast on the other system.

1.6 RESPONSIBILITIES

- A. Contract documents are detailed only to the extent required to show design intent. It shall be understood and agreed upon by the Contractor that all work described herein shall be complete in every detail.
- B. Furnish additional items not mentioned herein to meet requirements as specified, to include hardware, rack panels, 66Blocks etc., and other devices that are required for installation.
- C. Labor furnished shall be trained and experienced in telecommunication systems.
- D. All equipment unless otherwise specified, shall be new, free from defects, and the best craftsmanship in its class.
- E. All manufactured equipment shall be installed as recommended by the manufacturers, or as indicated in their published installation manual.
- F. Furnish and install necessary equipment, backboxes, supports and enclosures.

- G. Furnish and install all necessary wire.
- H. Furnish shop drawings.
- I. Perform initial programming of system and audio level adjustments.
- J. Perform final programming of system and audio level adjustments.
- K. Provide system documentation including equipment manuals and drawings.
- L. Guarantee all equipment and components for their specified period from date of acceptance.
- M. Provide information on system requirements to any Contractor responsible for supplying related materials for this system.
- N. System must be U.L. 813 and FCC Part 15 listed for safety reasons. Systems not listed as above shall not be acceptable.

1.7 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

- C. It is the responsibility of the Contractor to provide the necessary documentation to demonstrate equal quality and performance to the specified system.
- D. Submit layout drawings of the communication system and all components.
- E. Submit drawings of control equipment showing all major components and positions in the rack.
- F. Provide block diagrams showing components and relative connections.
- G. Submit a certificate showing a completion of installation, programming, and service training from the system manufacturer.
- H. Submit data sheets on equipment provided.
- I. Test Reports: Indicate procedures and results for specified field testing and inspection.
- J. Manufacturer's Field Reports: Indicate activities on site, adverse findings, and recommendations.

1.8 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of speakers, control equipment, and outlets for input/output connectors.
- C. Operation and Maintenance Data: Submit instructions for adjusting, operating, and extending system, and repair procedures and spare parts documentation.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. The Contractor shall be from an established and local company providing solutions to the school market for a minimum of 5 (five) years with Telecom/Data/Sound Experience.
- C. The Contractor shall maintain an adequate parts inventory to perform necessary service and upgrades.

1.10 PRE-INSTALLATION MEETINGS

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

1.11 MAINTENANCE SERVICE

- A. Section 01 70 00 - Execution and Closeout Requirements: Maintenance service.
- B. The Contractor shall provide a 12 (twelve)-month guarantee of the installed system against defects in material and workmanship. All warranty material shall be provided at no expense to the Owner. Guarantee period shall begin on the date of acceptance by the Owner or Engineers.

1.12 PLEDGE OF QUALITY

- A. The Contractor shall be an authorized dealer of the supplied equipment with full warranty privileges.
- B. The Contractor must have attended the Manufacturers' Training Program and be an authorized Class Connection Distributor.
- C. The Contractor shall inventory the necessary parts in order to maintain and service the equipment being supplied. This equipment inventory level shall be in direct proportion to total systems installed as recommended by the manufacture.
- D. The Contractor shall provide complete drawings detailing all interconnections, panel wiring diagrams, and specification sheets.

1.13 IN-SERVICE TRAINING

- A. The Contractor shall furnish in-service training with the system. The sessions shall facilitate the training of personnel in operating classroom equipment, administrative equipment, program distribution, and user programming functions. System specific customized user manuals shall be provided at the time of training.

1.14 WIRING

- A. Wiring shall be in accordance with the Manufacturer's specifications. Wiring shall meet all local and state codes. All wiring shall be ground and short tested.

PART 2 PRODUCTS

2.1 COMMUNICATION SYSTEM

- A. The Communication System shall provide at least the following functions and features:
- B. Direct dialed, paging from all administrative telephones to any location equipped with a talkback speaker.
- C. Automatic gain control on intercom speech to assure constant talkback speech level.

- D. Microprocessor based system capable of handling up to 360 points
- E. System shall be modular in design and capable of expanding in increments of 24 points allowing for budget flexibility and expandability.
- F. System shall interface with any telephone system, thus allowing the school(s) to upgrade or replace their telephone system without suffering a requirement to replace, or lose any feature of, their internal communications (intercom) system. Any system that limits system features based upon any selected telephone system, and/or is proprietary to one or only a few telephone systems shall not be acceptable.
- G. Automatically sound a tone or play a pre-page WAV file over any loudspeaker connected for two-way communication to alert the classroom teacher that this two-way call has been established. This is intended to prevent unauthorized monitoring. The privacy tone must repeat every 15 (fifteen) seconds.
- H. Distribution of emergency announcement(s) from any authorized telephone to all areas furnished with a loudspeaker. Emergency announcements shall have the highest system priority.
- I. Distribution of general announcements from any administrative telephone, staff telephone, or classroom telephone. The system shall be capable of providing all-call, group calls, multiple group call, or dial-on-the-fly page groups.
- J. Provide the ability to define and archive unlimited time tone schedules with up to 255 events per schedule. Each scheduled event shall be capable of controlling any one of 6 (six) internal tones; user selected custom audio/voice phrases, audio from any of 3 auxiliary sources or up to 40 relays for building control. Each scheduled audio event shall be distributable to up to 72 audio groups. The system shall feature the ability to automatically initiate up to 8 schedules per day, based upon the day of the week or calendar dates up to one year in advance. Up to 8 daily schedules shall operate simultaneously. Schedule administration, modification and creation functions must be available through administration PC software. Systems that do not allow the school to manage their own schedules with PC software or do not offer calendar based scheduling up to one year in advance or require separate page and time groups shall not be acceptable.
- K. Provide 1, 2, 3 or 4 digits numbering plan, thus allowing the classroom speaker and the classroom telephone to be the same architectural number.
- L. Any classroom/area loudspeaker must have the flexibility to be programmed as a testing room. A testing room shall be excluded from receiving general announcements, class change tones, group announcements and program material. The testing room must receive emergency tones and announcements. A dial code must be provided that will access these testing rooms at the same time, allowing for an announcement to the testing rooms for applications such as standardized testing. The testing rooms may be reactivated to normal operation at any time by the administration staff as needed. Testing rooms shall automatically be reset to normal operation before start of class the next day.

- M. Programmable features shall be stored in non-volatile memory and shall not be lost due to power failures.
- N. System functionality must include the capability to manually distribute up to 5 (five) alert emergency tones via pushbuttons, contact closure, or dial up tones from any administrative telephone. These tones shall be customizable with respect to cadence, type and duration. Dial up tones must only be accessible by authorized users.
- O. The system must provide a minimum of 4 (four) ports to be connected to the telephone system from the intercom system. Systems that require integration to a specific telephone system or systems in order to offer this feature, or any system feature, shall not be acceptable.
- P. The system shall have the ability to control all system relays. Relays shall be controlled through the administrative software, DTMF controlled, automatically cycle at a programmed time of day, follow time schedule events, follow audio group events. All relays must be software programmable with the flexibility to change as required. A minimum of eight (8) relays shall be provided.
- Q. The system shall provide at least three simultaneously operating, non-restrictive program distribution channels. The audio program material shall be controlled and distributed with administration PC software allowing simple and easy changes. Systems that require manual operated switch-banks or cumbersome DTMF telephone codes for distribution shall not be acceptable.
- R. The Communication System shall feature the capability to operate a system of cameras such that visual and audible communication may be seamlessly synchronized. The resulting system of cameras and intercom (visual intercom) shall feature a capacity of at least 192 camera locations and 4 administrative monitors. The system shall provide functionality such that each monitor can display a full motion visual broadcast of the area corresponding to any active intercom path. The camera system shall feature a PC based setup utility and shall use standard UTP infrastructure. Systems that do not offer the capability to seamlessly integrate with a camera system as described above shall not be acceptable.
- S. The Communication System shall feature voice call progress. When 2 or more system users attempt to announce into the same area, the unsuccessful user shall be notified via a voice message. When a user's announcement attempt is overridden by a higher priority announcement, the overridden user shall be notified via a voice message.
- T. The system shall have the ability to store up to 60 minutes of WAV files directly onto the CPU and shall not be lost due to power outage.
- U. The WAV files shall be activated via the Administration Software, Telephone and/or Telephone system, and/or pushbuttons.

- V. The WAV files shall be programmable as to what level of priority they can be broadcast. They shall be programmable as to override any class change tones, normal all call, music, and intercom in the event of an emergency.
- W. The WAV files shall also have the ability to be broadcast into any one or all of the 72 audio groups as well to any zone within the system.
- X. The WAV files shall be have the ability to be broadcast via a schedule for any day of the week or time of the day. They shall also have the ability to be broadcast for any duration of time and repeat number of plays with the ability to select how long the duration is between each repeated broadcast.
- Y. The WAV files shall be able to be broadcast via a pushbutton. When this pushbutton is activated it shall be programmable to select which WAV file is broadcast, the priority level, where it is broadcast, and how many times it shall play.
- Z. The WAV files shall also have the ability to be a part of the class change tones within the system. These files shall be able to replace any tone within the class change schedules as to offer the flexibility of customizable tones and or phrases in this class change mode.
- AA. The WAV files shall be programmable as to replace the hands-free alert tone, repeated alert tone, or the all call alert tones.

2.2 CONTROL UNIT

- A. Shall be capable of expanding to 360 points. A point is defined as a speaker output.
- B. Ability to program and control the built-in master clock with unlimited events and unlimited time schedules with multiple audio groups.
- C. Ability to control wireless clocks.
- D. Ability to produce user defined tone signals for time tones or emergency tones.
- E. Ability to select the tone on an all-call basis from any, or selected, administrative telephones.
- F. Provide an RS-232 and Ethernet port, which will give ability to monitor operations and functions of the systems.
- G. Provide off-site programming and diagnostics of the system. It shall also be capable of determining basic circuit faults.
- H. The system shall be capable of simultaneous conversations between administrative ports.
- I. The system shall have a Windows® based PC administration programming tool which allows the administrative personnel to easily manage Audio Sources, Class Change schedules, paging groups, time updates, holiday schedules and day/night mode operation

from their desktop PC across a standard Ethernet LAN. It shall also have the ability to activate on board WAV files on a schedule and/or immediately in the event of an emergency at the highest priority override level. Systems that require propriety consoles, special LCD displays or solely utilize DTMF for changes to perform these functions shall not be acceptable.

- J. System shall provide calendar based scheduling up to one year in advance.
- K. The system shall be programmable via Ethernet or direct COM port cable connection.
- L. System speakers shall be capable of utilizing standard telephone/data wiring for installation, thus allowing for only one type of wiring infrastructure within the school. The speakers, call buttons and clocks shall be capable of utilizing pairs within a single cable to the classroom, allowing for lower installation cost. Systems that waste infrastructure by requiring separate heavy gauge infrastructure wire shall not be acceptable.
- M. Provide 8 (eight) unrestricted simultaneous audio paths for communication between administrative phones, program material, time tone distribution, and paging. Systems that do not allow simultaneous pages to different paging groups will not be accepted.
- N. Provide 6 (six) software programmable pushbutton inputs that can be used to activate tones, emergency tones, time tones, schedules, set system time, force a holiday schedule, door entry, etc.
- O. Provide 8 (eight) software programmable output contact closures which can be activated manually to turn on cameras, unlock doors, emergency lockdown, etc., or automatically via Master Time Control Center.

2.3 SPEAKERS

- A. 2x2 Lay in Speaker
 1. Cone Diameter: 8"
 2. Power Handling: 12 Watts
 3. Frequency response: 80Hz to 15Khz
- B. Wall Speaker
 1. Cone Diameter: 8"
 2. Power Handling: 12 Watts
 3. Frequency response: 80Hz to 15Khz
 4. Gray Metal enamel fish with Black cloth grill

2.4 WIRING

- A. All wiring shall be listed for the intended purpose. The intercom shall use U.L. listed cable. All classrooms shall be homerun.
- B. All interior wiring shall be in accordance with new construction guidelines suggested by the Manufacturer; including the speaker and the call-in switch.

PART 3 EXECUTION

3.1 EXISTING WORK

- A. Disconnect and remove abandoned public address and music equipment.
- B. Extend existing public address and music installations using materials and methods compatible with existing installations as required to maintain the existing system during phased construction.
- C. Provide the necessary equipment and wiring to bridge the two systems during construction to allow an “all call” generated from either system to broadcast on the other system.
- D. Clean and repair existing public address and music equipment remaining or to be reinstalled.

3.2 INSTALLATION

- A. Mounting Heights: Coordinate locations of outlet boxes specified in Section 27 05 33 to obtain mounting heights as indicated on Drawings.
- B. Connect speakers to amplifier with matching transformers.
- C. Install equipment racks in location shown; arrange for adequate ventilation and access.
- D. Install speaker signal audio connection in each classroom to AV system “Topcat” sound amplification system to mute AV system when paging system is active.
- E. Install engraved plastic nameplates in accordance with Section 27 05 53.
- F. Ground and bond public address and music equipment in accordance with Section 27 05 26.

3.3 FIELD QUALITY CONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Measure and record sound power levels at designated locations.

3.4 MANUFACTURER'S FIELD SERVICES

- A. Section 01 40 00 - Quality Requirements: Manufacturer's field services.
- B. Include services of technician employed by manufacturer to supervise installation, adjustments, final connections, system testing, and Owner training.
- C. Verify installation is complete and performs according to specified requirements.

3.5 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Adjust transformer taps for appropriate sound level.
- C. Adjust devices and wall plates to be flush and level.

3.6 DEMONSTRATION AND TRAINING

- A. Furnish 8 hours of instruction each for two persons, to be conducted at project site with manufacturer's representative.

END OF SECTION

SECTION 275313 - CLOCK SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Each Contractor, Subcontractor and/or supplier providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section "Summary", Paragraph 1.1A, entitled "Related Documents."

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 SUMMARY

- A. Section includes central clock and program system equipment, indicating (secondary) clocks, GPS antenna, transmitters and program control relays, and signal wire and cable.

1.5 SYSTEM DESCRIPTION

- A. Description: Synchronized wireless master-satellite time System to include master clock system controller, GPS antenna, transmitters and wireless (communications) secondary clocks.

- B. System establishes time standard signal for:
 - 1. Indicating clocks.
 - 2. Time period audible and visual signals.
- C. Configuration: Synchronized wireless.

1.6 REGULATORY REQUIREMENTS

- A. Equipment and components furnished shall be of manufacturer's latest model.
- B. Transmitter and receiver shall comply with Part 90 of FCC rules, as follows:
 - 1. The equipment shall not cause harmful interference.
 - 2. The equipment shall accept interference that will cause adverse on equipment operation.
 - 3. Transmitter frequency shall be governed by FCC Part 90.35.
 - 4. Transmitter output power shall be governed by FCC Part 90.257 (b).
- C. System shall be installed in compliance with local and state authorities having jurisdiction.

1.7 SUBMITTALS

- A. Product Data: Submit complete catalog data for each component, describing physical characteristics and method of installation. Submit brochure or color card showing available colors and finishes of clocks.
- B. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer

literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

- C. Operating License: Submit evidence of application for operating license prior to installing equipment. Furnish the license, or if the license has not been received, a copy of the application for the license, to the Engineer prior to operating the equipment. When license is received, deliver original license to Engineer.
- D. Samples: Submit one clock for approval. Approved sample shall be tagged and shall be installed in the work at location directed.
- E. Manufacturer's Instructions: Submit complete installation, set-up and maintenance instructions.

1.8 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Required.

1.9 QUALITY ASSURANCE

- A. Permits: Obtain operating license for the transmitter from the FCC.
- B. Qualifications:
 - 1. Manufacturer: Company specializing in manufacturing commercial time systems with a minimum of 5 continuous years of documented experience.
 - 2. Installer: Company with documented experience in the installation of commercial time systems.

1.10 DELIVERY, STORAGE AND HANDLING

- A. Deliver all components to the site in the manufacturer's original packaging. Packaging shall contain manufacturer's name and address, product identification number and other related information.
- B. Store equipment in unopened containers until ready for installation. Store in building in finished, air-conditioned space.

1.11 PROJECT SITE CONDITIONS

- A. Clocks shall not be installed until other finish work in each room is complete.
- B. Coordinate installation of GPS receiver with work on the roof or exterior side wall so that the bracket and related fasteners are watertight.

1.12 SYSTEM STARTUP

- A. At completion of installation and prior to final acceptance, start up the equipment, assure that all equipment is operating properly and that all clocks are functioning.

PART 2 PRODUCTS

2.1 CLOCK SYSTEMS

- A. Manufacturers:
1. Primex Wireless.
 2. American Time and Signal.
 3. Rauland.
 4. Substitutions: Permitted.

Note: basis of design system as specified below is based on Primex Wireless components and operation. Systems by the manufacturer's listed will be considered, subject to compliance with the system function and operation as specified.

2.2 MASTER CLOCK

- A. Product Description: Programmable master clock for maintaining standard time and transmitting time, correcting, and program control signals.
- B. Front Panel Time Display: Digital.
- C. Timing Reference: GPS satellite.
- D. Selectable Program Schedules: 25 zones, 96 events per zone.
- E. Enclosure: Surface.

2.3 SEQUENCE OF OPERATION

- A. Transmitter Operation: When power is first applied to the transmitter, it checks for and displays the software version, then it checks the position of the switches and stores their position in memory. The transmitter then looks for the GPS time signal. Once the transmitter has received the GPS time, it sets its internal clock to that time. The transmitter then starts to transmit its internal time once every second. The transmitter updates its internal clock every time it receives valid time data from the GPS.
- B. Clock Operation:
1. When power is supplied to the clock:
 - a. Press the red button when the red second hand is at the 12:00 position. At this time the microprocessor will lock in the location of the second hand.
 - b. After the red second hand has passed over the minute hand (first second hash mark after minute hand), press and release the red button. At this time the microprocessor will lock in the location of the minute hand. The microprocessor then assumes the location of the hour hand.
 2. After the red button has been pressed twice, the micro-processor will start searching the channels. It will start at channel No. 1 and proceed one by one until it either decodes a valid signal or reaches channel No. 16. If no signal is

- detected the receiver will be shut off and try again later. If a signal is received, the micro processor will store the channel number, set the clock to the receive time, then for the next minute the clock will beep every time that it receives a valid time signal. If the clock is in a good signal area it will beep once a second. If the clock beeps every few seconds, the clock is in a marginal signal area.
3. After initial set, the clock will shut off the receiver. On a pre-scheduled basis, the microprocessor will turn the receiver back on and starting with the stored channel, it will again look for a valid time signal. However the beeper will not operate.
 4. If the clock has not decoded a valid time signal for seven days, then it will go back to a double step mode.
 - a. General: The time system shall include a transmitter, a roof mounted GPS receiver, indicating clocks and all accessories for complete operation.
 - b. Transmitter : Primex Wireless Model XR05EM, consisting of wireless transmitter with GPS receiver. Unit shall obtain current atomic time from the satellite. The clock system shall transmit time continuously to all clocks in the school.
 - 1) Transmission:
 - a) Frequency Range: Five watt at frequency of 72.100 to 72.400 MHz.
 - b) Radio Technology: Narrowband FM.
 - c) Number of Channels: 16
 - d) Channel Bandwidth: 20 kHz maximum.
 - e) Transition Mode: One-way communication
 - f) Data rate: 2KBps
 - g) Operating Range: 0 degrees c. to 70 degrees C.
 - 2) Transmitter (Provide minimum of three transmitters):
 - a) Transmitter Output Power: +30 dBm (five watt)
 - b) Frequency Deviation: +1 – 4 kHz
 - c) Transmitter Power Requirements: 120 VAC 60 Hz
 - d) Internal Power Requirements: 5 volts DC
 - e) Carrier Frequency Stability: +11 20 ppm
 - 3) Transmitter shall have 16 selectable channels to assure interference-free reception.
 - 4) Transmitter shall have the following switches:
 - a) Time zone adjust switches for all time zones in the world. Includes all US time zones: Eastern, Central, Mountain, Pacific, Alaska and Hawaii.
 - b) Daylight saving time bypass switch.
 - c) 12 hour or 24 hour display.
 - 5) Transmitter housing shall be black metal case, 22”W by 17 “H by 22”D in size.
 - 6) Antenna shall be, commercial type, mounted on roof. Antenna gain shall be > 110 dBm. Antenna polarization shall be data logic, zero to 5 volts.
 - 7) Transmitter housing shall incorporate a display which shall include the following:
 - a) Time readout.

- b) AM and PM indicator if 12 hour time display is set.
 - c) Day and date readout.
 - d) Indicator for daylight savings or standard time.
 - e) LED which shall flash red in event of reception problem.
 - f) GPS reception indicator.
- 8) Transmitter shall contain an internal clock such that failure of reception from the GPS will not disable the operation of the clocks.
- C. Power Supply:
- 1. Transmitter: 120VAC, 6.0 A max.
 - 2. Secondary clocks: 120 VAC, 134 mA max.
- D. GPS Receiver: GPS roof mounted, with 15' cable attached, provide extension cables from manufacturer as required for specified antenna location.
- 1. The GPS Receiver shall be a complete GPS receiver including antenna in a waterproof case, 3-7/8 inches by 4-3/16 inches by 2 inches, designed for roof or outdoor mounting. Provide mounting bracket for attachment to roof structure.
- E. Wireless Tone Generator: Model XRA480 system with wireless tone generator, scheduler software, and wireless transmitters.
- F. Primex Wireless clocks, 12-1/2 inch diameter or 16 inch diameter as selected, color and finish as selected from manufacturer's standard colors and finishes. Clocks shall be wall mounted, and shall have polycarbonate frame and polycarbonate lens. Face shall be white. Hour and minute hands shall be black. Clocks shall be provided with red sweep second hand.
- 1. Clocks shall be electric (120 VAC power).
 - 2. Clocks shall be capable of automatically adjusting for daylight saving time. An on-off switch located on the transmitter shall disable this function if desired.
 - 3. Time shall be automatically updated from the transmitter 6 times per day.
 - 4. Clock lock: Tamper-proof/theft resistant hangers and slots in the backs of the clocks.
 - 5. Clock receivers shall be as follows:
 - a. Decode Sensitivity: >-110 dBm.
 - b. Receiver Power: Two alkaline"D" cells.
 - c. Antenna Type: internal.
 - d. Antenna Gain: -7 dBD.
 - 6. If transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded.
 - 7. Provide 16 inch diameter clocks in the Cafeteria, Gymnasiums, Pool and Auditorium. All other clocks shall be 12.5 inch diameter.
 - 8. Provide clocks with wire guards in Gymnasiums.
 - 9. Provide clocks as shown on drawings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that construction is complete in spaces to receive equipment and that rooms are clean, dry and permanent air conditioning systems are operating.
- B. Verify that 120 volt electrical outlet is located within 6 feet of location of transmitter and that outlet is operational and properly grounded.
- C. Provide factory services layout system transmitter and receiver equipment to ensure coverage throughout the facility.

3.2 INSTALLATION

- A. GPS Unit: Install on roof in location in clear view of the sky. Install unit in location free from standing water, and above accumulations of leaves or debris. Seal cable connection to GPS with cable connection sealant. Any added cable lengths must be protected from outside elements.
- B. Transmitter:
 - 1. Locate transmitter where indicated, a minimum of 2 to 3 feet above the floor, away from large metal objects such as filing cabinets, lockers or metal framed walls.
 - 2. Attach receiver to transmitter using coaxial cable.
 - 3. Connect antenna to transmitter, using care not to strip threads.
 - 4. Connect power supply to the transmitter.
 - 5. Set the channel number on the display to correspond to the FCC license.
 - 6. Plug power supply into electrical outlet.
- C. Clocks: Perform the following operations with each clock:
 - 1. Connect to power source.
 - 2. Set clock to correct time in accordance with manufacturer's instructions.
 - 3. Observe clock until valid signals are received and clock adjusts itself to correct time.
 - 4. Install the clock on the wall in the indicated location, plumb, level and tight against wall. Attach using Clock-Lock hanging method and suitable fasteners as approved by clock manufacturer.

3.3 ADJUSTING

- A. Prior to final acceptance, inspect each clock, adjust as required and replace parts which are found defective.
- B. Adjust program functions to meet Owner's schedule as published at time of Substantial Completion.

3.4 CLEANING

- A. Prior to final acceptance, clean exposed surfaces of clocks, using cleaning methods recommended by clock manufacturer. Remove temporary labels from clock faces. Do not remove labels from backs of clocks.

3.5 DEMONSTRATION

- A. Demonstration and Training: Furnish 2 hours of instruction each for two persons, to be conducted at project site with manufacturer's representative.

3.6 PROTECTION

- A. Protect finished installation until final acceptance of the project.

END OF SECTION

SECTION 280529 - HANGERS AND SUPPORTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Conduit supports.
 - 2. Formed steel channel.
 - 3. Spring steel clips.
 - 4. Sleeves.
 - 5. Mechanical sleeve seals.
 - 6. Firestopping relating to electrical work.
 - 7. Firestopping accessories.
 - 8. Equipment bases and supports.

- B. Related Sections:
 - 1. Section 03 30 00 - Cast-In-Place Concrete: Product requirements for concrete for placement by this section.
 - 2. Division 07 Section – Penetration Firestopping.
 - 3. Section 26 05 29 - Hangers and Supports for Electrical Systems.
 - 4. Section 27 05 29 - Hangers and Supports for Communications Systems.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.

- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. ASTM International:
 - 1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 3. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
 - 4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
- B. FM Global:
 - 1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.
- C. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.
- D. Underwriters Laboratories Inc.:
 - 1. UL 263 - Fire Tests of Building Construction and Materials.
 - 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
 - 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
 - 4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
 - 5. UL - Fire Resistance Directory.

1.5 PHASE 2 SUPPORT REQUIREMENTS

- A. All electronic safety and security systems including equipment, conduit, junction boxes and accessories being hung from above shall not be supported from the existing "space truss" roof structure unless noted otherwise. Systems shall be supported from new framing only. Refer to structural drawings for locations of new framing. Provide supplemental framing as required.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
- C. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.

2. Firestopping: Submit data on product characteristics, performance and limitation criteria.
- D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.
- E. Design Data: Indicate load carrying capacity of trapeze hangers and[hangers and supports.
- F. Manufacturer's Installation Instructions:
 1. Hangers and Supports: Submit special procedures and assembly of components.
 2. Firestopping: Submit preparation and installation instructions.
- G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- H. Engineering Judgements: For conditions not covered by UL listed designs, submit judgements by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.
- I. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.7 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile

Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings”, where applicable.

2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.
- B. Installer: Company specializing in performing work of this section with minimum years experience approved by manufacturer.

1.9 PRE-INSTALLATION MEETINGS

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

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

PART 2 PRODUCTS

2.1 CONDUIT SUPPORTS

- A. Manufacturers:
 1. Allied Tube & Conduit Corp.
 2. Electroline Manufacturing Company.
 3. O-Z Gedney Co.
 4. Thomas and Betts
 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.

- C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.
- D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.
- E. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.
- F. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.

2.2 FORMED STEEL CHANNEL

- A. Manufacturers:
 - 1. Allied Tube & Conduit Corp.
 - 2. B-Line Systems.
 - 3. Midland Ross Corporation, Electrical Products Division.
 - 4. Unistrut Corp.
 - 5. Substitutions: Section 01 60 00 - Product Requirements
- B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.3 SPRING STEEL CLIPS

- A. Manufacturers:
 - 1. Allied Tube & Conduit Corp.
 - 2. B-Line Systems
 - 3. Midland Ross Corporation, Electrical Products Division.
 - 4. Unistrut Corp.
 - 5. Substitutions: Section 01 60 00 - Product Requirements
- B. Product Description: Mounting hole and screw closure.

2.4 SLEEVES

- A. Sleeves for conduit, cable tray, raceway or cable through Non-fire Rated Floors: 18 gage thick galvanized steel.
- B. Sleeves for conduit, cable tray, raceway or cable through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
- C. Sleeves for conduit, cable tray, raceway, or cable through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.
- D. Fire-stopping Insulation: Glass fiber type, non-combustible.

2.5 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
 - 1. Thunderline Link-Seal, Inc.
 - 2. NMP Corporation.
 - 3. PSI Link-Seal.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify openings are ready to receive sleeves.
- C. Verify openings are ready to receive firestopping.

3.2 INSTALLATION - HANGERS AND SUPPORTS

- A. Anchors and Fasteners:
 - 1. Concrete Structural Elements: Provide precast inserts and expansion anchors.
 - 2. Steel Structural Elements: Provide beam clamps, spring steel clips, and welded fasteners.
 - 3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
 - 4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.
 - 5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
 - 6. Sheet Metal: Provide sheet metal screws.
 - 7. Wood Elements: Provide wood screws.
- B. Inserts:
 - 1. Install inserts for placement in concrete forms.
 - 2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.
- C. Install conduit and raceway support and spacing in accordance with NEC.

- D. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
- E. Install multiple conduit runs on common hangers.
- F. Supports:
 - 1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
 - 2. Install surface mounted cabinets and panelboards with minimum of four anchors.
 - 3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.
 - 4. Support vertical conduit at every floor.

3.3 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment. Refer to Section 03 30 00.
- B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of formed steel channel. Brace and fasten with flanges bolted to structure.

3.4 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with adjustable interlocking rubber links.
- B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.
- C. Set sleeves in position in forms. Provide reinforcing around sleeves.
- D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- E. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- G. Install chrome plated steel escutcheons at finished surfaces.

3.5 FIELD QUALITY CONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

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State Project No.s: 014-0034 EA / 014-0035 BE-EA

3.6 CLEANING

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

3.7 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

END OF SECTION

SECTION 280533 - CONDUITS AND BACKBOXES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.
- B. Related Sections:
 - 1. Division 7 Section – Penetration Firestopping.
 - 2. Section 26 05 03 - Equipment Wiring Connections.
 - 3. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
 - 4. Section 26 27 26 - Wiring Devices.
 - 5. Section 27 05 33 - Conduits and Backboxes for Communications Systems.
 - 6. Section 28 05 29 - Hangers and Supports for Electronic Safety and Security.
 - 7. Section 28 05 53 - Identification for Electronic Safety and Security.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.

2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
- B. National Electrical Manufacturers Association:
1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
 3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
 4. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
 5. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.5 SYSTEM DESCRIPTION

- A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.
- B. Underground More than 5 feet outside Foundation Wall: Provide thickwall Schedule 40/80 nonmetallic conduit. Provide cast metal boxes or nonmetallic handhole.
- C. Underground within 5 feet from Foundation Wall: Provide rigid steel conduit. Provide cast metal or nonmetallic boxes.
- D. In or Under Slab on Grade: Provide thickwall Schedule 40/80 nonmetallic conduit. Provide rigid steel conduit sweeps.
- E. Outdoor Locations, Above Grade: Provide rigid steel conduit. Provide cast metal outlet, pull, and junction boxes.
- F. Wet and Damp Locations: Provide rigid steel conduit, electrical metallic tubing. Provide cast metal outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.
- G. Concealed Dry Locations: Provide electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- H. Exposed Dry Locations: Provide electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- I. Existing Gymnasiums and Natatorium: Existing recessed backboxes and concealed conduits can be reused for devices shown on the technology drawings in the same vicinity. Provide recessed backboxes in infill areas at columns in these spaces. Do not install exposed conduit or raceways below 12 ft. AFF in these spaces without prior approval from the Architect and Engineer.

1.6 DESIGN REQUIREMENTS

- A. Minimum Raceway Size: 3/4 inch unless otherwise specified.

1.7 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit for the following:
1. Liquidtight flexible metal conduit.
 2. Nonmetallic conduit.
 3. Nonmetallic tubing.
 4. Raceway fittings.
 5. Conduit bodies.
 6. Surface raceway.
 7. Wireway.
 8. Pull and junction boxes.
 9. Handholes.
- C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
- D. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.8 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents:
 - 1. Record actual routing of conduits larger than 2 inch.
 - 2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.9 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- C. Protect PVC conduit from sunlight.

1.11 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate installation of outlet boxes for equipment connected under Section 26 05 03.
- C. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 PRODUCTS

2.1 METAL CONDUIT

- A. Manufacturers:
 - 1. Allied Tube and Conduit.
 - 2. Western Tube and Conduit.
 - 3. Wheatland Tube Company.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.

- B. Rigid Steel Conduit: ANSI C80.1.
- C. Fittings and Conduit Bodies: NEMA FB 1; all steel fittings.

2.2 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Manufacturers:
 - 1. Carlon Electrical Products.
 - 2. Anamet Electrical.
 - 3. Allied Tube and Conduit.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Interlocked steel construction with PVC jacket.
- C. Fittings: NEMA FB 1.

2.3 ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 - 1. Allied Tube and Conduit.
 - 2. Western Tube and Conduit.
 - 3. Wheatland Tube Company.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: ANSI C80.3; galvanized tubing.
- C. Fittings and Conduit Bodies: NEMA FB 1; steel, compression (damp locations), and set screw type.

2.4 SURFACE METAL RACEWAY

- A. Manufacturers:
 - 1. Hubbell Wiring Devices.
 - 2. Thomas & Betts Corp.
 - 3. The Wiremold Co.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.
- C. Size: as indicated on drawings.
- D. Finish: Manufacturers standard finish as selected by Architect.
- E. Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories; match finish on raceway.

2.5 OUTLET BOXES

- A. Manufacturers:
 - 1. Erico Products.
 - 2. Raco.
 - 3. Thomas & Betts Corp.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
 - 1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
 - 2. Concrete Ceiling Boxes: Concrete type.
- C. Cast Boxes: NEMA FB 1, Type FD, cast fer alloy. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.
- D. Wall Plates for Finished Areas: As specified in Section 26 27 26.
- E. Wall Plates for Unfinished Areas: Furnish gasketed cover.

2.6 PULL AND JUNCTION BOXES

- A. Manufacturers:
 - 1. Carlon Electrical Products.
 - 2. Hubbell Wiring Devices.
 - 3. Thomas & Betts Corp.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- C. Hinged Enclosures: As specified in Section 26 27 16.
- D. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
 - 1. Material: Galvanized cast iron.
 - 2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.
- E. Concrete Composite Handholes: Die-molded, concrete composite hand holes:
 - 1. Cable Entrance: Pre-cut 6 inch x 6 inch cable entrance at center bottom of each side.
 - 2. Cover: Concrete composite, weatherproof cover with nonskid finish.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 EXISTING WORK

- A. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces.
- B. Remove concealed abandoned raceway to its source.
- C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets when raceway is abandoned and removed. Install blank cover for abandoned outlets not removed.
- D. Maintain access to existing boxes and other installations remaining active and requiring access. Modify installation or provide access panel.
- E. Extend existing raceway and box installations using materials and methods compatible with existing electrical installations, or as specified.
- F. Clean and repair existing raceway and boxes to remain or to be reinstalled.

3.3 INSTALLATION

- A. Ground and bond raceway and boxes in accordance with Section 26 05 26.
- B. Fasten raceway and box supports to structure and finishes in accordance with Section 26 05 29.
- C. Identify raceway and boxes in accordance with Section 26 05 53.
- D. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.4 INSTALLATION - RACEWAY

- A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.
- B. Arrange raceway supports to prevent misalignment during wiring installation.
- C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

- D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29; provide space on each for 25 percent additional raceways.
- E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports
- F. Do not attach raceway to ceiling support wires or other piping systems.
- G. Construct wireway supports from steel channel specified in Section 26 05 29.
- H. Route exposed raceway parallel and perpendicular to walls.
- I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.
- J. Route conduit under slab from point-to-point.
- K. Maintain clearance between raceway and piping for maintenance purposes.
- L. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.
- M. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- N. Bring conduit to shoulder of fittings; fasten securely.
- O. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.
- P. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
- Q. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install factory elbows for bends in metal conduit larger than 2 inch size.
- R. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.
- S. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.
- T. Install suitable pull string or cord in each empty raceway except sleeves and nipples.
- U. Install suitable caps to protect installed conduit against entrance of dirt and moisture.
- V. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.

W. Close ends and unused openings in wireway.

3.5 INSTALLATION - BOXES

- A. Install wall mounted boxes at elevations to accommodate mounting heights as specified in section for outlet device.
- B. Coordinate communications device locations with furniture plan and receptacle locations to accommodate the intended purpose prior to rough-in.
- C. Adjust box location up to 10 feet prior to rough-in to accommodate intended purpose.
- D. Orient boxes to accommodate wiring devices oriented as specified in Section 271343.
- E. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- F. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- G. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- H. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic rated walls.
- I. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- J. Install stamped steel bridges to fasten flush mounting outlet box between studs.
- K. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- L. Install adjustable steel channel fasteners for hung ceiling outlet box.
- M. Do not fasten boxes to ceiling support wires or other piping systems.
- N. Support boxes independently of conduit.
- O. Install gang box where more than one device is mounted together. Do not use sectional box.
- P. Install gang box with plaster ring for single device outlets.

3.6 INTERFACE WITH OTHER PRODUCTS

- A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with Division 07 Section "Penetration Firestopping".

- B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket.
- C. Locate outlet boxes to allow luminaires positioned as indicated on Drawings.
- D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

3.7 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Adjust flush-mounting outlets to make front flush with finished wall material.
- C. Install knockout closures in unused openings in boxes.

3.8 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Clean interior of boxes to remove dust, debris, and other material.
- C. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 280553 - IDENTIFICATION FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Nameplates.
 - 2. Labels.
 - 3. Wire markers.
 - 4. Conduit markers.
 - 5. Underground Warning Tape.
 - 6. Lockout Devices.
- B. Related Sections:
 - 1. Section 09 90 00 - Painting and Coating: Execution requirements for painting specified by this section.
 - 2. Section 26 05 53 - Identification for Electrical Systems.
 - 3. Section 27 05 53 - Identification for Communications Systems.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data:
 - 1. Submit manufacturer's catalog literature for each product required.
 - 2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.
- C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.
- D. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of tagged devices; include tag numbers.

1.6 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile

Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings”, where applicable.

2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept identification products on site in original containers. Inspect for damage.
- C. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- D. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Install labels only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

PART 2 PRODUCTS

2.1 NAMEPLATES

- A. Manufacturers:
 1. Seton.
 2. Brady.
 3. Ideal Industries
 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Laminated three-layer plastic with engraved white letters on black contrasting background color.
- C. Letter Size:
 1. 1/8 inch high letters for identifying individual equipment and loads.
 2. 1/4 inch high letters for identifying grouped equipment and loads.
- D. Minimum nameplate thickness: 1/8 inch.

2.2 LABELS

- A. Manufacturers:
 - 1. Seton.
 - 2. Brady.
 - 3. Ideal Industries
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Labels: Embossed, pre-printed adhesive tape, with 3/16 inch white letters on black background.

2.3 WIRE MARKERS

- A. Manufacturers:
 - 1. Seton.
 - 2. Brady.
 - 3. Ideal Industries
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Description: Cloth tape or split sleeve type wire markers.
- C. Legend:
 - 1. Power and Lighting Circuits: Branch circuit or feeder number as indicated on Drawings.
 - 2. Control Circuits: Control wire number as indicated on shop drawings.

2.4 CONDUIT AND RACEWAY MARKERS

- A. Manufacturers:
 - 1. Seton.
 - 2. Brady.
 - 3. Ideal Industries
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Description: Nameplate fastened with straps.
- C. Color:
 - 1. Fire Alarm System: Red lettering on white background.
 - 2. Security System (Access Control, Intrusion Detection & Video Surveillance): White lettering on black background.
- D. Legend:
 - 1. Fire Alarm System: FIRE ALARM.
 - 2. Access Control System: ACCESS CONTROL.
 - 3. Intrusion Detection: ALARM.
 - 4. Video surveillance: CCTV.

2.5 LOCKOUT DEVICES

- A. Lockout Hasps:
 - 1. Manufacturers:
 - a. Master Lock.
 - b. Ideal Industries.
 - c. Brady.
 - d. Substitutions: Section 01 60 00 - Product Requirements.
 - 2. Anodized aluminum hasp with erasable label surface; size minimum 7-1/4 x 3 inches.

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Section 09 90 00 for stencil painting.

3.2 INSTALLATION

- A. Install identifying devices after completion of painting.
- B. Nameplate Installation:
 - 1. Install nameplate parallel to equipment lines.
 - 2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners.
 - 3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners.
 - 4. Secure nameplate to equipment front using screws.
 - 5. Install nameplates for the following:
 - a. Equipment racks and cabinets.
- C. Label Installation:
 - 1. Labeling procedures shall meet TIA/EIA 568B Series standard and BICSI Standards and shall be pre-approved by the Architect.
 - 2. Permanently label, using pre-printed labels, all cables and terminations.
 - a. Patch panels and cross-connect blocks, numerically from top to bottom.
 - b. Patch panel port with work area outlet label.
 - c. Cable segments.
 - 3. Install label parallel to equipment lines.
 - 4. Use industry standard TIA/EIA and BICSI color codes.
- D. Wire Label Installation:
 - 1. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.
 - 2. Install labels at data outlets identifying patch panel and port designation as specified.

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State Project No.s: 014-0034 EA / 014-0035 BE-EA

- E. Conduit Marker Installation:
1. Install conduit marker for each conduit longer than 10 feet.
 2. Conduit Marker Spacing: 20 feet on center.

END OF SECTION

SECTION 281300 - ACCESS CONTROL

PART 1 GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.
- B. Attention is directed Section 26 0400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specification

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 SECTION INCLUDES

- A. Provide a modular and network-enabled access control system, video management system and intrusion detection system for security management. All systems should be fully integrated to provide one network coordinated security management system. Equipment shall include Network Video Recorders, IP cameras, card readers, access system controllers, security system controllers, security system field devices, software, and computer servers for a complete integrated security management system.

1.5 RELATED SECTIONS

- A. Carefully examine all of the Contract Documents for requirements that affect the work of this section. Other specification sections that directly relate to the work of this section include, but are not limited to, the following:
1. Section 08 1113 – Hollow Metal Doors and Frames
 2. Section 08 1416 – Flush Wood Doors
 3. Section 08 8323 – Overhead Coiling Doors
 4. Section 08 7100 – Finish Hardware
 5. Section 27 1300 – Structured Cabling
 6. Section 27 0526 – Grounding & Bonding for Communications Systems
 7. Section 27 0529 – Hangers & Supports for Communications Systems
 8. Section 28 1600 – Intrusion Detection
 9. Section 28 2300 - Video Surveillance

1.6 REFERENCES

- A. Reference Standards: Provide systems which meet or exceed the requirements of the following publications and organizations as applicable to the Work of this Section:
1. Underwriters Laboratories Inc. (UL):
 - a. UL 365: Police Station Connected Burglar Alarm Units and Systems.
 - b. UL 609: Local Burglar Alarm Units and Systems.
 - c. UL 611: Central Station Burglar-Alarm Units.
 - d. UL 636: Holdup Alarm Units and Systems.
 - e. UL 684: Local, Central Station, and Remote Station.
 - f. UL 1023: Household Burglar-Alarm System Units.
 - g. UL 1076: Proprietary Burglar-Alarm Units and Systems.
 - h. UL 1610: Central-Station Burglar-Alarm Units.
 2. Federal Communications Commission (FCC):
 - a. Code of Federal Regulations Title 47: Part 15: Radio Frequency Devices.
 - b. Code of Federal Regulations Title 47: Part 68: Connection of Terminal Equipment to the Telephone Network.

1.7 SYSTEM DESCRIPTION

- A. The Security Management System shall function as an electronic access control system and shall integrate alarm monitoring, CCTV, IP video, and database management into a single platform. A modular and network-enabled architecture shall allow maximum versatility for tailoring secure and dependable access and alarm monitoring solutions.
- B. The SMS shall meet the requirements of business and government access control systems. The system shall monitor and control facility access, and shall perform alarm monitoring, camera and video monitoring (when integrated with a compatible integrated Video Monitoring System), communications loss monitoring, and temperature monitoring. The system shall also maintain a database of system activity, personnel access control information, and system user passwords and user role permissions. The system shall be controlled from a web browser and require no software installation or client licenses. The system shall provide control and access to users on Local Area

Networks (LAN), Wide Area Networks (WAN), wireless networks, and the Internet. The system shall provide email and/or text message alerts for all alarm conditions and threats.

- C. SMS head-end hardware shall be capable of supporting all access controlled doors indicated in drawings.
- D. The SMS includes the following sub-components:
 - 1. Operating Systems (OS) software and firmware
 - 2. Application Software
 - 3. Database Software
 - 4. Network connected Server and Client computer hardware
 - 5. Network connected field level controllers
- E. Provide interconnections with the building's other security systems.

1.8 SUBMITTALS

- A. Submit under provisions of section 01 3300.
- B. Product Data: Provide details and technical specifications for each product indicated. Include physical dimensions, features, performance, electrical characteristics, ratings, software versions, and operating system details.
- C. Shop Drawings: Include system line diagrams, equipment locations, installation details, and system integration plans.
 - 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. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types, quantities, and sizes.
 - 3. Plans and Elevations: Dimensioned plans and elevations of equipment racks, enclosures, and conduit interconnections, including access and workspace requirements.
 - 4. Data Calculations: Provide data bandwidth and storage calculations, including data backup and archive configuration details meeting the minimum project requirements as described herein.
 - 5. Power and Heat Load Calculations: Provide power and heat load calculations for all hardware, including UPS capacity calculations.
 - 6. Wiring Diagrams: For power and signal wiring.
- D. Record Drawings: During construction maintain record drawings indicating location of equipment and wiring. Submit an electronic version of record drawings for the Security Management System not later than Substantial Completion of the project.
- E. Equipment and Software List: Include every piece of equipment and software by product/model name and/or number, manufacturer, serial number, revision number, location, and date of original installation. If factory and/or bench testing regimens are

required by the project plan, add pretesting record of each piece of equipment and software, listing name of person testing, date of test, and adjustments made.

- F. Operation and Maintenance Data: Submit manufacturer's operation and maintenance data, customized to the system installed. Include system and operator manuals.
- G. Field Tests: Submit results of field testing of every device including date, testing personnel, retesting date if applicable, and confirmation that every device passed field testing.
- H. Maintenance Service Agreement: Submit a sample copy of the manufacturer's maintenance service agreement, including cost and services for a two year period for Owner's review. Maintenance shall include, but not be limited to; labor and materials to repair the system, provide test and adjustments, and regular inspections.
- I. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.9 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 – Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of all equipment.

1.10 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.11 QUALIFICATIONS

- A. Manufacturer: Minimum five years' experience in manufacturing and maintaining similar systems. Alarm manufacturer shall be certified compliant with ISO 9001.
- B. Installer: Minimum two years' experience installing similar systems, and acceptable to the manufacturer.

1.12 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 – Administrative Requirements: pre-installation meeting.
- B. Convene minimum THREE WEEKS prior to commencing work of this section.

1.13 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials and product in unopened, factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from all possible damage. Sequence deliveries to avoid delays, but minimize on-site storage.

1.14 COORDINATION

- A. Coordinate the installation of cable and equipment with other construction activities and the work of other sections.

1.15 WARRANTY

- A. All SMS systems and components shall be provided with an explicit manufacturer warranty of one year for software and two years for hardware.
- B. Manufacturer's warranties shall not start until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later. The contractor responsible for this section shall include in their base bid any additional cost for extending manufacturer's warranties until the date of Substantial Completion or, until all

aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Basis of Design: Pro-Watch® Corporate Edition Security Management Suite by Honeywell.
 - 1. Acceptable alternate manufacturers:
 - a. S2 Security Netbox® (head-end unit); and NetDoor™ MicroNode (door controller)
 - b. Lenel
 - c. Software House
 - 2. Substitutions: Section 01 60 00 - Product Requirements.

2.2 SECURITY MANAGEMENT SYSTEM SOFTWARE REQUIREMENTS

- A. Software Requirements: The Security Management System shall be a modular and network-enabled access control system. The Security Management System shall be capable of controlling multiple remote sites, alarm monitoring, video imaging, ID badging, paging, digital video and CCTV switching and control that allows for easy expansion or modification of inputs and remote control stations. The Security Management System control at a central computer location shall be under the control of a single software program and shall provide full integration of all components. It shall be alterable at any time depending upon facility requirements. Security Management System reconfiguration shall be accomplished online through system programming. The Security Management System shall include the following:
 - 1. Multi-User/Network Capabilities: The Security Management System shall support multiple operator workstations via local area network/wide area network (LAN/WAN). The communications between the workstations and the server computer shall utilize the TCP/IP standard over industry standard IEEE 802.3 (Ethernet). The communications between the server and workstations shall be supervised, and shall automatically generate alarm messages when the server is unable to communicate with a workstation. The operators on the network server shall have the capability to log on to workstations and remotely configure devices for the workstation. Standard operator permission levels shall be enforced, with full operator audit.
 - 2. Concurrent Licensing: The Security Management System shall support concurrent client workstation licensing. The Security Management System application shall be installed on any number of client workstations, and shall provide the ability for any of the client workstations to connect to the database server as long as the maximum number of concurrent connections purchased has not been exceeded.
 - 3. Security Key: The Security Management System shall require a software security key to be present on the system server for the Security Management System to operate. The Security Management System shall support the installation, update, superseding, transfer, and termination of the security key.

4. Web Interface: The Security Management System shall require a web interface to monitor alarm events and perform event reporting.
5. Access Control Software Suite: The Security Management System shall offer a security management software suite available in four scalable versions: Lite, Professional, Corporate, and Enterprise Editions. The Security Management System platform shall offer a complete access control solution: alarm monitoring, video imaging, ID badging and video surveillance control.
 - a. Corporate Edition: The Security Management System shall operate in the Windows Server 2008 (32-bit and 64-bit) environment and utilize SQL 2005 (32-bit) or SQL 2008 (32-bit or 64-bit) as the database engine.
 - b. Configurations, cardholder and clearance code data and transaction history. The enterprise server and regional server(s) shall support Windows Server 2008 (32-bit or 64-bit).
6. Terminal Services: The Security Management System shall support Windows Server 2008 Terminal Service. Terminal Services shall allow the Security Management System server application to reside on the Windows Terminal Server. Operating systems supporting a standard web browser shall be capable of utilizing the thin client architecture. The Security Management System shall support connections, based on concurrent licensing, to the Security Management System software. Full functionality shall be obtained through the intranet connection allowing full administration and monitoring without the need for a local installation.
7. Relational Database Management System: The Security Management System shall support industry standard relational database management systems. This shall include relational database management system Microsoft SQL Server 2005/2008.
8. Database Partitioning: The Security Management System shall provide the option to restrict access to sensitive information by user ID.
9. Memory: Proprietary software programs and control logic information used to coordinate and drive system hardware shall be stored in read-only memory.
10. LDAP/ Microsoft Active Directory Services: The Security Management System shall provide support of Lightweight Directory Access Protocol (LDAP) for enabling the user to locate organizations, individuals, and other resources such as files and devices in a network, whether on the public internet or on a private intranet. The Security Management System shall provide a direct link to Microsoft Active Directory Services. The Security Management System shall allow the transfer of Active Directory users into the database via the Data Transfer Utility. Conversely, Security Management System users shall be capable of being exported to the Active Directory.
11. Unicode: The Security Management System shall utilize the Unicode worldwide character set standard. The Security Management System shall support double-byte character sets to facilitate adaptation of the Security Management System user interface and documentation to new international markets. Language support shall include at a minimum English, Spanish, Portuguese, French, German and Simple Chinese.
12. Encryption: The Security Management System shall provide multiple levels of data encryption:
 - a. True 128-bit AES data encryption between the host and intelligent controllers. The encryption shall ensure data integrity that is compliant

with the requirements of FIPS-197 and SCIF environments. Master keys shall be downloaded to the intelligent controller, which shall then be authenticated through the Security Management System based on a successful match.

- b. Transparent database encryption, including log files and backups.
 - c. SQL secure connections via SSL.
13. Supervised Alarm Points: Both supervised and non-supervised alarm point monitoring shall be provided. Upon recognition of an alarm, the system shall be capable of switching CCTV cameras that are associated with the alarm point.
14. Compliance and Validation: The Security Management System shall incorporate signature authentication where modifications to Security Management System resources will require either a single or dual signature authentication. Administrators will have the ability to select specified devices in the Security Management System where data manipulation will be audited and signatures will be required to account for the data modification. Upon resource modification, the user will be required to enter a reason for change or select a predefined reason from a list. All data will be securely stored and maintained in the database and can be viewed using the reporting tool. This functionality will meet the general requirements of Validation and Compliance through Digital Signatures with special attention to the case of Title 21 CFR Part 11 Part B compliance.

2.3 OPERATIONAL REQUIREMENTS

- A. Security Management System Operational Requirements:
- 1. System Operations:
 - a. Windows Authentication Login: The Security Management System shall use an integrated login method which accepts the user ID of the person who has logged on to Windows.
 - b. Password: The Security Management System shall use an integrated authentication method which utilizes Windows user accounts and policies.
 - c. Information Access: The Security Management System shall be capable of limiting operator access to sensitive information. Operators must have proper authorization to edit the information.
 - d. Shadow Login: The Security Management System shall allow users to login over a currently logged-on user without having the current user log off the Security Management System or out of the Windows operating system.
 - e. Web Interface: The Security Management System shall allow users to login to the web interface to monitor, acknowledge, and act upon alarm events.
 - f. Graphical User Interface: The Security Management System shall be fully compliant with Microsoft graphical user interface standards, with the look and feel of the software being that of a standard Windows application, including hardware tree-based system configuration.
 - g. Guard Tour: The Security Management System shall include a guard tour module, which shall allow the users to program guard tours for their facility. The tours shall not require the need for independent or dedicated readers.

- h. Secure Mode Verification (e.g., force guard to do a visual verify): The Security Management System shall provide 'secure mode' control from the verification viewer. This shall allow a user or guard to decide the access of an individual who presents his/her card at a designated secure mode reader.
- i. Database Partitioning: The Security Management System shall support dynamic partitioning. A Security Management System in which partitions are set up at installation and cannot be easily changed shall not be acceptable.
- j. Status Groups: The Security Management System shall support a real-time system status monitor that graphically depicts all logical devices.
- k. Keyboard Accelerators: The Security Management System shall allow the user to use a shortcut key to enable designated system commands.
- l. Automatically Disable Card upon Lack of Use: The Security Management System shall allow system operators to set a predefined time period in which cardholders must swipe their card through a card reader in the Security Management System.
- m. User Functions and ADA Ability: The Security Management System shall provide user functions and ADA (Americans with Disabilities Act) ability that provides the capability to trigger an event at the Security Management System intelligent controller when a defined card is presented.
- n. Pathways: The Security Management System shall support the capability of programming pathways. A pathway shall be an object that combines input points to be masked (shunted) for a set duration, and an output point to be activated when a particular card receives a local grant at a reader.
- o. Database Audit Log: The Security Management System shall be capable of creating an audit log in the history file following any change made to the Security Management System database by an operator.
- p. Operator Log: The Security Management System shall be capable of creating an action log in the history file following actions performed by an operator.
- q. Alarm Routing: The Security Management System shall be capable of defining routing groups that determine what event information shall be routed to a user or class of users.
- r. Global and Nested Anti-passback: The Security Management System shall support the use of an optional anti-passback mode, in which cardholders are required to follow a proper in/out sequence within the assigned area.
- s. Two Person Rule: The Security Management System shall support a "two person rule" to restrict access to specific access areas unless two cardholders present two different valid cards to the reader one after the other within a period, time defined by the door unlock time multiplied by a factor of 2.
- t. Occupancy Restrictions: The Security Management System shall allow the user to define the minimum and maximum occupancy allowed in a designated area.

- u. Multiple Sequential Card Swipes to Initiate Procedure: The Security Management System shall allow the user to define a logical device, quantity of consecutive identical events, a time period and a Security Management System procedure that activates a trigger when an event occurs that number of times in the allocated time period.
 - v. Hardware Templates: The Security Management System shall include the ability to define hardware templates (door templates) in order to simplify the process of creating an access control system. Hardware templates shall allow a user to define a “typical” door configuration and then use that template over and over in the process of defining doors.
2. Access Control Functional Requirements: Functions shall include validation based on time of day, day of week, holiday scheduling, site code verification, automatic or manual retrieval of cardholder photographs, and access validation based on positive verification of card/PIN, card, and video. The following features shall be programmable and shall be capable of being modified by a user with the proper authorization:
- a. Time Zones: Shall define the period during which a reader, card, alarm point, door, or other system feature is active or inactive. In addition to Monday-Sunday, there shall be at least one day of the week called Holiday.
 - b. Holidays: The application shall allow holidays to be entered into the Security Management System. Holidays shall have a start date plus duration defining multiple days. Holidays shall have a holiday type of 1, 2, or 3, which may be defined by the user.
 - c. Response Codes: The Security Management System shall allow the user to enter a predefined code to represent a response to an alarm occurring in the facility.
 - d. Clearance Codes: The Security Management System shall allow the user to establish groups of readers at a facility for the purpose of granting or denying access to badgeholders. Clearance codes shall be assigned to companies and individuals employed by the company, and may be modified for individual users in the badgeholder maintenance application.
 - e. Companies: Each badgeholder entered into the Security Management System shall be assigned a company code identifying the individual’s employer. The company information dialog box displays and maintains information related to companies having access to the facility.
 - f. Group Access: The Security Management System shall deny temporarily a user or group of users, via company selection, access to specific readers or areas based on a preconfigured event. The group access function shall limit access to a group of cardholders, overriding all other access criteria.
 - g. Events: The event editors shall control processing done at the host computer that allows the user to associate nearly any input (trigger) with almost any sequence of outputs (actions) that the Security Management System is capable of executing.
 - h. Alarm Pages: The Security Management System shall include the capability to create an unlimited number of customized alarm pages for the alarm monitor and each shall be assignable to users and user classes.

- i. Event Types: Definitions shall be shipped with system software but shall be capable, upon installation, of being modified, added to, or deleted from the Security Management System.
- j. Dynamic Graphical Maps: The Security Management System shall provide the user with the means to add maps and indicator icons to maps that shall represent input/output points, logical devices, or cameras located throughout the Security Management System. Security Management System maps shall display the state and condition of alarm points. The Security Management System shall also provide the ability to monitor the channels or panels.
- k. Brass Keys: Shall maintain information related to assets that are issued in the facility, including brass keys, laptops, RSA keys, cell phones, company cards, etc.
- l. ID Badging Client: The Security Management System shall maintain information related to a badgeholder's card access privileges. Upon entering this application, a window shall appear on the screen and all actions (add, modify, or delete) involving badges and cards shall be initiated from this window. Access privileges shall be linked to the cards used to gain access to doors in the facility. Modifications shall be made by adding or deleting clearance codes, or by door types assigned the cards or to a badgeholder.
- m. Proximity Cards: Provided by Owner.
- n. Users: Information related to the users of the Security Management System software shall be stored in the database. Users entered into the Security Management System shall be assigned the access privileges of the class to which they are assigned.
- o. Elevator Control: The elevator control shall be of the Security Management System intelligent controller-based line of devices. The elevator control shall include the following functional features:
 - 1) Elevator call: Valid card read calls elevator to the floor. No reader in the elevator car.
 - 2) Floor control: Valid card read in the elevator car enables selectable floor buttons.
 - 3) Floor select: Valid card read in the elevator car enables selectable floor buttons and logs which floor is selected after the card is presented.
- p. Data Transfer Unit (DTU): The DTU enables data to be imported from an external system directly into the Security Management System database and also exported from Pro-Watch to an external system.
 - 1) Insert only: If a "data file key column #" shall be provided, the DTU will only insert a new badge record if the key column value is not found. An error shall be displayed in the log file if an existing badge record is found. If no "data file key column #" is provided, every record will be inserted into the Security Management System.
 - 2) Updates only: The DTU shall use the "data file key column #" to look for the matching Security Management System record. An error shall be logged in the log file if the badgeholder is not found in the Security Management System database.

- 3) Inserts, updates: The DTU shall use the “data file key column #” to look for the matching Security Management System record. If a matching record is not found, the DTU shall insert the data. If a matching record is found, the record shall be updated.
- q. Generic Channel Interface: The Security Management System shall provide the ability to define generic communications channels over serial port or TCP/IP network socket including IP address and port/socket, to support custom integration of external foreign devices. The Security Management System shall generate events based on data received from the channel matching operator pre-defined instructions.
3. Application Localization: The Security Management System shall support at least seven languages including English. The languages available must include German, French, Spanish, Italian, Chinese (simplified), Portuguese (Brazil), Norwegian, Chinese (Traditional), Danish, and Dutch. All database resources will be localized, and will include a standard U.S. English help file.
4. Event Manager: The Security Management System shall utilize an event manager as a component of system administration and offer the ability to have users control the amount of data stored as well as a quick snapshot of the logged data in the system. Using the various logs in event manager, the user will be able to gather information about events, auditing, and operator actions. The logs are defined as follows: event log, audit log, and unacknowledged alarms.

2.4 HARDWARE REQUIREMENTS

A. INTELLIGENT CONTROLLERS

1. Distributed architecture shall allow controllers to operate independently of the host. The architecture shall place key access decisions, event/action processing and alarm monitoring functions within the controllers, eliminating degraded mode operation.
2. Flash memory management shall support firmware updates and revisions to be downloaded to the system. Upgrades to the hardware and software shall occur seamlessly without the loss of database, configurations, or historical report data.
3. Manufacturers: Subject to compliance with requirements, provide Honeywell Security PW3K11C intelligent controllers; PW5K2ENC1 high density enclosures; and associated reader, input and output modules.
4. Cardkey Controllers: The Security Management System software suite shall provide functionality to Cardkey Controllers using Nodal Protocol B, the Cardkey Controllers D620 (Firmware revision PS-143D or PS143-E), and the Cardkey D600AP (Firmware Revisions PS-155A or PS-155B). Supported interface is currently, but not limited to, standard STI and STIE devices.
Minimum functionality to be supported:
 - a. Controller to host communications.
 - b. Downloading of cards.
 - c. Downloading of Security Management System parameters.
 - d. Downloading of reader parameters.
 - e. Downloading of input point parameters.
 - f. Downloading of relay output point parameters.

B. FIELD HARDWARE

1. The Security Management System shall be equipped with access control field hardware required to receive alarms and administer all access granted/denied decisions. All field hardware shall meet UL requirements.
2. Intelligent Controller Board
 - a. Honeywell Security PW3K1IC.
3. Interface Module
 - a. Ingersoll Rand PIM400-485
4. Dual Reader Module (DRM)
 - a. Honeywell Security PW6K1R2
5. Alarm Input Module (AIM)
 - a. Honeywell Security PW6K1IN
6. Relay Output Module (ROM)
 - a. Honeywell Security PW6K1OUT
7. Card Readers
 - a. HID
 - 1) ProxPro
 - 2) ThinLine II
 - 3) ProxPro II

2.5 SYSTEM INTERFACES

- A. Network Video Recording Systems
 1. The Security Management System shall provide fully integrated support for a powerful digital video recording and transmission system. The Security Management System shall record, search, and transmit video, and shall provide users with live, pre- and post- event assessment capabilities. The NVRs shall be seamlessly integrated with existing video equipment and incorporated into any TCP/IP network. The NVRs shall provide multiple levels of integration with the Security Management System software, providing control of the digital video system from the access control application.
 2. Manufacturer(s) and part numbers:
 - a. Honeywell MAXPRO® NVR PE
- B. Video Management Systems (VMS)
 1. With integration to VMS, the Security Management System shall control multiple sources of video subsystems in a facility to collect, manage and present video in a clear and concise manner. VMS intelligently determines the capabilities of each subsystem across various sites, allowing video management of any analog or digital video device through a unified configuration and viewer. Disparate video systems are normalized and funneled through a common video experience. Drag and drop cameras from the Security Management System hardware tree into VMS views. Leverage Security Management System alarm integration and advanced features such as pursuit that help the operator track a target through a set of sequential cameras with a single click to select a new central camera and surrounding camera views.
 2. Manufacturer(s) and part numbers:
 - a. Honeywell Security MAXPRO NVR PE

2.6 CARD READERS

A. MANUFACTURERS

1. HID iClass SE R40 (standard), SE R15 (mullion).
2. Honeywell
3. Substitutions: See division 1 – Product Requirements.

B. PRODUCT DESCRIPTION

1. Provide contactless smart card readers as shown on the drawings.
2. The reader shall have a Weigand output.
3. The reader shall have both an audio and visual notification for access granted and access denied.
4. The reader shall be suitable for both outdoor and indoor applications.
5. The reader shall be able to communicate with any proximity card by same manufacturer.
6. The reader shall operate up to 500ft away from door controller.

C. MOUNTING

1. Card readers shall have the ability to be mounted on glass, using kit by same manufacturer, if necessary.
2. Exact card reader locations shall be coordinated with door hardware installation.
3. All card reader wiring shall be run in conduit.
4. In locations where reader is shown on mullion, route conduit through mullion.

2.7 POWER SUPPLIES

A. Manufacturers:

1. LifeSafety Power #FP015/250-C8D8E4
2. Substitutions: Or Owner Approved Equal.

B. Product Description: Dual-voltage (12/24 VDC) power-supply/battery charger in a lockable enclosure.

1. 120 VAC input power rated @450W.
2. Output Current:
 - a. 12A @ 12 VDC.
 - b. 10A @ 24 VDC.
3. Battery charge Capacity: 80 Ah.
4. C8 output module: 8 fused lock outputs, fused @ 3A each.
5. D8 output module: 8 fused auxiliary outputs fused @ 3A each.
6. Fire Alarm interface.
7. E4 Cabinet: 24" H x 20" W x 4.5" D with key lock and backplane with standoffs for module mounting.

C. Certifications:

1. UL294, UL 603, UL 864, UL 1076, UL 1481, UL 2044, & UL 2572.
2. FCC Part 15, Subpart B.

D. Batteries: Provide with batteries capable of 24 hour battery back-up at full load in an appropriately sized NEMA 1 enclosure.

2.8 PROXIMITY CARDS

- A. Proximity cards to be provided by owner. Currently the owner uses HID 26 bit wiegand format proximity cards. Coordinate facility code and confirm format with format with Owner.

2.9 VIDEO INTERCOM SYSTEM

- A. MANUFACTURER:
 - 1. Basis of Design: Aiphone Corp., which is located at: 6670 185th Ave. NE; Redmond, WA 98052 ; Toll Free Tel: 800-692-0200; Tel: 425-455-0510; Fax: 425-455-0071; Web:www.aiphone.com
 - 2. Requests for substitutions will be considered in accordance with provisions of Division 1 - Product Requirements.
- B. Color Video Intercom System: JP Series Intercom System as manufactured by Aiphone Corporation.
- C. Room Master Station: JP-4MED 7 inches (180 mm) Digital PTZ Video Master Station with Memory.
 - 1. The JP Series shall accommodate up to 4 Door Stations and 8 Master Stations in a single system.
 - 2. Provide icon driven One Touch Hands Free operation. Touch the screen to communicate with visitors using the built-in microphone and speaker or use the handset at any time during conversation for privacy.
 - 3. Operation: From Master Station. Provide the following.
 - a. Room Call: Touch screen icon to call a single sub master station or all sub master stations simultaneously.
 - b. Play: Touch screen icon to play recorded images from door stations.
 - c. Settings: Touch screen icon to program settings and adjustments.
 - d. Security: Touch screen icon to activate the security mode or to change security settings.
 - e. Monitor: Touch screen icon to monitor a door station or sub master station.
 - f. Option: Touch screen icon to activate the connected external device(s).
 - 4. Available Functions During Monitoring: Provide the following.
 - a. Pan-Tilt-Zoom/Wide camera control.
 - b. When monitoring is started, an image shall be shown in wide mode. Pan & Tilt and adjusting images shall be possible from the Master Station.
 - c. Door release shall be possible from the Master Station.
 - d. Volume control shall be possible from the Master Station.
 - e. Manual recording shall be possible from the Master Station.
 - f. If a CCTV camera is connected instead of a video door station at entrance, provide audio monitoring and communication via the GT-D.
 - 5. Physical Characteristics:
 - a. Power supply: DC 24V (from power supply).
 - b. Current Consumption: 390 mA.
 - c. Communication: Handset - Simultaneous communication.
 - d. Communication: Hands-free - Auto-voice actuation.

- e. Ambient Temperature 32 degree F to 104 degree F (0 to 40 degrees C).
 - f. Monitor: 7 inches (180 mm) color LCD monitor.
 - g. Mounting: Wall mount.
 - h. Electrical box: 3-gang box
 - i. Material: Flame resistant ABS resin.
 - j. Color: White.
 - k. Dimensions: 5-11/16 inches H x 10-1/16 inches W x 1-7/8 inches D (145 mm by 255 mm by 48 mm).
 - l. Weight: Approx. 1.74 lbs (790 g).
- D. Room Station (Sub Master Station): JP-4HD.
1. Provide icon driven One Touch Hands Free operation. Touch the screen to communicate using the built-in microphone and speaker or use the handset at any time during conversation for privacy.
 2. Physical Characteristics:
 - a. Power supply: DC 24V (from power supply).
 - b. Current Consumption: 200 mA.
 - c. Communication: Handset - Simultaneous communication.
 - d. Communication: Hands-free - Auto-voice actuation.
 - e. Ambient Temperature: 32 degree F to 104 degrees F (0 to 40 degrees C).
 - f. Monitor: 7 inch color LCD monitor.
 - g. Electrical box: 3-gang box.
 - h. Material: Flame resistant ABS resin.
 - i. Color: White.
 - j. Dimensions: 5-11/16 inches H x 10-1/16 inches W x 1-7/8 inches D (145 mm by 255 mm by 48 mm).
 - k. Weight: Approx. 1.74 lbs (790 g).
 3. The JP-4MED shall automatically record images. Recording starts approximately 2 seconds after receiving a call.
 4. 170 degree wide angle and 100 degree vertical angle camera to minimize blind spots, ensuring a clear view of the door station area.
 5. Zoom for Clarity/ Pantilt for Control:
 - a. Video door stations feature a wide angle camera to observe more activity behind the door. In addition, digital PanTilt and Zoom can focus on an area for greater detail.
 - b. Oversized buttons and intuitive icons allow for quick navigation and control. Conventional push buttons shall not be permitted.
 - c. Equipped with an advanced light adjustment feature to compensate for varying light levels. If a picture is too dark, increase of the brightness level at the door station shall be controlled at the master station.
 6. Record Images of Visitors:
 - a. After a call is placed, the JP Series records 6 images per call to internal memory.
 - b. Provide an SD / SDHC card (not included) as the primary storage location, with which recording frequency increases to 4 pictures per second for up to 10 seconds per call.
 - c. Provide documentation of outside disturbances by manually recording them at any time.
 7. Physical Characteristics:

- a. Operating Temperature: 14 degrees F to 140 degrees F (-10 to 60 degrees C).
 - b. Dimensions:
 - 1) JP-DA 5-1/8 inches x 3-7/8 inches x 1-9/16 inches (131 x 99 x 40 mm).
 - 2) JP-DV 6-13/16 inches x 3-7/8 inches x 1 inch (173 x 98 x 25 mm).
 - 3) JP-DVF 8-1/4 inches x 5-5/16 inches x 7/32 inch (209 x 135 x 5.5 mm).
 - 4) JP-DVF back box 7-3/32 inches x 4-3/8 inches x 1-25/32 inches (180 x 110 x 45 mm)
 - c. Power Supply: DC 24V (from master station).
 - d. Current Consumption: 90 mA.
 - e. Mounting:
 - 1) JP-DA: Surface mount to 2x4 electrical box.
 - 2) JP-DV: Surface mount direct to surface.
 - 3) JP-DVF: Flush mount with included back box.
 - f. Weight:
 - 1) JP-DA: 0.46 lbs (210g).
 - 2) JP-DV: 1.3 lbs (550g).
 - 3) JP-DVF: 1.2 lbs (550g).
 - 4) Back Box: 0.95 lbs (430g).
- E. Power Supply: PS-2420UL, 24V DC Power supply.
- F. Call Extension Speaker: IER-2, Call extension speaker
- G. External Devices:
 - 1. RY-3DL: Multiple (3) door release adaptor.
 - 2. AC-10S: Access control keypad, surface mount.
 - 3. JP-DV+ AC-10S: PanTilt & Zoom vandal-resistant video door station. Surface mounted with access control keypad.
- H. Long Distance Adaptor: JPW-BA.
 - 1. Power Supply: DC 24V (from power supply)
 - 2. Current Consumption: 90 mA
 - 3. Operating Temperature: 32 degree F to 104 degrees F (0 to 40 degrees C).
 - 4. Mounting: Wall-mount
 - 5. Weight: Approx. 7 oz (200 g).
- I. Distribution Adaptor: JP-8Z.
 - 1. Power Supply: DC 24V (from power supply)
 - 2. Current Consumption: 90 mA
 - 3. Operating Temperature: 32 degree F to 104 degrees F (0 to 40 degrees C).
 - 4. Mounting: Wall-mount.
 - 5. Weight: Approx. 7.5 oz (210 g).

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine cable pathways including conduit, raceways, cable trays, and other pathway elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- B. Examine rough-in for control cable and conduit systems to controllers, card readers, and other ACS components to verify conduit and back-box locations prior to installation of ACS devices
- C. Examine available network capacity and support infrastructure. Consult with network administrator for compliance with network standards and capacity.
- D. Examine install location for compliance with space allocations, installation tolerance, hazards to safe system operation, and other conditions affecting installation.
- E. Examine roughing-in for LAN, WAN, and IP network before device installation.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with ANSI/TIA-606-B Labelling Standard.
- B. Prepare detailed project planning forms for programming and configuration of the SMS. Fill in all data available from project plans and specifications and publish as project planning documents for review and approval. These may include (but are not limited to):
 - 1. Define SMS Partitions.
 - 2. For each Location, record setup of controller features and access requirements.
 - 3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
 - 4. Set up groups, facility codes, software triggers, and list inputs and outputs for each controller.
 - 5. Assign action message names and compose messages.
 - 6. Set up alarms. Establish trigger actions between events and video surveillance features.
 - 7. Prepare and install alarm graphic maps.
 - 8. Develop user-defined fields.
 - 9. Develop screen layout formats.
 - 10. Discuss badge layout options; design badges.
 - 11. Complete system diagnostics and operation verification.
 - 12. Prepare a specific plan for system testing, startup, and demonstration.
 - 13. Develop acceptance test concept and, on approval, develop specifics of the test.
 - 14. Develop cable and asset-management system details; input data from construction documents. Include system schematics and technical drawings in electronic format.

- C. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final programming and configuration documents. Use final documents to program and configure SMS software.

3.3 INSTALLATION

- A. Rated Stairs: Penetrations into stairs are NOT permitted except for items serving that stair.
- B. Make all connections to built-in door wiring in junction boxes.
- C. Test all components before shipping to the project location.
- D. Access control system shall be installed, programmed, and tested in accordance with manufacturer's installation instructions.
 - 1. Coordinate interfaces with Owner's representative where appropriate.
 - 2. Provide backboxes, racks, connectors, supports, conduit, cable, and wire for a complete and reliable installation. Obtain Owner's approval for exact location of all boxes, conduit, and wiring runs prior to installation.
 - 3. Install conduit, cable, and wire parallel and square with building lines, including raised floors areas. Do not exceed forty percent fill in conduits. Gather wires and tie to create an orderly installation.
 - 4. Coordinate with other trades to provide proper sequencing of installation.
- E. Supervise installation to appraise ongoing progress of other trades and contracts, make allowances for all ongoing work, and coordinate the requirements of the installation of the Security Management System.
- F. Coordinate wiring pathway and conduit requirements through doors and frames with Division 8.
- G. Division 8 to provide all electrified hardware including, but not limited to: electric locks, electrified panic hardware, electrified door closers, transfer hinges; and power transfer devices. Wiring of devices by Division 28.
- H. Coordinate door and frame prep requirements for magnetic door contacts and request-to-exit devices supplied by Division 28 with Division 8.
- I. Comply with TIA 569-C, "Commercial Building Standard for Telecommunications Pathways and Spaces."
- J. Card Readers and Keypads and Peripheral Devices:
 - 1. Install number of conductor pairs recommended by device manufacturer for the functions specified.
 - 2. Follow device manufacturer's installation requirements for maximum cable distances and sizes.

3.4 FIELD COMMISSIONING AND CERTIFICATION

- A. Field Commissioning: Test system as recommended by manufacturer, including the following:
1. Conduct complete inspection and testing of equipment, including verification of operation with connected equipment.
 2. Test devices and demonstrate operational features for Owner's representative and authorities having jurisdiction as applicable.
 3. Correct deficiencies until satisfactory results are obtained.
 4. Submit written copies of test results.
- B. Testing: The access control, alarm monitoring, CCTV, and ID badging system shall be tested in accordance with the following:
1. Conduct a complete inspection and test of all installed access control and security monitoring equipment. This includes testing and verifying connection to equipment of other divisions such as life safety and elevators.
 2. Provide staff to test all devices and all operational features of the Security Management System for witness by the Owner's representative and authorities having jurisdiction as applicable.
 3. Correct deficiencies until satisfactory results are obtained.
 4. Submit written copies of test results.
 5. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA 568-C, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA 568-C.
 6. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
 7. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

3.5 TRAINING

- A. Conduct on-site system administrator and security/surveillance operator training, with the number of sessions and length of sessions as recommended by the system manufacturer. Training shall include administration, provisioning, configuration, operation, and diagnostics.

END OF SECTION

SECTION 281600 - INTRUSION DETECTION

PART 1 GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.
- B. Attention is directed Section 26 0400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 SUMMARY

- A. Provide combination intrusion detection control panels, including engineering, components, installation and commissioning.

1.5 RELATED SECTIONS

- A. Carefully examine all of the Contract Documents for requirements that affect the work of this section. Other specification sections that directly relate to the work of this section include, but are not limited to, the following:
1. Section 08 1113 – Hollow Metal Doors and Frames
 2. Section 08 1416 – Flush Wood Doors
 3. Section 08 8323 – Overhead Coiling Doors
 4. Section 08 7100 – Finish Hardware
 5. Section 27 1000 – Structured Cabling
 6. Section 27 0526 – Grounding & Bonding for Communications Systems
 7. Section 27 0529 – Hangers & Supports for Communications Systems

1.6 REFERENCES

- A. Reference Standards: Provide systems which meet or exceed the requirements of the following publications and organizations as applicable to the Work of this Section:
1. Underwriters Laboratories Inc. (UL):
 - a. UL 365: Police Station Connected Burglar Alarm Units and Systems.
 - b. UL 609: Local Burglar Alarm Units and Systems.
 - c. UL 611: Central Station Burglar-Alarm Units.
 - d. UL 636: Holdup Alarm Units and Systems.
 - e. UL 684: Local, Central Station, and Remote Station.
 - f. UL 1023: Household Burglar-Alarm System Units.
 - g. UL 1076: Proprietary Burglar-Alarm Units and Systems.
 - h. UL 1610: Central-Station Burglar-Alarm Units.
 2. Federal Communications Commission (FCC):
 - a. Code of Federal Regulations Title 47: Part 15: Radio Frequency Devices.
 - b. Code of Federal Regulations Title 47: Part 68: Connection of Terminal Equipment to the Telephone Network.

1.7 SUBMITTALS

- A. Submit under provisions of section 01 3300.
- B. Manufacturer's Product Data: Submit manufacturer's data sheets indicating systems and components proposed for use, including instruction manuals.
- C. Shop Drawings: Submit complete shop drawings including connection diagrams for interfacing equipment, list of connected equipment, and locations for major equipment components.
- D. Record Drawings: During construction maintain record drawings indicating location of equipment and wiring. Submit an electronic version of record drawings not later than Substantial Completion of the project.
- E. Operation and Maintenance Data: Submit manufacturer's operation and maintenance data, customized to the system installed. Include system and operator manuals.

- F. Field Tests: Submit results of field testing of every device including date, testing personnel, retesting date if applicable, and confirmation that every device passed field testing.
- G. Maintenance Service Agreement: Submit a sample copy of the manufacturer's maintenance service agreement, including cost and services for a one year period for Owner's review. Maintenance shall include, but not be limited to; labor and materials to repair the system, provide test and adjustments, and regular inspections.
- H. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.8 QUALITY ASSURANCE

- A. Manufacturer: Minimum ten years' experience in manufacturing and maintaining similar systems. Alarm manufacturer shall be certified compliant with ISO 9001.
- B. Installer: Minimum two years' experience installing similar systems, and acceptable to the manufacturer.
- C. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles

shall be documented in accordance with the High Performance Building Requirements of this Section.

3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's labeled packages. Store and handle in accordance with manufacturer's requirements, in a facility with environmental conditions within recommended limits.

1.10 WARRANTY

- A. Contractor's Warranty: Warranty the installation to be free of defect for a period of one (1) year.
- B. Manufacturer's warranties shall not start until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later. The contractor responsible for this section shall include in their base bid any additional cost for extending manufacturer's warranties until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Intrusion detection alarm panel manufacturer: VISTA 128BPT by Honeywell, www.security.honeywell.com
- B. Accepted Alternates: Bosch, DMP.
- C. Substitutions: See Division 1 – Product Requirements.

2.2 CONTROL PANEL

- A. Control Panel - The control panel shall be an eight (8)-partition, UL commercial burglary control panel that supports up to 128 zones using basic hardwired, polling loop, and wireless zones. It shall also provide supervision of the bell output, RF receivers, and relay modules. In addition, the control shall provide the ability to schedule time-driven events, and allow certain operations to be automated by pressing a single button. The system shall be capable of interfacing with an ECP long-range radio (LRR) unit that can send Contact ID messages, and alphanumeric paging devices. The control shall provide integrated access control and CCTV-switching capability.
 1. Basic Hardwired Zones - The control shall provide nine (9) style-B hardwire zones with the following characteristics:

- a. EOLR supervision (optional for zones 2-8): Shall support N.O. or N.C. sensors (EOLR supervision required for UL installations).
- b. Individually assignable to one of eight (8) partitions.
2. Optional Expansion Zones
 - a. Polling Loop Expansion – The control shall support up to 119 additional hardwire zones using a built-in two-wire polling (multiplex) loop interface. The polling loop shall provide power and data to remote point modules, and constantly monitor the status of all zones on the loop. Maximum current draw shall not exceed 128 mA. The polling loop zones shall have the following characteristics:
 - 1) Interface with RPM (Remote Point Module) devices that provide Class B, Style Y (e.g., 4208U/4208SN) or a combination of Class B, Style Y, and Class A, Style Z (e.g., 4208SNF) zones.
 - 2) Individually assignable to one of eight (8) partitions.
 - 3) Supervised by the control panel.
 - 4) A 12,000 ft (3658 m) wire run capability without using shielded cable.
 - 5) Each RPM (Remote Point Module) shall be tamper protected.
 - b. Wireless Expansion – The control shall support up to 128 wireless zones using a 5800 series RF receiver (fewer if using hardwire and/or polling loop zones). Wireless zones shall have the following characteristics:
 - 1) Supervised by control panel for check-in signals (except certain non-supervised transmitters).
 - 2) Tamper-protection for supervised zones.
 - 3) Individually assignable to one of eight (8) partitions.
 - 4) Supports wireless devices listed for Commercial Burglary using the 5881ENHC RF Receiver.
3. Partitions – The control shall provide the ability to operate eight (8) separate areas, each functioning as if it had its own control. Partitioning features shall include:
 - a. A Common Lobby partition (1-8), which can be programmed to perform the following functions:
 - 1) Arms automatically when the last partition that shares the common lobby is armed.
 - 2) Disarms when the first partition that shares the common lobby is disarmed.
 - b. A Master partition (9), used strictly to assign keypads for the purpose of viewing the status of all eight (8) partitions at the same time (master keypads).
 - c. Assignable by zone.
 - d. Assignable by keypad.
 - e. Assignable by relay to one or all eight (8) partitions.
 - f. Ability to display fire and/or burglary and panic and/or trouble conditions at all other partitions' keypads (selectable option).
 - g. Certain system options selectable by partition, such as entry/exit delay and subscriber account number.
4. User Codes – The control shall accommodate 150 user codes, all of which can operate one or all partitions. Certain characteristics must be assignable to each user code, as follows:

- a. Authority level (Master, Manager, or several other Operator levels). Each User Code (other than the installer code) shall be capable of being assigned the same or a different authority level for each partition that it will operate.
 - b. Opening/Closing central station reporting option.
 - c. Specific partitions that the code can operate.
 - d. Global arming capability (ability to arm all partitions the code has access to in one command).
 - e. Use of an RF (button) to arm and disarm the system (RF key must first be enrolled into the system).
5. Peripheral Devices – The control shall support up to 30 addressable ECP devices, which can be any combination of keypads, RF receivers, relay modules, annunciator modules, and interactive phone modules. Peripheral devices have the following characteristics:
- a. Each device set to an individual address according to the device's instructions.
 - b. Each device enabled in system programming.
 - c. Each device's address shall be supervisable (via a programming option).
6. Keypad/Annunciator – The control shall accommodate up to 16 keypads or six (6) touch-screen (i.e., advanced user interface) keypads. The keypads shall be capable of the following:
- a. Performing all system arming functions.
 - b. Being assigned to any partition.
 - c. Providing four programmable single-button function keys, which can be used for:
 - 1) Panic Functions –activated by wired and wireless keypads; reported separately by partition.
 - 2) Keypad Macros –32 keypad macro commands per system (each macro is a series of keypad commands). Assignable to the A, B, C, and D keys by partition.
7. Output Relays - A total of 96 relay outputs shall be accommodated using any combination of ECP or polling loop relay modules. Each ECP relay module shall provide four (4) Form C (normally open and normally closed) relays for general-purpose use or two (2) ClassB, Style-Y supervised notification appliance circuit outputs, when using the 4204CF module. The relays shall be capable of being:
- a. Programmed to activate in response to system events.
 - b. Programmed to activate using time intervals.
 - c. Activated manually.
 - d. Assigned an alpha descriptor.
 - e. Used for Class B, Style-Y supervised bell outputs (4204CF module).
 - f. A combination of 4204 (ECP) and 4101SN (polling loop) relays.
8. Vista Interactive Phone Module – The control shall support the ADEMCO 4285/4286 VIP Modules, which permit access to the security system in order to perform the following functions:
- a. Obtain system status information.
 - b. Arm and disarm the security system.
 - c. Control relays.
9. LED Annunciator – The control shall support the ADEMCO FSA-8 and FSA-24 annunciators, which are capable of:

- a. Visually identifying a zone or point that is in alarm or trouble.
 - b. Programmable for system silence/reset.
 - c. Supporting up to 96 LEDs in one system.
 - d. Supporting a total of four (4) FSA-24 or 12 FSA-8 annunciators in one system.
 - e. Supporting an optional keyswitch, FSAKSM module, for UL listed Silence and Reset capability.
10. Keyswitch – The control shall support the ADEMCO 4146 Keyswitch on any one of the system's 8 partitions. If used, zone 7 is no longer available as a protection zone.
11. Voltage Triggers – The system shall provide voltage triggers, which change state for different conditions. Used with LRR (Long-Range Radio) equipment or other devices such as a remote keypad sounder, keyswitch ARMED and READY LEDs, or a printer to print the system's event log.
12. Event Log – The System shall maintain a log of different event types (enabled in programming). The event log shall provide the following characteristics:
- a. Stores up to 512 events.
 - b. Viewable at the keypad or through the use of Compass software.
 - c. Printable on a serial printer using a 4100SM Module including zone alpha descriptors.
 - d. Stores PassPoint access control events.
 - e. Sends printed events to up to eight alphanumeric pagers via a 4100APG pager interface module.
13. Scheduling - Provides the following scheduling capabilities:
- a. Open/close schedules (for control of arming/disarming and reporting).
 - b. Holiday schedules (allows different time windows for open/close schedules).
 - c. Timed events (for activation of relays, auto-bypassing and unbypassing, auto-arming and disarming, etc.).
 - d. Access schedules (for limiting system access to users by time).
 - e. End User Output Programming Mode (provides 20 timers for relay control).
 - f. Automatic adjustment for daylight savings time.
14. Communication Features - Supports the following formats and features for the primary and secondary central station receivers:
- a. Formats
 - 1) ADEMCO Low Speed (Standard or Expanded).
 - 2) Sescoa/Radionics.
 - 3) ADEMCO Express.
 - 4) ADEMCO High Speed.
 - 5) ADEMCO Contact ID.
 - b. Backup reporting – The system shall support backup reporting via the following:
 - 1) Secondary phone number.
 - 2) ECP long-range radio (LRR) interface.
 - 3) Option to select long-range radio (LRR) or dialup as the primary reporting method (dynamic signaling feature).
15. Audio Alarm Verification Option - Provides a programmable Audio Alarm Verification (AAV) option that can be used in conjunction with an output relay to

- permit voice dialog between an operator at the central station and a person at the premises.
16. Cross-Zoning Capability - Helps prevent false alarms by preventing a zone from going into alarm unless its cross-zone is also faulted within 5 minutes.
 17. Pager Interface – The Control Panel shall be capable of sending event information to an alphanumeric pager via a 4100APG pager interface module.
 18. Exit Error False Alarm Prevention Feature – The System shall be capable of differentiating between an actual alarm and an alarm caused by leaving an entry/exit door open. If not subsequently disarmed, the control panel shall:
 - a. Bypass the faulted E/E zone(s) and/or interior zones and arm the system.
 - b. Generate an Exit Error report by user and by zone so the central station knows it was an exit alarm and who caused it.
 19. Built-in User's Manual and Descriptor Review - For end-user convenience, the control panel shall contain a built-in User's Manual. It shall include the following capabilities:
 - a. By depressing any of the function keys on the keypad for five (5) seconds, a brief explanation of that function shall scroll across the alphanumeric display.
 - b. By depressing the READY key for five (5) seconds, all programmed zone descriptors shall be displayed (one at a time). This feature shall provide a check for installers and ensure all descriptors have been entered properly.
 20. Programming - The Control shall be capable of being programmed locally or remotely using the ADEMCO Compass Downloader and shall be capable of:
 - a. Uploading and downloading all programming information at 300 baud.
 - b. Uploading and displaying firmware revision levels from the control.
- B. Environmental Conditions:
1. Storage Temperature: Designed for a storage temperature of -10° C to 70°C.
 2. Operating Temperature: System shall be designed for an operating temperature of 0° C to 50°C (32° F to 120°F).
 3. Humidity: System shall be designed for normal operation in an 85% relative humidity environment.
 4. Electromagnetic Interference: System shall meet or exceed the requirements of FCC Part 15, Class B devices, FCC Part 68, IEC EMC directive.
- C. Power Requirements:
1. The system shall operate using standard 120 VAC, 50 Hz/60 Hz power.
 2. Control Primary Power: Transformer power shall be 16.5 VAC, 40 VA.
 3. Backup Battery: Rechargeable 12 VDC, gel type, lead acid backup battery shall be provided. The battery shall be rated between 12 and 34-ampere hours (AH).
 4. Alarm Power: 12 VDC, 1.7 amps for each bell output.
 5. Auxiliary Standby Power: 12 VDC, 0.75 amp maximum.
 6. Total Power: Combined auxiliary standby and alarm currents shall be 2.3 amps.
 7. Fusing: The battery input, auxiliary, and bell outputs shall be protected using PTC circuit breakers. All outputs shall be power limited.

- D. Control Panel Enclosure:
1. A metal cabinet, suitable for wall mounting. Dimensions shall not exceed 14.5 inches (36.8 cm) in height, 18 inches (45.7 cm) in width or 4.3 inches (10.9 cm) in depth.

2.3 ALARM COMMAND CENTERS (KEYPADS)

A. MANUFACTURERS

1. Basis of Design: Honeywell 6160 Alpha Display Keypad.
2. Accepted Alternates: Bosch, DMP.
3. Substitutions: See Division 1 – Product Requirements.

B. PRODUCT DESCRIPTION

1. Alarm command centers shall be compatible with intrusion detection head-end panel, and shall remotely control the arming/disarming of intrusion detection alarms.
2. All alarm command centers shall be keypads with the following features:
 - a. LCD display
 - b. Distinct audible tones for the following scenarios:
 - 1) Burglary signal
 - 2) Entrance Warning
 - 3) Exit warning
 - 4) Keypad encoding
 - 5) System Status
 - c. English wording with at least two(2) lines of display.
 - d. Password protection
 - e. Four(4) programmable function keys.

C. MOUNTING

1. Quantity and location of keypads as indicated in drawings.

D. ACCESSORIES

1. Power supply requirements shall be coordinated with supplied access control panel. If necessary, remote 120V-1P-20A power supplies shall be provided by same manufacturer, and shall be located behind wall cavity. Power shall be fed from local receptacle circuit.
2. If remote power supply is provided, Furnish battery-operated emergency power supply with capacity for operating keypad in standby mode for 24 hours.

2.4 MOTION SENSORS

A. MANUFACTURERS

1. Basis of Design: Honeywell DT 9 (Dual Tec Series)
2. Acceptable alternate manufacturers: Bosch, DMP.
3. Substitutions: See Division 1 – Product Requirements.

B. PRODUCT DESCRIPTION

1. Hard-wired infrared type motion detector with the following features:
 - a. R.F. and noise immunity
 - b. Walk test compatible
 - c. Completely compatible with intrusion detection expanders

C. All detectors shall include swivel mounting bracket for wall mounting.

D. Locations:

1. Corridors: DT 906
2. Open Spaces: DT8050A
3. Offices: DT8035

2.5 DOOR CONTACTS

A. MANUFACTURERS

1. Basis of Design: General Electric 1078/1076 Series
2. Acceptable alternate manufacturers: Honeywell, Bosch.
3. Substitutions: See Division 1 – Product Requirements.

B. PRODUCT DESCRIPTION

1. Closed loop magnetic door contacts with the following features:
 - a. Screw-in installation coordinated with door hardware
 - b. Maximum gap with of 1”
 - c. Single pole single throw switching
 - d. Minimum operating temperature of -40°C or lower

C. MOUNTING

1. Coordinate installation with section 087100 – Finish Hardware.

D. OVERHEAD DOORS

1. Provide overhead door contacts by same manufacturer in locations indicated on drawings.
2. Coordinate installation with section 083323 – Overhead Coiling Doors

2.6 SIREN ALARMS

A. MANUFACTURERS

1. Basis of Design: Honeywell WAVE2.
2. Acceptable alternate manufacturers: Bosch, DMP.
3. Substitutions: See Division 1 – Product Requirements.

B. PRODUCT DESCRIPTION

1. Hard-wired indoor electronic siren.
2. 106dB dual tone siren output.
3. 8 ohm impedance, 15W peak.

2.7 UNINTERRUPTIBLE POWER SUPPLY (UPS)

- A. Manufacturers:
 - 1. Basis of design: APC
 - 2. Acceptable alternates shall be approved based on compatibility with intrusion detection system manufacturer and compliance with requirements listed in this specification.
 - 3. Substitutions: Substitutions: See Division 1 – Product Requirements.
- B. General Requirements: Provide UPS for EACH intrusion detection control panel and zone expansion module that meets or exceeds the following requirements:
 - 1. Sized to provide power to associated control panel/ expansion module for 10 minutes after loss of building power.
 - 2. Powered via 120VAC, dedicated receptacle shown on drawings.
 - 3. Has at least two(2) NEMA 5-20 output receptacles.
- C. MOUNTING
 - 1. Mount on wall adjacent to control panel/ expansion module. Provide all necessary mounting hardware and accessories.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine site conditions prior to installation. Notify Architect and Owner in writing if unsuitable conditions are encountered. Do not start installation until site conditions are acceptable.

3.2 INSTALLATION

- A. Test all components before shipping to the project location.
- B. Intrusion detection system shall be installed, programmed, and tested in accordance with manufacturer's installation instructions.
 - 1. Coordinate interfaces with Owner's representative where appropriate.
 - 2. Provide backboxes, racks, connectors, supports, conduit, cable, and wire for a complete and reliable installation. Obtain Owner's approval for exact location of all boxes, conduit, and wiring runs prior to installation.
 - 3. Install conduit, cable, and wire parallel and square with building lines, including raised floors areas. Do not exceed forty percent fill in conduits. Gather wires and tie to create an orderly installation.
 - 4. Coordinate with other trades to provide proper sequencing of installation.

3.3 FIELD COMMISSIONING AND CERTIFICATION

- A. Field Commissioning: Test system as recommended by manufacturer, including the following:
 - 1. Conduct complete inspection and testing of equipment, including verification of operation with connected equipment.
 - 2. Test devices and demonstrate operational features for Owner's representative and authorities having jurisdiction as applicable.
 - 3. Correct deficiencies until satisfactory results are obtained.
 - 4. Submit written copies of test results.

3.4 TRAINING

- A. Conduct on-site system administrator and security/surveillance operator training, with the number of sessions and length of sessions as recommended by the system manufacturer. Training shall include administration, provisioning, configuration, operation, and diagnostics.

END OF SECTION

SECTION 282300 - VIDEO SURVEILLANCE

PART 1 GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.
- B. Attention is directed Section 26 0400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 SUMMARY

- A. Provide a complete IP video recording system, including engineering, components, installation and commissioning.

1.5 RELATED SECTIONS

- A. Carefully examine all of the Contract Documents for requirements that affect the work of this section. Other specification sections that directly relate to the work of this section include, but are not limited to, the following:
1. Section 27 0533 – Conduits & Backboxes for Telecom Wiring
 2. Section 27 1000 – Structured Cabling
 3. Section 27 0526 – Telecom Grounding & Bonding
 4. Section 27 0529 – Hangers & Supports for Telecom Wiring
 5. Section 28 1300 – Access Control

1.6 REFERENCES

- A. Reference Standards: Provide systems which meet or exceed the requirements of the following publications and organizations as applicable to the Work of this Section:
1. Canadian ICES-003
 2. Consultative Committee for International Radio (CCIR)
 3. Conformity for Europe (CE)
 4. Electronic Industry Association (EIA)
 5. Federal Communications Commission (FCC)
 6. Joint Photographic Experts Group (JPEG)
 7. Moving Pictures Experts Group (MPEG)
 8. Motion Joint Photographic Experts Group (MJPEG)
 9. National Television Systems Committee (NTSC)
 10. Phase Alternating by Line (PAL)
 11. Underwriters Laboratories Inc. (UL)
 12. Institute for Electrical and Electronics Engineers (IEEE)
 13. Physical Security Interoperability Alliance (PSIA)
 14. Open Network Video Interface Forum (ONVIF)
 15. Real Time Streaming Protocol (RTSP)

1.7 DEFINITIONS

- A. HD (High-definition) – refers to video having resolution substantially higher than traditional television systems. HD has one or two million pixels per frame.
- B. CIF (Common Intermediate Format) – refers to a standard video format, which is categorized based on the resolution.
- C. IR (Infrared) – refers to a visual range requiring little to no light to visualize.
- D. IP (Internet Protocol) – refers to a device that operates over the building's network.
- E. VMS (Video Management System) – The software that operates all video surveillance cameras and allows for end user control of the system.
- F. NVR (Network Video Recorder) – Server that configures and stores recorded data from the cameras.

1.8 SYSTEM DESCRIPTION

- A. The Network Video Recorder (NVR) supports simultaneous recording, search, and system management for up to 64 IP cameras including high definition formats. Multiple NVRs may be deployed for system expansion using a distributed architecture and integrated with the multi-site software or enterprise video management system
- B. Honeywell MAXPRO NVR PE is the basis-of-design system for the purpose of setting the level of quality, features and system performance. Systems of equal demonstrated quality and performance will be considered.
- C. The Video Management System shall support both centralized and decentralized configurations as well as hybrid options for architecture. Centralized management shall be available no matter the surveillance architecture. The system shall allow for integration with other security devices and products and be designed to allow for leveraging of those products to improve the user experience of the Video Management System.
- D. The Video Management System must not require a central management server.
- E. The VMS shall make the user experience seamless to the end user irrespective of the system architecture.
- F. The Video Management System must be capable of each server being able to handle an unlimited number of cameras for recording.
- G. The VMS must support Windows Server 2008 and Windows Server 2012 for the server side. Client side software must be available for Windows Vista, Windows 7, Windows 8, Mac OSX, iOS 6 and above, and Android. The operating system shall have all current and available patches.
- H. The VMS shall include the following without additional license fees:
 - 1. Server software for recording the video
 - 2. Client software for Windows
 - 3. Client software for Mac OSX
 - 4. Client software for iOS6 and above
 - 5. Client software for Android based platforms
 - 6. Client software using a web based interface
 - 7. Standalone clients designed to provide fixed displays
 - 8. Video Wall functionality
 - 9. Access Control Integration
 - 10. Failover server functionality
 - 11. A separate health monitor application
- I. The VMS shall not require a separate application for administration and user based roles. Limitations for non-administrative users shall be handled via permissions.
- J. The system shall support running in virtual servers for both the server application and client applications.

- K. VMS head-end hardware shall be capable of supporting all surveillance cameras indicated in drawings.

1.9 SUBMITTALS

- A. Submit under provisions of section 01 3300.
- B. Manufacturer's Product Data: Submit manufacturer's data sheets indicating systems and components proposed for use, including instruction manuals.
- C. Shop Drawings: Submit complete shop drawings including connection diagrams for interfacing equipment, list of connected equipment, and locations for major equipment components.
- D. Record Drawings: During construction maintain record drawings indicating location of equipment and wiring. Submit an electronic version of record drawings not later than Substantial Completion of the project.
- E. Operation and Maintenance Data: Submit manufacturer's operation and maintenance data, customized to the system installed. Include system and operator manuals.
- F. Field Tests: Submit results of field testing of every device including date, testing personnel, retesting date if applicable, and confirmation that every device passed field testing.
- G. Maintenance Service Agreement: Submit a sample copy of the manufacturer's maintenance service agreement, including cost and services for a one year period for Owner's review. Maintenance shall include, but not be limited to; labor and materials to repair the system, provide test and adjustments, and regular inspections.
- H. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile

Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.10 QUALITY ASSURANCE

- A. Manufacturer: Minimum five years' experience in manufacturing and maintaining IP video recording systems. Manufacturer shall provide toll-free technical assistance and support available 24/7.
- B. Manufacturing Location: Provide equipment assembled in the United States.
- C. Installer: Minimum five years experience installing similar systems, and acceptable to the manufacturer of the IP video recording system.
- D. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's labeled packages. Store and handle in accordance with manufacturer's requirements, in a facility with environmental conditions within recommended limits.

1.12 WARRANTY

- A. Contractor's Warranty: Warranty the installation to be free of defect for a period of one (1) year.
- B. Manufacturer's warranties shall not start until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later. The contractor responsible for this section shall include in their base bid any additional cost for extending manufacturer's warranties until the date of Substantial Completion or, until all aspects of the commissioning of the respective system are complete and accepted by the Commissioning Authority and the Owner, whichever date is later.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Network Video Recording System (NVR) Manufacturer: Honeywell MAXPRO NVR PE.
 - 1. Accepted alternate manufactures:
 - a. Nice Vision
 - b. Intransa
- B. Substitutions: Section 01 2500 – Substitution Procedures.

2.2 DEVICES FURNISHED BY OWNER

- A. Video management system must be compatible with all cameras and other surveillance devices that are furnished by owner. Refer to drawings for manufacturers, model numbers and general specifications of these devices.
- B. Refer to drawings for locations of devices furnished by owner.

2.3 SYSTEM COMPONENTS

- A. NVR Server: The NVR Server shall contain the recording engine, database of all network-connected cameras and encoders, integrated components and their configurations. Server shall be provided as a combined hardware and software device.
- B. Workstation Software (NVR Client): The NVR Client software shall render video and act as a main human/machine interface.

2.4 OPERATIONAL REQUIREMENTS

- A. NVR shall provide a user-friendly graphical user interface (GUI) to configure the cameras, create schedules for recording, perform video surveillance and recording operations, and view various reports.
- B. NVR shall be configured to store and to view images captured by 32 cameras.
- C. NVR shall have following major capabilities: (provide multiple NVR's cable operating all cameras and include a minimum of 20 spare ports)
 - 1. Live viewing of up to 32 IP cameras on a single remote workstation with up to two (2) monitors set up at CIF resolution. For 4CIF and HD resolution, the number of live streams needs to be benchmarked based on client hardware configuration deployed.
 - 2. Powerful investigation and video archive search tools.
 - 3. Pre-event and Post-event recording based on camera motion detection events and "advanced" search on recordings.
 - 4. Preview Search permitting search for videos and events based on user-selected date and time.
 - 5. Simultaneous use of multiple video compressions including MPEG-4 and H.264.

6. Internationalization - supports the following languages: French, German, Russian, Italian, Spanish, Dutch, Arabic and English.
 7. E-mail on alarm.
 8. Instant clip creation from snapshot.
 9. Dynamic IP Camera Discovery – Automatically discover all compatible cameras connected to NVR.
 10. Capable of managing motion detection-based recording and advanced search capabilities of the recording devices.
 11. Multi-level user access rights for viewing and manages access to the recorder functions.
 12. Capable of managing continuous, scheduled, manual, event-based, and alarm-based recording features.
 13. Support for mobile apps.
- D. Mode for User Login: NVR shall have the option of two modes of user logins:
1. Windows Authentication: Uses Windows logged-in user name.
 2. User DB Authentication: Uses preconfigured user name and password.
- E. Workstation (NVR Client) shall provide the following operator options:
1. Configuration: The operator (with Administrator privileges) shall have the option to configure the NVR. Live update of all configurations is supported. The following configurations shall be possible:
 - a. System Configuration: Provide options to configure the system level settings.
 - b. Camera Configuration: Provide options to add/edit/delete IP cameras and encoders.
 - c. Schedules: Provide options to configure schedule based recording for cameras connected to the NVR.
 - d. Input and Output: Provide options to configure camera input and output.
 - e. Sequences: Provide options to group a fixed number of cameras to view video.
 - f. User Management (Users and Roles): Provide option to add/edit/delete users.
 - g. Clip Deletion Settings: Provide the ability to automatically utilize more storage on event-initiated recording.
 - h. Independent deletion setting for continuous recording.
 - i. Independent deletion setting for event recording.
 - j. Surrounding Cameras: Provide option to grant a user the ability to view a single camera surrounded by the cameras programmed as the “Surrounding Cameras”.
- F. Configurations for cameras connected to NVR
1. Camera Configuration: The user shall be able to configure the following parameters for each camera connected to the NVR.
 - a. Camera Name
 - b. IP Address
 - c. Camera Type
 - d. Fixed/PTZ

- e. Continuous Recording: All cameras added shall be defaulted to "24/7" recording with the option to select other recording modes.
 - f. Event Based Recording: Shall be "None" by default, with the option to select motion-based recording.
 - g. User name: Shall display and enable setting the user name for a camera.
 - h. Password: Shall enable setting the password for a camera.
 - i. Camera Advanced Settings: Shall enable configuration of Video Format, Compression Format, Resolution, Compression, Video Frame Rate, GOP, Record Quality Settings, Clip Deletion Settings, and Launching Web View for Advanced Setup, Video Preview. Shall enable configuration of RTSP URL for cameras or encoders added with camera type – Generic RTSP.
2. The following video recording options shall be supported:
- a. Scheduled based recording: The system shall support the ability to schedule recordings for each individual camera for times in the future. By default, the NVR shall be pre-loaded with the following four schedules: 24x7, Weekday, Daytime, and Nighttime, which cannot be edited. A maximum of 50 schedules can be created in the NVR.
 - b. User based recording: The user shall be able to configure user activated settings for recording moments of interest while viewing live video from a camera. After configuring the user activated settings, the operator can start recording of video when needed. The video is recorded for the time period specified in the System settings for user activated recording. The User based Recording Time Duration shall be selectable from a list of values ranging between 30 seconds and 5 minutes.
 - c. Event based recording: Event based recording shall be possible on Video Motion Detection and alarms triggered.
- G. Viewer: The NVR Viewer shall have the following minimum capabilities:
- a. Main video viewing screen capable of showing 1, 4, 9, 16, and other customized split salvos of live or recorded video. Standard presets shall be customizable to the user preferences.
 - b. Capable of saving current salvo as a View and allowing the user to drag this view at any later point in time.
 - c. Capable of configuring and running scan sequences.
 - d. Capable of adjusting the contrast, brightness, and saturation settings for each camera independently.
 - e. Capable of exporting user selected image or video clips. A digital signature shall be attached to every exported clip.
 - f. Capability to play back the video clips exported. Each video channel that is being recorded by the recording system shall be overlaid with text and a time stamp that is customizable by the user.
 - g. Allow the user to initiate recording through the GUI or a controller.
 - h. Capability of complete alarm management for the alarms coming from the NVR.
 - i. Facility of surrounding camera view.
 - j. Option to perform various operations through context menu on a particular video (live/recorded/sequence). These operations include: Full screen, point and drag, maintain aspect ratio, toggle text, digital PTZ, add

- bookmark, start recording, stop recording, mark in, mark out, save image, save image as, show surrounding cameras.
- k. Ability to manage timeline control of the recording device, which provides camera recording statistics. Timeline control shall have the following features: Mark input (with looping facility), bookmark, snapshot, time slider, time jump, play controls.
 - l. Preference configuration including: frame rate of unselected panels, rendered type, preview pane, text display format.
- H. Search: The Search facility shall include search for recorded video and events based on date and time.
- I. Reports: The Report facility shall include event history report and audit log report.

2.5 NVR INTEGRATIONS

- A. NVR shall be compatible with the following Multi-site Video Management Systems:
 - 1. Honeywell MAXPRO® Viewer
 - 2. Honeywell MAXPRO VMS
- B. NVR shall be compatible and integrate with the Access Control Security System.
- C. Video Analytics supported through MAXPRO® VMS:
 - 1. Honeywell Active Alert

2.6 SYSTEM HARDWARE

- A. Provide 1 MAXPRO NVR PE Server: NVR Server shall operate with no performance degradation using the following minimum hardware and operating system configuration:
 - 1. 2U 10 bay storage unit with SAS hard drives
 - 2. Processor: Intel Core i3-550, 3.2GHZ
 - 3. Memory: 4 GB
 - 4. Power supply: Dual 650 W, field removable
 - 5. OS Hard drive: 2x 2.5" 160 GB SATA hard drives, field removable, RAID 0 support
 - 6. Operating system: Windows 7 Professional 64-bit SP1
 - 7. Database: Microsoft SQL Server Express 2008
 - 8. Storage capacities: 4 TB to 20 TB raw storage, Video storage redundancy with RAID 5/6 support
 - 9. Video Storage Hard Disk Options: 10 field-upgradable 1TB or 2TB SAS Hard Disk Drive options
 - 10. Optical drive: 8x DVD, 24x CD
 - 11. Network interface: Dual 1 Gigabit Ethernet
 - 12. RAID card: 3 GB SAS/SATA RAID card, PCI Express x8, supports 60 RAID levels
 - 13. Human Interface: 102-key keyboard and a mouse pointing device
 - 14. Monitor Output: VGA
 - 15. Rack kit: Rack kit for use with 2U chassis

- B. Provide two NVR Workstation shall operate with no performance degradation using the following minimum hardware and operating system configuration:
1. Processor: Intel® Core™ 2 Duo Processor E6750 2.66 GHz or Quad Core Intel® Xeon® E5405 2.0 GHz
 2. System Memory (RAM): 4 GB
 3. Optical Drive: DVD-RW
 4. Hard Disk Drives: Single Disk or RAID 0 or 0+1 10K SATA 80GB or 10K to 15K SAS 73GB.
 5. Network Interface Card (NIC): 1 Gbps
 6. Human Interface: 102 -key keyboard and a mouse pointing device
 7. Graphics Card: 1 x 256MB PCIe x16 NVIDIA Quadro NVS 285/300, Dual DVI or Dual VGA or DVI+VGA. This is for a two monitor setup with each monitor requiring 128 MB
 8. Operating System Options: Microsoft® Windows 7 Professional (32-bit and 64-bit), Microsoft® Windows Server 2008 R2

2.7 FIXED POSITION INDOOR DOME CAMERA – TYPE A

- A. Manufacturers
1. Basis of Design: Hikvision® 2.0MP Indoor Dome, model DS-2CD2722FWD-IZS
 2. Acceptable alternates: Honeywell, Pelco.
 3. Substitutions: Section 01 2500 – Substitution Procedures.
- B. Compatibility
1. Camera must be listed as a compatible device by both the NVR and VMS software manufacturer. All camera features must be available when utilizing the VMS client software.
- C. General Requirements
1. This product shall be manufactured by a firm whose quality system is in compliance with ISO-9001.
 2. All equipment and materials used shall be standard components that are regularly manufactured and used in the manufacturer's system.
 3. All systems and components shall have been thoroughly tested and proven in actual use.
 4. All systems and components shall be provided with comprehensive repair and spare parts replacement. The manufacturer on warranty and non-warranty items shall guarantee the spare parts and the repair.
 5. All systems and components must be in compliance with FCC, CE, ICES-003, UL, cUL, and RoHS requirements.
 6. All materials furnished under this item shall be compliant with 802.3 Ethernet standards.
- D. Product Specifications
1. Power Supply: 12 VDC; PoE (802.3af); RJ-45.
 2. Power Consumption: 7W (max.).
 3. Network Interface: 10M/100M Base-TX; RJ-45.
 4. Image Sensor: 1/2.8" progressive scan CMOS.

5. Minimum Illumination Color: 0.014 lux @ (f/1.4, AGC on), B/W: 0 lux with IR.
6. Lens:
 - a. 2.8 mm to 12 mm
 - b. f/1.4
 - c. Motorized
 - d. Horizontal angle of view: 106° to 35°
7. Lens Mount: ϕ 14
8. Angle Adjustment: 3-axis positioning (pan: 0° to 355°, tilt: 0° to 75°, rotate: 0° to 355°) via bracket.
9. Day/Night: Day, Night, Auto, Scheduled
10. IR:
 - a. Smart IR Enabled/disabled
 - b. IR LEDs Enabled/disabled
11. Digital Zoom: Supported
12. TV System: NTSC (30 fps); PAL (25 fps)
13. Audio 1 line in, 1 line out
14. Compression: H.264+, H.264, MJPEG
15. Resolutions: 2MP 1080p (1920 x 1080).
16. Maximum Frame Rate: 30 @ 1920 x 1080, 1280 x 960, 1280 x 720
17. Backlight Compensation: zone configured.
18. Smart features: Line crossing detection, intrusion detection.
19. Audio:
 - a. Compression: G.711/G.726, MP2L2, G.722.1
 - b. Bit Rate: 64 kbps (G.711)/16 kbps (G726)/32 to 128 kbps (MP2L2)
 - c. I/O: 1 line in, 1 line out
20. Digital Noise Reduction: On/Off
21. Software Interface:
 - a. Web browser view, remote PC client, and remote mobile client
22. Day/Night:
 - a. There shall be true Day/Night Infrared Cut Filter Removal (ICR) low-light capabilities.
 - b. Sensitivity shall be down to 0.014 lux @ (f/1.4, AGC on), 0 lux with IR
 - c. IR shall auto switch with color/black image
23. Wide Dynamic Range (WDR):
 - a. Up to 120 dB of WDR
 - b. WDR level shall be selectable (0 to 100), On/Off.
24. Operating Conditions: -30° C to 60° C (-22° F to 140° F)
25. Motion Detection: Supported.
26. Accessories:
 - a. CB135 conduit base – use for surface mount applications on CMU walls.

2.8 FIXED POSITION INDOOR DOME CAMERA – TYPE B

A. Manufacturers

1. Basis of Design: Hikvision® 4.0MP Indoor Dome, model DS-2CD2742FWD-IZS.
2. Acceptable alternates: Honeywell, Pelco.
3. Substitutions: Section 01 2500 – Substitution Procedures.

- B. Compatibility
1. Camera must be listed as a compatible device by both the NVR and VMS software manufacturer. All camera features must be available when utilizing the VMS client software.
- C. General Requirements
1. This product shall be manufactured by a firm whose quality system is in compliance with ISO-9001.
 2. All equipment and materials used shall be standard components that are regularly manufactured and used in the manufacturer's system.
 3. All systems and components shall have been thoroughly tested and proven in actual use.
 4. All systems and components shall be provided with comprehensive repair and spare parts replacement. The manufacturer on warranty and non-warranty items shall guarantee the spare parts and the repair.
 5. All systems and components must be in compliance with FCC, CE, ICES-003, UL, cUL, and RoHS requirements.
 6. All materials furnished under this item shall be compliant with 802.3 Ethernet standards.
- D. Product Specifications
1. Power Supply: 12 VDC; PoE (802.3af); RJ-45
 2. Power Consumption: 7W (max.)
 3. Network Interface: 10M/100M Base-TX; RJ-45
 4. Image Sensor: 1/3" progressive scan CMOS
 5. Minimum Illumination: Color: 0.014 lux @ (f/1.4, AGC on), B/W: 0 lux with IR.
 6. Lens:
 - a. 2.8 mm to 12 mm
 - b. f/1.4
 - c. Motorized
 - d. Horizontal angle of view: 112° to 33.8°
 7. Lens Mount: ϕ 14
 8. Angle Adjustment: 3-axis positioning (pan: 0° to 355°, tilt: 0° to 75°, rotate: 0° to 355°) via bracket.
 9. Day/Night: Day, Night, Auto, Scheduled
 10. IR:
 - a. Smart IR Enabled/disabled
 - b. IR LEDs Enabled/disabled
 11. Digital Zoom: Supported
 12. TV System: NTSC (30 fps); PAL (25 fps)
 13. Audio: 1 line in, 1 line out
 14. Compression: H.264+, H.264, MJPEG
 15. Resolutions: 4MP (2688 x 1520).
 16. Maximum Frame Rate: 20 fps @ 2688 x 1520, (1920 x 1080/1280 x 720), @ 30 fps.
 17. Backlight Compensation: zone configured.
 18. Smart features: Line crossing detection, intrusion detection.
 19. Audio:
 - a. Compression: G.711/G.726, MP2L2, G.722.1

- b. Bit Rate: 64 kbps (G.711)/16 kbps (G726)/32 to 128 kbps (MP2L2)
- c. I/O: 1 line in, 1 line out
- 20. Digital Noise Reduction: On/Off
- 21. Software Interface:
 - a. Web browser view, remote PC client, and remote mobile client
- 22. Day/Night:
 - a. There shall be true Day/Night Infrared Cut Filter Removal (ICR) low-light capabilities.
 - b. Sensitivity shall be down to 0.014 lux @ (f/1.4, AGC on), 0 lux with IR
 - c. IR shall auto switch with color/black image
- 23. Wide Dynamic Range (WDR):
 - a. Up to 120 dB of WDR
 - b. WDR level shall be selectable (0 to 100), On/Off.
- 24. Operating Conditions -30° C to 60° C (-22° F to 140° F)
- 25. Motion Detection: Supported.
- 26. Accessories:
 - a. CB135 conduit base – use for surface mount applications on CMU walls.

2.9 FIXED POSITION 180 DEGREE INDOOR DOME CAMERA – TYPE C

A. Manufacturers

- 1. Basis of Design: Hikvision® 8.0MP Indoor Multi-Imager Panoramic 180 Degree Dome, model DS-2CD6986F-H.
- 2. Acceptable alternates: Honeywell, Pelco.
- 3. Substitutions: Section 01 2500 – Substitution Procedures.

B. Compatibility

- 1. Camera must be listed as a compatible device by both the NVR and VMS software manufacturer. All camera features must be available when utilizing the VMS client software.

C. General Requirements

- 1. This product shall be manufactured by a firm whose quality system is in compliance with ISO-9001.
- 2. All equipment and materials used shall be standard components that are regularly manufactured and used in the manufacturer's system.
- 3. All systems and components shall have been thoroughly tested and proven in actual use.
- 4. All systems and components shall be provided with comprehensive repair and spare parts replacement. The manufacturer on warranty and non-warranty items shall guarantee the spare parts and the repair.
- 5. All systems and components must be in compliance with FCC, CE, ICES-003, UL, cUL, and RoHS requirements.
- 6. All materials furnished under this item shall be compliant with 802.3 Ethernet standards.

D. Product Specifications

- 1. Power Supply: 24 VAC; PoE (802.3at); RJ-45
- 2. Power Consumption: 22W (max.)

3. Network Interface: 10M/100M Base-TX; RJ-45
4. Image Sensor 1 1/8" progressive scan CMOS
5. Minimum Illumination Color: 0.002 lux @ (f/1.4, AGC on), B/W: 0 lux with IR.
6. Lens:
 - a. 5 mm x 4, pan: 180°, tilt: 78.4°.
7. Lens Mount: CS
8. Angle Adjustment: Pan: 0° to 360°, tilt: 45° to 90°.
9. Day/Night: Day, Night, Auto, Scheduled.
10. IR:
 - a. Smart IR Enabled/disabled
 - b. IR LEDs Enabled/disabled
11. TV System: NTSC (30 fps); PAL (25 fps).
12. Audio: 1 line in, 1 line out
13. Compression: H.264+, H.264, MJPEG
14. Resolutions: 8MP (4096 x 1800).
15. Maximum Frame Rate: 30 fps @ 4096 x 1800, 3840 x 1680.
16. Backlight Compensation: zone configured.
17. Smart features: Line crossing detection, intrusion detection.
18. Audio:
 - a. Compression: G.711/G.726, MP2L2, G.722.1
 - b. Bit Rate: 64 kbps (G.711)/16 kbps (G726)/32 to 128 kbps (MP2L2)
 - c. I/O: 1 line in, 1 line out
19. Digital Noise Reduction: 3D DNR.
20. Software Interface:
 - a. Web browser view, remote PC client, and remote mobile client
21. Day/Night
 - a. There shall be true Day/Night Infrared Cut Filter Removal (ICR) low-light capabilities.
 - b. Sensitivity shall be down to 0.002 lux @ (f/1.4, AGC on), 0 lux with IR.
 - c. IR shall auto switch with color/black image.
22. Operating Conditions: -30° C to 60° C (-22° F to 140° F)
23. Motion Detection: Supported.
24. Accessories:
 - a. Long Wall Mount with backbox: use on CMU wall in Natatorium.
 - b. Conduit base – included.

2.10 PAN-TILT-ZOOM INDOOR DOME CAMERA - TYPE D

- A. Manufacturers
 1. Basis of Design: Hikvision® 2.0MP PTZ, model DS-2DE5230W-AE.
 2. Acceptable alternates: Honeywell, Pelco.
 3. Substitutions: Section 01 2500 – Substitution Procedures.
- B. Compatibility
 1. Camera must be listed as a compatible device by both the NVR and VMS software manufacturer. All camera features must be available when utilizing the VMS client software.
- C. General Requirements

1. This product shall be manufactured by a firm whose quality system is in compliance with ISO-9001.
2. All equipment and materials used shall be standard components that are regularly manufactured and used in the manufacturer's system.
3. All systems and components shall have been thoroughly tested and proven in actual use.
4. All systems and components shall be provided with comprehensive repair and spare parts replacement. The manufacturer on warranty and non-warranty items shall guarantee the spare parts and the repair.
5. All systems and components must be in compliance with FCC, CE, ICES-003, UL, cUL, and RoHS requirements.
6. All materials furnished under this item shall be compliant with 802.3 Ethernet standards.

D. Product Specifications

1. Power Supply: 24VAC \pm 10%; Hi PoE (802.3at); RJ-45.
2. Power Consumption: Maximum 18 W
3. Network Interface: 10 Base-T/100M Base-TX; RJ-45
4. Image Sensor: 1/2.8" progressive scan CMOS
5. Minimum Illumination: 0.05 lux @ (f/1.6, AGC on), B/W: 0.01 lux.
6. Lens:
 - a. 4.3 mm to 129 mm (30X) zoom lens.
 - b. Digital Zoom: 16x
 - c. Angle of View: 65.5° to 2.11° (optical wide to zoom).
 - d. Aperture: f 1.6 to f 5.0.
 - e. Focus Mode: auto/semi-auto/manual.
7. AGC: Auto/manual.
8. Pan and Tilt:
 - a. Pan: 360° endless.
 - b. Tilt: -5° to 90° (auto-flip).
 - c. Speed: Pan manual – 0.1° to 250°/s; Tilt manual -0.1° to 150°/s.
 - d. Number of Presets: 300.
 - e. Patrols: 8 (32 presets per patrol).
9. Max. Image Resolution: 1920 x 1080
10. Day/Night: Day, Night, Auto, Scheduled
11. IR:
 - a. Smart IR: Enabled/disabled
 - b. IR LEDs: Enabled/disabled
12. TV System: NTSC (30 fps); PAL (25 fps)
13. Compression:
 - a. Main stream H.264, MJPEG.
14. Audio Compression: G.711 ulaw/ G.711 alaw/G.726/MP2L2/G.722.
15. Max. Frame Rate (main): 30 fps @ 1920 x 1080.
16. Software Interface:
 - a. Web browser view, remote PC client, and remote mobile client.
17. Operating Conditions: -30° C to 65° C (-22° F to 149° F).
18. Accessories:
 - a. CPM-L: Long ceiling pendant mount: use in auditorium.

2.11 FIXED POSITION OUTDOOR BULLET CAMERA- TYPE E

A. Manufacturers

1. Basis of Design: Hikvision® 3.0MP outdoor bullet. Models: DS-2CD4A35FWD-IZH8 (Long range).
2. Acceptable alternates: Honeywell, Pelco..
3. Substitutions: Section 01 2500 – Substitution Procedures.

B. Compatibility

1. Camera must be listed as a compatible device by both the NVR and VMS software manufacturer. All camera features must be available when utilizing the VMS client software.

C. General Requirements

1. This product shall be manufactured by a firm whose quality system is in compliance with ISO-9001.
2. All equipment and materials used shall be standard components that are regularly manufactured and used in the manufacturer's system.
3. All systems and components shall have been thoroughly tested and proven in actual use.
4. All systems and components shall be provided with comprehensive repair and spare parts replacement. The manufacturer on warranty and non-warranty items shall guarantee the spare parts and the repair.
5. All systems and components must be in compliance with FCC, CE, ICES-003, UL, cUL, and RoHS requirements.
6. All materials furnished under this item shall be compliant with 802.3 Ethernet standards.

D. Product Specifications

1. Power Supply: 12 VDC; PoE (802.3af); RJ-45
2. Network Interface: 10M/100M Base-TX; RJ-45
3. Image Sensor: 1/2.8" progressive scan CMOS
4. Minimum Illumination 0.14 lux @ (f/1.4, AGC on), 0 lux with IR.
5. Lens (LONG RANGE):
 - a. 8 mm to 32 mm
 - b. f/1.4
 - c. Motorized
 - d. Horizontal angle of view: 29.7° to 9.7°
 - e. Auto Iris: DC drive.
6. Lens Mount: M12
7. Day/Night: Day, Night, Auto, Scheduled
8. IR:
 - a. Smart IR: Enabled/disabled.
 - b. IR LEDs: Enabled/disabled.
9. Digital Zoom: Supported.
10. Digital Noise Reduction: 3D DNR
11. TV System: NTSC (30 fps); PAL (25 fps)
12. Compression: H.264+, H.264, MJPEG
13. Resolutions: 3MP (2048 x 1536), 1080p (1920 x 1080).

14. Maximum Frame Rate: 30 @ 1920 x 1080 (20 @ 2048 x 1536)
15. Audio:
 - a. Compression: G.711/G.726, MP2L2, G.722.1
 - b. Bit Rate: 64 kbps (G.711)/16 kbps (G726)/32 to 128 kbps (MP2L2)
 - c. I/O: 1 line in, 1 line out
16. Software Interface:
 - a. Web browser view, remote PC client, and remote mobile client
17. Day/Night:
 - a. There shall be true Day/Night Infrared Cut Filter Removal (ICR) low-light capabilities.
 - b. Sensitivity shall be down to 0.014 lux @ (f/1.4, AGC on), 0 lux with IR.
 - c. IR shall auto switch with color/black image.
18. Wide Dynamic Range (WDR):
 - a. Up to 120 dB of WDR
 - b. WDR level shall be selectable (0 to 100)
19. Operating Conditions: -40° C to 60° C (-40° F to 140° F)
20. Motion Detection: Supported.
21. Ingress Protection: IP67
22. Accessories:
 - a. CBS: Conduit base for exterior wall mounting.

2.12 PAN-TILT-ZOOM OUTDOOR DOME CAMERA – TYPE F

- A. Manufacturers
 1. Basis of Design: Hikvision® 2.0MP PTZ, model DS-2DF823615W-AELW.
 2. Acceptable alternates: Honeywell, Pelco..
 3. Substitutions: Section 01 2500 – Substitution Procedures.
- B. Compatibility
 1. Camera must be listed as a compatible device by both the NVR and VMS software manufacturer. All camera features must be available when utilizing the VMS client software.
- C. General Requirements
 1. This product shall be manufactured by a firm whose quality system is in compliance with ISO-9001.
 2. All equipment and materials used shall be standard components that are regularly manufactured and used in the manufacturer's system.
 3. All systems and components shall have been thoroughly tested and proven in actual use.
 4. All systems and components shall be provided with comprehensive repair and spare parts replacement. The manufacturer on warranty and non-warranty items shall guarantee the spare parts and the repair.
 5. All systems and components must be in compliance with FCC, CE, ICES-003, UL, cUL, and RoHS requirements.
 6. All materials furnished under this item shall be compliant with 802.3 Ethernet standards.
- D. Product Specifications

1. Power Supply: 24VAC \pm 10%; Hi PoE (802.3at); RJ-45 (Manufacture shall provide PoE injector).
2. Power Consumption: Maximum 60 W
3. Network Interface: 10M Base T/100M Base-TX; RJ-45
4. Image Sensor: 1/1.9" progressive scan CMOS
5. Minimum Illumination: 0.002 lux @ (f/1.5, AGC on)
6. Lens:
 - a. 5.7 mm to 205 mm (36X) zoom lens.
 - b. Digital Zoom: 16x
 - c. Angle of View: 62° to 2° (optical wide to zoom).
 - d. Aperture: f 1.5 to f 4.5.
 - e. Focus Mode: auto/semi-auto/manual.
7. WDR: 120 dB.
8. AGC: Auto/manual.
9. Pan and Tilt:
 - a. Pan: 360° endless.
 - b. Tilt: -20° to 90° (auto-flip).
 - c. Speed: Pan manual – 0.1° to 160°/s; Tilt manual -0.1° to 120°/s.
 - d. Number of Presets: 300.
 - e. Patrols: 8 (32 presets per patrol).
10. Max. Image Resolution: 1920 x 1080
11. Day/Night: Day, Night, Auto, Scheduled
12. IR:
 - a. Smart IR Enabled/disabled
 - b. IR LEDs Enabled/disabled
13. TV System: NTSC (30 fps); PAL (25 fps)
14. Compression:
 - a. Main stream H.264,MJPEG
15. Audio Compression: G.711 ulaw/ G.711 alaw/G.726/MP2L2/G.722.
16. Max. Frame Rate (main): 30 fps @ 1920 x 1080
17. Motion Detection: 330 regions, select sensitivity (0 to 100), scheduled activation, linkage (e-mail/FTP upload/notify surveillance center).
18. Software Interface:
 - a. Web browser view, remote PC client, and remote mobile client
19. Operating Conditions: -40° C to 65° C (-40° F to 149° F).
20. Accessories:
 - a. JBPW-L: Power box with wall bracket - use for wall mounting.
 - b. PMP: Pole mount bracket – use for pole mounting.
 - c. WMP-L: Wall mount bracket – use with pole mount bracket.

2.13 POE EXTENDERS

A. MANUFACTURERS

1. Basis of Design: Veracity OUTREACH MAX
2. Acceptable alternate manufacturers: Microsemi, Axis.
3. Substitutions: See Division 1 – Product Requirements.

B. PRODUCT DESCRIPTION

1. Ethernet and POE extender for IP cameras. Extender shall increase the maximum length of cable run beyond the typical 100m (328 foot) length.
2. Extender shall have the following features:
 - a. Ability to extend signal up to 200m (656 feet) without any additional power supplies.
 - b. 10BASE-T / 100BASE-TX network operation.
 - c. Supports IEEE 802.3af POE
 - d. Supports IEEE 802.3at POE+

C. MOUNTING

1. Extenders shall be mounted as close to the middle of cable run as possible.
2. Mount above closest accessible ceiling.
3. Provide all required mounting accessories.

D. TERMINATIONS

1. Two (2) separate cable runs shall terminate at RJ-45 jacks in each end of extender. Contractor is responsible for providing male RJ-45 connectors for termination.

2.14 IP-OVER-FIBER CONVERTERS

A. MANUFACTURERS

1. Basis of Design: Axis T8604.
2. Acceptable alternate manufacturers: Honeywell, Sony.
3. Substitutions: See Division 1 – Product Requirements.

B. Product Description

1. Media converter switch, capable of extending Ethernet over a single fiber optic cable for camera interfacing.
2. Connectors: 2x RJ45 (10/100 Mbps); 2x SFP (100/1000 Mbps) for SFP fiber optic modules or SFP to copper modules.
3. Operating temperature: -40°F to 167°F.

C. Provide all necessary power supplies at device locations for a complete and operational system. Power supplies shall be UL listed.

D. Mounting

1. Mount on exterior poles, and above suspended ceilings. Refer to drawings for further specifications.
2. When in exposed location outside the building, extenders shall be mounted in NEMA 4 enclosures.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine site conditions prior to installation. Notify Architect and Owner in writing if unsuitable conditions are encountered. Do not start installation until site conditions are acceptable.

3.2 INSTALLATION

- A. Test all components before shipping to the project location.
- B. Provide all necessary licensing for each camera.
- C. NVR and Camera system shall be installed, programmed, and tested in accordance with manufacturer's installation instructions.
 - 1. Coordinate interfaces with Owner's representative where appropriate.
 - 2. Provide backboxes, racks, connectors, supports, conduit, cable, and wire for a complete and reliable installation. Obtain Owner's approval for exact location of all boxes, conduit, and wiring runs prior to installation.
 - 3. Install conduit, cable, and wire parallel and square with building lines, including raised floors areas. Do not exceed forty percent fill in conduits. Gather wires and tie to create an orderly installation.
 - 4. Coordinate with other trades to provide proper sequencing of installation.

3.3 FIELD COMMISSIONING AND CERTIFICATION

- A. Field Commissioning: Testing the IP Video Recording system as recommended by manufacturer, including the following:
 - 1. Conduct complete inspection and testing of equipment, including verification of operation with connected equipment.
 - 2. Test devices and demonstrate operational features for Owner's representative and authorities having jurisdiction as applicable.
 - 3. Correct deficiencies until satisfactory results are obtained.
 - 4. Submit written copies of test results.

3.4 TESTING

- A. The Integrator shall demonstrate the functionality of the VMS upon completion of installation, documenting the result of all tests and providing these results to the Owner.
 - 1. The VMS shall be tested in accordance with the following:
 - a. The Integrator shall be responsible for documenting and entering the initial database into the system debugging all issues. Prior to full operation, a complete demonstration of the computer real-time functions shall be performed. A printed validation log shall be provided as proof of operation for each software application package. In addition, a point utilization report shall be furnished listing each point.
 - b. Upon satisfactory on-line operation of the system software, the entire installation including all subsystems shall be field inspected. Each device

shall be tested as a working component of the completed system. All system controls shall be inspected for proper operation and response.

- c. Tests shall demonstrate the response time and display format of each different type of input sensor and output control device. Response time shall be measured and documented with the system functioning at full capacity. Computer operation shall be tested with the complete data file.
- d. The Integrator shall maintain a complete log of all inspections and tests. Upon final completion of system tests, a copy of the log records shall be submitted as part of the as-built manuals along with a letter of certification to indicate that the tests have been performed, and all devices are operational.
- e. The completed system shall be tested in front of the owner or owner's agent. The system test shall be witnessed by the Authority Having Jurisdiction if necessary. Any deficiencies noted during the testing must be corrected.

3.5 MAINTENANCE

- A. Installing integrator shall maintain proper manufactures certification and training during the warranty period. The availability of expansion, replacement and spare parts shall be accessible during the warranty period at standard pricing.
- B. User training for multiple shifts shall be available at the time of acceptance at the owners location. Additional user e-training shall be available from the manufacturer during the warranty and license periods.

3.6 Hard and electronic copies of installation, maintenance and operations manuals shall be provided at the time of acceptance. As-Built drawings are also to be provided at this time

3.7 TRAINING

- A. Conduct on-site system administrator and security/surveillance operator training, with the number of sessions and length of sessions as recommended by the NVR system manufacturer. Training shall include administration, provisioning, configuration, operation, and diagnostics.

END OF SECTION

SECTION 283100 - FIRE DETECTION AND ALARM

PART 1 GENERAL

1.1 DESCRIPTION:

- A. This section of the specification includes the furnishing, installation, connection and testing of a microprocessor control, intelligent reporting fire alarm equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Fire Alarm Remote Control Panels, auxiliary control devices, transponders, annunciator, and wiring as shown on the drawings and specified herein.
- B. The fire alarm system shall comply with requirements of 2002 NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.
- C. The fire alarm manufacturer shall be of the highest caliber and insist on the highest quality. The system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994.
- D. The FACP and peripheral devices shall be manufactured 100% by a single U.S. manufacturer (or division thereof).
- E. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and shall be in compliance with the UL listing.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 DEFINITIONS:

- A. Initiation Device: A manual or automatic operated device that when operated results in the transmission of a fire alarm or supervisory indication at the control panel.
 - 1. Common alarm initiation devices include:
 - a. Smoke detectors.
 - b. Heat detectors.
 - c. Multi-criteria detectors.
 - d. Manual pull stations.
 - e. Water flow devices.
 - f. Fire suppression system switches.
 - 2. Common supervisory initiation devices include:
 - a. Valve position (tamper) switches.
 - b. Water levels witches.
 - c. Hi/Low pressure switches.
 - d. Fire suppression system trouble switches.
 - e. Carbon Monoxide detectors.

1.5 RELATED SECTIONS

- A. Related Sections:
 - 1. Division 01 Section – Cutting and patching
 - 2. Division 07 Section – Penetration Firestopping.
 - 3. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 4. Section 28 05 29 - Hangers and Supports for Electronic Safety and Security.
 - 5. Section 28 05 53 - Identification for Electronic Safety and Security.
 - 6. Section 27 05 26 - Grounding and Bonding for Communications Systems.

1.6 SCOPE:

- A. New fire alarm equipment shall be installed in accordance to the project specifications and drawings.
- B. Provide a framed drawing (24"x 36" minimum size) of building showing device locations with all rooms labeled and each Fire alarm Annunciator location. Provide with clear lexan cover.
- C. Basic Performance:
 - 1. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Style 4 (Class B) Signaling Line Circuits (SLC).
 - 2. Initiation Device Circuits (IDC) shall be wired Class B (NFPA Style B) as part of an addressable device connected by the SLC Circuit.

3. Notification Appliance Circuits (NAC) shall be wired Class B (NFPA Style Y) as part of an addressable device connected by the SLC Circuit.
4. Digitized electronic signals shall employ check digits or multiple polling.
5. A single ground or open on the system signaling line circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
6. Alarm signals arriving at the main FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.
7. NAC speaker circuits shall be arranged such that there is a minimum of one speaker circuit per floor of the building or smoke zones whichever is greater.
8. Audio amplifiers and tone generating equipment shall be electrically supervised for normal and abnormal conditions.
9. NAC speaker circuits and control equipment shall be arranged such that loss of any one (1) speaker circuit will not cause the loss of any other speaker circuit in the system.

D. BASIC SYSTEM FUNCTIONAL OPERATION

When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:

1. The system alarm LED on the FACP shall flash.
2. A local piezo electric signal in the control panel shall sound.
3. A backlit 80 character LCD display on the FACP shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
4. Printing on the FACP and history storage equipment shall log the information associated each new fire alarm control panel condition, along with time and date of occurrence.
5. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated, including fan shut downs via notification to the facility DDC system, and security system functions shall be initiated thru the security head end controls.
6. Remote receiving station shall be notified automatically.

1.7 SUBMITTALS

A. General:

1. Ten copies of all submittals shall be submitted to the Architect/Engineer for review.
2. All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality.

B. Shop Drawings:

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.

2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
 3. Show annunciator layout, configurations, and terminations.
 4. Provide battery calculations as described in Part 2 of this specification under "Batteries".
- C. Manuals:
1. Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets
 2. Maintenance and instruction manuals shall be submitted per Paragraph 3.10 in Section 019113.
 3. Wiring diagrams shall indicate internal wiring for each device and the interconnections between the items of equipment.
 4. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system.
- D. Software Modifications:
1. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.
 2. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.
- E. Certifications:
1. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of the installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.
- F. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.

2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.8 QUALITY ASSURANCE

- A. High Performance Building Requirements:
1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.9 GUARANTY:

- A. All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance. The full cost of maintenance, labor and materials required to correct any defect during this one year period shall be included in the submittal bid.

1.10 APPLICABLE STANDARDS AND SPECIFICATIONS:

The specifications and standards listed below form a part of this specification. The system shall fully comply with the latest issue of these standards.

- A. National Fire Protection Association (NFPA) - USA:
- | | |
|---------------|-------------------------------------|
| No. 12 | CO2 Extinguishing Systems |
| No. 12A & 12B | Halon Extinguishing Systems |
| No. 15 | Water Spray Systems |
| No. 16 | Foam/Water Deluge and Spray Systems |
| No. 72-1993 | National Fire Alarm Code |
| No. 101 | Life Safety Code |
- B. Underwriters Laboratories Inc. (UL) - USA:
- | | |
|---------|---|
| No. 268 | Smoke Detectors for Fire Protective Signaling Systems |
| No. 864 | Control Units for Fire Protective Signaling Systems |

No. 268A	Smoke Detectors for Duct Applications
No. 521	Heat Detectors for Fire Protective
No. 464	Audible Signaling Appliances
No. 38	Manually Actuated Signaling Boxes
No. 346	Waterflow Indicators for Fire Protective Signaling Systems
No. 1076	Control Units for Burglar Alarm Proprietary Protective Signaling Systems
No. 1971	Visual Notification Appliances

- C. Local and State Building Codes.
- D. All requirements of the Authority Having Jurisdiction (AHJ).
- E. Distributor of fire alarm to be an approved UUIS certified company.

1.11 APPROVALS:

- A. The system shall have proper listing and/or approval from the following nationally recognized agencies:
 - UL Underwriters Laboratories Inc.
 - FM Factory Mutual
- B. The fire alarm control panel shall meet UL Standard 864 (Control Units) and UL Standard 1076 (Proprietary Burglar Alarm Systems).

1.12 MAINTENANCE MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish three manual station break-glass rods.
- C. Furnish six keys of each type.
- D. Provide (2) manual fire alarm pullstations, complete with all labor, material, and programming, to be located in the field as directed by the Local Authority Having Jurisdiction.
- E. Provide (6) fire alarm audio/visual appliances, complete with all labor, material, and programming, to be located in the field as directed by the Local Authority having Jurisdiction.
- F. Provide (2) addressable duct mounted smoked detectors, including all labor, material, and programming, to be located in the field as directed by the Local Authority having Jurisdiction.

1.13 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Provide (4) manual fire alarm pullstation.
- C. Provide (4) fire alarm audio/visual appliances of each type.
- D. Provide (4) addressable ceiling type smoke detector.

PART 2 PRODUCTS

2.1 EQUIPMENT AND MATERIAL, GENERAL:

- A. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protective signaling system, meeting the National Fire Alarm Code.
- B. All equipment and components shall be installed in strict compliance with manufacturers' recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.
- C. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.
- D. All equipment proposed is based on Notifier. Products of equal quality and functionality as manufactured by Edwards/EST and Simplex will be considered.

2.2 CONDUIT AND WIRE:

- A. Metal Clad (MC) Cable:
 - 1. Type FPLP cable with galvanized interlocking steel with continuous red stripe.
 - 2. NEC Article 760 rating for fire alarm control cables.
 - 3. Install multiconductor cabling in accordance with NEC article 730.
 - 4. Use permitted above accessible ceilings and concealed within walls to devices. Provide conduit and wire for final homeruns to control panels , transponders and power supplies.
 - 5. Conductors shall comply with paragraph C.
- B. Conduit:
 - 1. Conduit shall be in accordance with the National Electrical Code (NEC), local and state requirements.

2. Where exposed, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
 3. Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-29.
 4. Wiring for 24 volt DC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
 5. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
 6. Conduit shall be 3/4 inch (19.1 mm) minimum.
- C. Wire:
1. All fire alarm system wiring shall be new.
 2. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for initiating device circuits and signaling line circuits, and 14 AWG (1.63 mm) for notification appliance circuits.
 3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
 4. Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR).
 5. Wiring used for the SLC multiplex communication loop shall be twisted and shielded and support a minimum wiring distance of 10,000 feet. In certain applications, the system shall support up to SLC loops with up to 1,000 feet of untwisted, unshielded wire. The system shall permit use of IDC and NAC wiring in the same conduit with the SLC communication loop.
 6. All field wiring shall be completely supervised.
 7. The fire alarm control panel shall be capable of t-tapping Class B (NFPA Style 4) Signaling Line Circuits (SLCs). Systems which do not allow or have restrictions in, for example, the amount of t-taps, length of t-taps etc., are not acceptable.
- D. Terminal Boxes, Junction Boxes and Cabinets: All boxes and cabinets shall be UL listed for their use and purpose.
- E. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.
- F. The fire alarm control panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the main power distribution panel as FIRE ALARM. Fire alarm control panel primary power wiring shall be 12 AWG. The

control panel cabinet shall be grounded securely to either a cold water pipe or grounding rod.

2.3 MAIN FIRE ALARM CONTROL PANEL:

- A. The specification is based on a Notifier Model NFS2-640 main control panel. The system shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, annunciators, and other system controlled devices.
- B. Operator Control:
1. Acknowledge Switch:
 - a. Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the 80-character LCD display to the next alarm or trouble condition.
 - b. Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.
 2. Alarm Silence Switch:
 - a. Activation of the alarm silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition after an alarm condition. The selection of notification circuits and relays that are silence able by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.
 3. Alarm Activate (Drill) Switch:
 - a. The Alarm Activate switch shall activate all notification appliance circuits. The drill function shall latch until the panel is silenced or reset.
 4. System Reset Switch:
 - a. Activation of the System Reset switch shall cause all electronically-latched initiating devices, appliances or software zones, as well as all associated output devices and circuits, to return to their normal condition.
 5. Lamp Test:
 - a. The Lamp Test switch shall activate all system LEDs and light each segment of the liquid crystal display.
- C. System Capacity and General Operation:
1. The control panel shall provide, or be capable of expansion to 636 intelligent/addressable devices.
 2. The system shall include Form-C alarm, trouble, supervisory, and security relays rated at a minimum of 3.0 amps @ 30 VDC. It shall also include four Class B (NFPA Style Y) or Class A (NFPA Style Z) programmable notification appliance circuits.
 3. The system shall support up to 8 additional output modules (signal, speaker, telephone, or relay), each with 8 circuits for an additional 64 circuits. These

circuits shall be either Class A (NFPA Style D) or Class B (NFPA Style Y) per the project drawings.

4. The fire alarm control panel shall include a full featured operator interface control and annunciation panel that shall include a backlit Liquid Crystal Display (LCD), individual color coded system status LEDs, and an alphanumeric keypad for the field programming and control of the fire alarm system.
 5. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel. The system shall be fully programmable, configurable, and expandable in the field without the need for special tools, PROM programmers or PC based programmers. It shall not require replacement of memory ICs to facilitate programming changes.
 6. The system shall allow the programming of any input to activate any output or group of outputs. Systems which have limited programming (such as general alarm), have complicated programming (such as a diode matrix), or require a laptop personal computer are not considered suitable substitutes.
 7. The FACP shall provide the following features:
 - a. Drift compensation to extend detector accuracy over life. Drift compensation shall also include a smoothing feature, allowing transient noise signals to be filtered out.
 - b. Detector sensitivity test, meeting requirements of NFPA 72, Chapter 7.
 - c. Maintenance alert, with two levels (maintenance alert/maintenance urgent), to warn of excessive smoke detector dirt or dust accumulation.
 - d. Nine sensitivity levels for alarm, selected by detector. The system shall also include up to nine levels of pre-alarm, selected as a percentage of the alarm level, in steps from 90% down to 50%.
 - e. System status reports to display or printer.
 - f. Alarm verification, with verification counters.
 - g. PAS pre-signal, meeting NFPA 72 3-8.3 requirements.
 - h. Rapid manual station reporting (under 3 seconds).
 - i. Non-alarm points for general (non-fire) control.
 - j. Periodic detector test, conducted automatically by the software.
 - k. Self optimizing pre-alarm for advanced fire warning, which allows each detector to learn its particular environment and set its pre-alarm level to just above normal peaks.
 - l. Cross zoning with the capability of counting: two detectors in alarm, two software zones in alarm, or one smoke detector and one thermal detector.
 - m. Walk test, with a check for two detectors set to same address.
 - n. Control-by-time for non-fire operations, with holiday schedules.
 - o. Day/night automatic adjustment of detector sensitivity.
 - p. Device blink control for sleeping areas.
 - q. UL-1076 security monitor points.
 8. The FACP shall be capable of coding notification circuits in march time (120 PPM), temporal (NFPA 72 A-2-2.2.2), and California code.
- D. Central Microprocessor
1. The microprocessor shall be a state-of-the-art, high speed, 16 bit RISC device and it shall communicate with, monitor and control all external interfaces. It shall include an EPROM for system program storage, non-volatile memory for

building-specific program storage, and a "watch dog" timer circuit to detect and report microprocessor failure.

2. The microprocessor shall contain and execute all control-by-event programs for specific action to be taken if an alarm condition is detected by the system. Control-by-event equations shall be held in non-volatile programmable memory, and shall not be lost even if system primary and secondary power failure occurs.
3. The microprocessor shall also provide a real-time clock for time annotation of system displays, printer, and history file. The time-of-day and date shall not be lost if system primary and secondary power supplies fail. The real time clock may also be used to control non-fire functions at programmed time-of-day, day-of-week, and day-of-year.
4. A special program check function shall be provided to detect common operator errors.
5. An auto-program (self-learn) function shall be provided to quickly install initial functions and make the system operational.
6. For flexibility and to ensure program validity, an optional Windows(TM) based program utility shall be available. This program shall be used to off-line program the system with batch upload/download. This program shall also have a verification utility which scans the program files, identifying possible errors. It shall also have the ability to compare old program files to new ones, identifying differences in the two files to allow complete testing of any system operating changes. This shall be in compliance with the NFPA 72 requirements for testing after system modification.

E. Display

1. The display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.
2. The display shall include status information and custom alphanumeric labels for all intelligent detectors, addressable modules, internal panel circuits, and software zones.
3. The display shall include an 80-character back-lit alphanumeric Liquid Crystal Display (LCD). It shall also provide 8 Light-Emitting-Diodes (LEDs, that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM WARNING, SECURITY ALARM, SUPERVISORY SIGNAL, SYSTEM TROUBLE, DISABLED POINTS, and ALARM SILENCED.
4. The display keypad shall be an easy to use QWERTY type keypad, similar to a PC keyboard. This shall be part of the standard system and have the capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels shall be provided to prevent unauthorized system control or programming.
5. The display shall include the following operator control switches: ACKNOWLEDGE, ALARM SILENCE, ALARM ACTIVATE (drill), SYSTEM RESET, and LAMP TEST.

F. Signaling Line Circuits (SLC)

1. The system shall include two SLC circuits. Each SLC interface shall provide power to and communicate with up to 159 intelligent detectors (ionization, photoelectric or thermal) and 159 intelligent modules (monitor or control) for a

system capacity of 636 devices. Each SLC loop shall be capable of NFPA 72 Style 4, Style 6, or Style 7 (Class A or B) wiring.

2. The Loop Control Module (LCM) shall receive analog information from all intelligent detectors to be processed to determine whether normal, alarm, pre-alarm, or trouble conditions exist for each detector. The software shall automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information shall also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.
3. The detector software shall meet NFPA 72, Chapter 7 requirements and be certified by UL as a calibrated sensitivity test instrument.
4. The detector software shall allow manual or automatic sensitivity adjustment.

G. Serial Interfaces

1. The system shall include two serial EIA-232 interfaces. Each interface shall be a means of connecting UL Listed Electronic Data Processing (EDP) peripherals.
2. One EIA-232 interface shall be used to connect an UL-Listed 40 or 80 column printer. Printers which are not UL-Listed are not considered acceptable substitutes.
3. The system shall include an EIA-485 port for the serial connection of optional annunciators and remote LCD displays.
4. The EIA-485 interface may be used for network connection to a proprietary receiving unit.

H. Notification Appliance Circuit (NAC) Module

1. The notification appliance circuit module shall provide four fully supervised Class A or B (NFPA Style Z or Y) notification circuits. An expansion circuit board shall allow expansion to eight circuits per module.
2. The notification circuit capacity shall be 3.0 amperes maximum per circuit and 6.0 amperes maximum per module.
3. The module shall not affect other module circuits in any way during a short circuit condition.
4. The module shall provide eight green ON/OFF LEDs and eight yellow TROUBLE LEDs.
5. The module shall also provide a momentary switch per circuit that may be used to manually turn the particular circuit on or off or to disable the circuit.
6. Each notification circuit shall include a custom label inserted to identify each circuits location. Labels shall be created using a standard typewriter or word processor.
7. The notification circuit module shall be provided with removable wiring terminal blocks for ease of installation and service. The terminal strips shall be UL listed for use with up to 12 AWG wire.
8. Each circuit shall be capable of, through system programming, deactivating upon depression of the signal silence switch.

I. Control Relay Module

1. The control relay module shall provide six Form-C auxiliary relay circuits rated at 5 amperes, 28 VDC. An expansion circuit board shall allow expansion to eight Form-C relays per module.

2. Each relay circuit shall be capable of being activated (change in state) by any initiating device or from any combination of initiating devices.
 3. The expansion module shall provide 8 green ON/OFF LEDs and 8 yellow LEDs (indicates disabled status of the relay).
 4. The module shall provide a momentary switch per relay circuit that may be used to manually turn the relay ON/OFF or to disable the relay.
 5. Each relay circuit shall include a custom label inserted to identify its location. Labels shall be created using a standard typewriter or word processor.
 6. The control relay module shall be provided with removable wiring terminal blocks for ease of installation and service. The terminal blocks shall be UL listed for use with up to 12 AWG wire.
- J. Digital Voice Command Center
1. The Digital Voice Command Center located with the FACP, shall contain all equipment required for all audio control, emergency telephone system control, signaling and supervisory functions. This shall include speaker zone indication and control, telephone circuit indication and control, digital voice units, microphone and main telephone handset.
 2. Function: The Voice Command Center equipment shall perform the following functions:
 - a. Operate as a supervised multi-channel emergency voice communication system.
 - b. Operate as a two-way emergency telephone system control center.
 - c. Audibly and visually annunciate the active or trouble condition of every speaker circuit and emergency telephone circuit.
 - d. Audibly and visually annunciate any trouble condition for digital tone and voice units required for normal operation of the system.
 - e. Provide all-call Emergency Paging activities through activation of a single control switch.
 - f. As required, provide vectored paging control to specific audio zones via dedicated control switches.
 - g. Provide a factory recorded "library" of voice messages and tones in standard WAV. File format, which may be edited and saved on a PC running a current Windows® operating system.
 - h. Provide a software utility capable of off-line programming for the VCC operation and the audio message files. This utility shall support the creation of new programs as well as editing and saving existing program files. Uploading or downloading the VCC shall not inhibit the emergency operation of other nodes on the fire alarm network.
 - i. Support an optional mode of operation with four analog audio outputs capable of being used with UL 864 fire-listed analog audio amplifiers and SCL controlled switching.
 - j. The Digital Voice Command shall be modular in construction, and shall be capable of being field programmable without requiring the return of any components to the manufacturer and without requiring use of any external computers or other programming equipment.
 - k. The Digital Voice Command and associated equipment shall be protected against unusually high voltage surges or line transients.

3. The voice control (speaker circuit) module shall provide four fully supervised Class B (NFPA Style Y) or Class A (NFPA Style Z) speaker circuits. An expansion circuit board shall allow expansion for up to eight circuits per module.
4. Each speaker circuit shall be capable of switching up to 30 watts maximum per circuit or 60 watts per four circuit module.
5. If a short-circuit trouble occurs on one of the circuits, that circuit will not activate on either manual or automatic command.
6. The module shall provide green ON/OFF LEDs and yellow TROUBLE LEDs.
7. The module shall also provide a momentary switch per circuit that may be used to manually turn the particular circuit on or off or to disable the circuit.
8. Each voice circuit shall include a custom label inserted to identify its location. Labels shall be created using a standard typewriter or word processor.
9. The voice control module shall be provided with removable wiring terminal blocks for ease of installation and service. The terminal strips shall be UL Listed for use with up to 12 AWG wire.
10. Each speaker circuit module may be programmed to activate on activation of the All-Call switch and to deactivate upon pressing the signal silence switch.

K. Enclosures:

1. The control panel shall be housed in a UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.
2. The back box and door shall be constructed of .060 steel with provisions for electrical conduit connections into the sides and top.
3. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. For convenience, the door may be selected for either right or left hand hinging.

L. Power Supply:

1. The Addressable Main Power Supply shall operate on 120/240 VAC, 50/60 Hz, and shall provide all necessary power for the FACP.
2. The Addressable Main Power Supply shall provide the required power to the CPU using a switching 24 VDC regulator and shall incorporate a battery charger for 24 hours of standby power using dual-rate charging techniques for fast battery recharge.
3. The Addressable Main Power Supply shall provide a battery charger for 24 hours of standby using dual-rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries ranging in capacity from 7-200 amp-hours within a 48-hour period.
4. The Addressable Main Power Supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.
5. The Addressable Main Power Supply shall be power-limited per UL864 requirements Fire Fighters' Telephones

M. Audio Amplifiers (Size amplifiers with a minimum spare capacity of 20% and provide a minimum of one backup amplifier.)

1. The audio amplifiers will provide audio power (@ 25 Volts RMS) for distribution to the speaker circuits.

2. Multiple audio amplifiers may be mounted in the fire alarm control panel using additional cabinets if necessary.
 3. The audio amplifiers shall include an integral power supply, and shall provide the following controls and indicators:
 - Normal Audio Level LED
 - Incorrect Audio Level LED
 - Brownout LED
 - Battery Trouble LED
 - Amplifier Trouble LED
 - Audio Amplifier Gain Adjust
 4. Adjustment of the correct audio level for the amplifier shall not require any special tools or test equipment.
 5. All terminal blocks for the connection of field wiring shall have a removable plug-in and be hardwired to allow for ease of field wire installation in a cabinet or at a remote location.
 6. The amplifier shall include audio input and amplified output supervision, back-up input, and automatic switch-over to back up (if primary amplifier should fail).
 7. Amplifiers shall be backed up in groups (one amplifier backs up several).
- N. Prerecorded Voice - Audio Message Generator
1. The voice communication system shall be capable of transmitting a prerecorded voice message to all speakers in the building, or to any programmed group of speakers.
 2. Actuation of any alarm initiating device shall cause a pre-recorded message to sound over the speakers. The message shall be repeated four times.
 3. A built-in microphone shall be provided to allow paging through speaker circuits and shall have priority over the alarm message.
 4. The message generator shall provide an interface to allow paging through telephone circuits.
 5. The audio message generator shall have the following controls and indicators to allow for proper operator understanding and control.
 - Audio Level Normal LED
 - All Call LED
 - On-Line LED
 - Amplifier Trouble LED
 - Speaker Trouble LED
 - All Call Switch
 - Local Speaker Volume Control
 6. The prerecorded message shall be stored on a non-volatile read only memory chip. The message shall be up to 24 seconds in length. An optional random access chip shall be available for a field programmable message. This message shall be programmed through the system's microphone or downloaded via a cassette recorder. Systems which utilize prerecorded memory storage other than on ROM type memory chips are not suitable substitutes.
- O. Specific System Operations
1. Smoke Detector Sensitivity Adjust: A means shall be provided for adjusting the sensitivity of any or all addressable intelligent detectors in the system from the

- system keypad. Sensitivity range shall be within the allowed UL window and have a minimum of 9 levels.
2. Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification delay shall be programmable from 5 to 30 seconds and each detector shall be able to be selected for verification. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.
 3. Point Disable: Any addressable device or conventional circuit in the system may be enabled or disabled through the system keypad.
 4. Point Read: The system shall be able to display or print the following point status diagnostic functions:
 - Device status
 - Device type
 - Custom device label
 - View analog detector values
 - Device zone assignments
 - All program parameters
 5. System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system status.
 6. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 1000 events. 200 events shall be dedicated to alarm and the remaining events are general purpose. Each of these activations will be stored and time and date stamped with the actual time of the activation. The contents of the history buffer may be manually reviewed, one event at a time, or printed in its entirety. The history buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable substitutes.
 7. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent detector and shall analyze the detector responses over a period of time. If any intelligent detector in the system responds with a reading that is above or below normal limits, then the system will enter the trouble mode, and the particular detector will be annunciated on the system display, and printed on the optional printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.
 8. Pre-Alarm Function: The system shall provide two levels of pre-alarm warning to give advance notice of a possible fire situation. Both pre-alarm levels shall be fully field adjustable. The first level shall give an audible indication at the panel. The second level shall give an audible indication and may also activate control relays. The system shall also have the ability to activate local detector sounder bases at the pre-alarm level, to assist in avoiding nuisance alarms.
 9. Software Zones: The FACP shall provide 99 software zones and 10 additional special function zones.
 10. The fire alarm control panel shall include a walk test feature. It shall include the ability to test initiating device circuits and notification appliance circuits from the field without returning to the panel to reset the system. Operation shall be as follows:

- a. Alarming an initiating device shall activate programmed outputs, which are selected to participate in walk test, for 3 seconds.
 - b. Introducing a trouble into the initiating device shall activate the programmed outputs for 8 seconds.
 - c. Walk test shall be selectable on a per device/circuit basis. All devices and circuits which are not selected for walk test shall continue to provide fire protection and if an alarm is detected, will exit walk test and activate all programmed alarm functions.
 - d. All devices tested in walk test shall be recorded in the history buffer.
11. Waterflow Operation (Provide one FMM-1 for Each)
- a. An alarm from a waterflow detection device shall activate the appropriate alarm message on the 80 character display, turn on all programmed notification appliance circuits and shall not be affected by the signal silence switch.
12. Supervisory Operation (Provide one FMM-1 for Each)
- a. An alarm from a supervisory device shall cause the appropriate indication on the 80 character display, light a common supervisory LED, but will not cause the system to enter the trouble mode.
13. Signal Silence Operation
- a. The FACP shall have the ability to program each output circuit (notification, relay, speaker etc.) to deactivate upon depression of the signal silence switch.
14. Non-Alarm Input Operation
- a. Any addressable initiating device in the system may be used as a non-alarm input to monitor normally-open contact type devices. Non-alarm functions are a lower priority than fire alarm initiating devices.

2.4 SYSTEM COMPONENTS:

- A. Speakers (Speaker/Strobes are to meet requirements of both paragraphs A and B)
1. All speakers shall operate on 25 VRMS or with field selectable output taps from 0.5 to 2.0 Watts.
 2. Speakers in corridors and public spaces shall produce a nominal sound output of 84 dBA at 10 feet (3m).
 3. Frequency response shall be a minimum of 400 HZ to 4000 HZ.
 4. The back of each speaker shall be sealed to protect the speaker cone from damage and dust.
- B. Strobe lights shall meet the requirements of the ADA, UL Standard 1971, NFPA 2002 and shall meet the following criteria:
1. The pulse duration shall be between minimum of one second and maximum of two seconds.
 2. Strobe intensity shall meet the requirements of UL 1971, NFPA 2002 and ADA.
 3. All visual units shall be synchronized to meet ADA requirements using sync modules.

- C. Alphanumeric LCD Type Annunciator
1. The alphanumeric display annunciator shall be a supervised, remotely located back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text.
 2. The LCD annunciator shall display all alarm and trouble conditions in the system.
 3. An audible indication of alarm shall be integral to the alphanumeric display.
 4. The display shall be UL listed for fire alarm application.
 5. It shall be possible to connect up to 32 LCD displays and be capable of wiring distances up to 6000 feet from the control panel.
 6. The annunciator shall connect to a separate, dedicated "terminal mode" EIA-485 interface. This is a two-wire connection and shall be capable of distances to 6,000 feet. Each terminal mode LCD display shall mimic the main control panel.
 7. The system shall allow a minimum of 32 terminal mode LCD annunciators. Up to 10 LCD annunciators shall be capable of the following system functions: Acknowledge, Signal Silence and Reset which shall be protected from unauthorized use by a key switch or password.
 8. Provide annunciator key switch to enable or disable operation of annunciator membrane control switches.
- D. All interfaces and associated equipment are to be protected so that they will not be affected by voltage surges or line transients consistent with UL standard 864.
- E. Field Wiring Terminal Blocks
1. For ease of service all panel I/O wiring terminal blocks shall be removable, plug-in types and have sufficient capacity for 18 to 12 AWG wire. Terminal blocks which are permanently fixed are not acceptable.
- F. Transponders
1. Transponders shall be listed under UL category UOJZ as an independent, local fire alarm control unit as well as being listed as a critical component in a multiplex fire alarm system. Transponders shall be located where shown on the plans.
The transponder shall serve as the interface between initiating fire devices, controlled signaling devices, and each FACP node. The supervised multiplex communication port shall be an integral part of the transponder.
 2. Each transponder shall be powered from a local power supply, and shall provide all power necessary for its own operation, including standby power.
 3. Transponders shall communicate with, and be controlled by, the host FACP via a 2-wire communications loop. The communications loop shall operate as an NFPA Style 4, Style 6 or Style 7 loop.
 4. Transponders shall be used to house amplifiers, batteries and power supplies to allow true distributed processing and amplification.
 5. Each transponder shall have the following indicators and operator controls:
 - Alarm Acknowledge/Reset Switch
 - Power LED
 - System Alarm LED
 - System Trouble LED

Local Piezoelectric Signal
Red Alarm Per Initiating Device Circuit
Green On/Off LED Per Notification Appliance
Circuit or Relay

6. Each transponder shall be capable of expansion of up to 24 field circuits of the following types in any mix:
 - a. Initiating Device Circuits (IDC): IDCs may be added to the transponder in groups of 8 Style B (Class B), or 4 Style D (Class A) circuits. Each circuit shall be capable of monitoring up to 30 compatible 2-wire smoke detectors, and/or any number of contact type initiating devices.
 - b. Fire Fighter's Telephone Circuits: Firefighter's telephone circuits may be added to the transponder in groups of up to 8 circuits.
 - c. Fire alarm speaker circuits: Fire alarm speaker circuits may be added to the transponder in groups of up to 8 circuits. Each circuit shall be cable of supervising the field circuit, and of transmitting up to 30 watts of audio power.
 - d. Auxiliary Control Relay Outputs: Auxiliary relay outputs may be added to the transponder in groups of eight individually controlled single Form-C circuits, or four dual Form-C circuits. All Auxiliary circuits shall be rated 2 A. @ 30 VDC.

2.5 SYSTEM COMPONENTS - ADDRESSABLE DEVICES

A. Addressable Devices - General

1. Addressable devices shall use simple to install and maintain decade (numbered 1 to 16) type address switches.
2. Addressable devices which use a binary address setting method, such as a Dip switch, are difficult to install and subject to installation error. This type of device is not an allowable substitute.
3. Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the fire alarm control panel signaling line circuits.
4. Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.
5. Smoke detector sensitivity shall be set in the fire alarm control panel and shall be adjustable in the field through the field programming of the system. Sensitivity may be automatically adjusted by the panel on a time-of-day basis.
6. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.
7. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base shall include a sounder base with a built-in

(local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications.

8. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
9. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).
10. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.
11. Detectors shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LEDs shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.
12. A magnetic test switch shall be provided to test each detector for 100% obscuration, reported to the FACP.
13. Addressable devices shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LED(s) shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.
14. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.
15. Devices with separate twist-lock base shall report as a trouble condition at the FACP when the device is removed.

B. Addressable Manual Pull Box

1. Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
3. Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches or larger.
4. Stations shall be suitable for surface mounting or semi-flush mounting as shown on the plans, and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor.

- C. Intelligent Photoelectric Smoke Detector
1. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
- D. Intelligent Thermal Detectors
1. Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit. Up to 159 intelligent heat detectors may connect to one SLC loop.
- E. Intelligent Duct Smoke Detector
1. The in-duct smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric detector, of that provides continuous analog monitoring and alarm verification from the panel.
 2. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.
 3. Provide with sampling tubes extending the entire width of the duct.
 4. Provide with keyed remote test/reset switches for **all** duct mounted smoke detectors.
- F. Intelligent Carbon Monoxide (CO) Detector
1. Advanced multi-criteria fire/CO detector shall be an addressable detector, with a separate signal for carbon monoxide (CO) detection. CO detection shall be per UL 2075 standards (complying with alarm threshold standards and sensitivity patterns of UL 2034). The CO detection signal shall report as a supervisory alarm only and shall not activate notification appliance circuits.
 2. The detector shall be comprised of four sensing elements, including a photoelectric (light-scattering) particulate sensor, an electrochemical CO sensor, a daylight-filtered infrared (IR) sensor and solid state thermal sensor(s) rated at 135°F (57.2°C). The device shall be able to indicate distinct smoke and heat alarms.
 3. The advanced multi-criteria detection device shall include the ability to combine the signal of the photoelectric signal with other sensing elements in order to react quickly in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a nuisance alarm condition. The detector shall be capable of selecting the appropriate sensitivity levels based on the environment type (office, manufacturing, kitchen, etc.) in which it is installed, and then have the ability to automatically change the setting as the environment changes.
 4. The CO detector component shall be capable of a functional gas test using a canned test agent to test the functionality of the CO sensing cell.
 5. The detector shall indicate CO trouble conditions, including six months of sensor life remaining and sensor life has expired. The detector shall indicate a combined

signal for any of the following: low chamber trouble, thermistor trouble, CO self test failure, IR self test failure, and freeze warning.

G. Addressable Dry Contact Monitor Module

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLC loops.
2. The monitor module shall mount in a 4-inch square, 2-1/8 inch deep electrical box.
3. The IDC zone may be wired for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
4. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch x 1-1/4 inch x 1/2 inch. This version need not include Style D or an LED.

H. Addressable Control Module

1. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay.
2. The control module shall mount in a standard 4-inch square, 2-1/8 inch deep electrical box, or to a surface mounted backbox.
3. The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
4. Audio/visual power shall be provided by a separate supervised power loop from the main fire alarm control panel or from a supervised, UL listed remote power supply.
5. The control module shall be suitable for pilot duty applications and rated for a minimum of .6 amps at 30 VDC.

I. Lexan Pull Station Guards

1. Provide Stopper II Lexan guards with integral buzzer for all manual pull stations. Provide with gaskets and spacers as required for the specific wall application in all instances.

2.6 BATTERIES:

- A. The battery shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus 5 minutes of alarm upon a normal AC power failure. Provide battery calculations with the submittals to verify requirements are met.
- B. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills, and leakage shall not be required.

- C. If necessary to meet standby requirements, external battery cabinet and charger systems may be used.

2.7 UDACT

- A. Digital Alarm Communicator Transmitter (UDACT). The UDACT is an interface for communicating digital information between a fire alarm control panel and a UL-Listed central station.
 1. The UDACT shall be an integral component of the fire alarm control panel requiring no interconnecting wiring or supervisory circuitry.
 2. The UDACT shall include connections for dual telephone lines (with voltage detect), per UL/NFPA/FCC requirements. It shall include the ability for split reporting of panel events up to two different telephone numbers.
 3. The UDACT shall be completely field programmable locally from the control panel keypad or remotely over a phone line using upload/download PC software.
 4. The UDACT shall be capable of transmitting events in at least 15 different formats. This ensures compatibility with existing and future transmission formats.
 5. Communication shall include vital system status such as:
 - a. Independent Zone (Alarm, trouble, non-alarm, supervisory)
 - b. Independent Addressable Device Status
 - c. AC (Mains) Power Loss
 - d. Low Battery and Earth Fault
 - e. System Off Normal
 - f. 12 and 24-Hour Test Signal
 - g. Abnormal Test Signal (per UL requirements)
 - h. EIA-485 Communications Failure
 - i. Phone Line Failure
 6. The UDACT shall support independent zone/point reporting when used in the Contact ID format. In this format, the UDACT shall support the transmission of up to 50 addressable points with the system. This enables the central station to have exact details concerning the location of the fire for emergency response.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.
- B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.
- C. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when

located in unfinished areas, or on existing block constructed walls with no means to fish wiring.

- D. Locate intelligent CO detectors as far away from CO source (fossil fuel burning appliance) as practical to minimize false alarms while maintaining manufacturer spacing criteria and NFPA required coverage.
- E. Wall mount duct mounted smoke detector keyed remote test/reset stations at 72" AFF at all duct mount smoke detector location. Wall mount below device and label with address.
- F. Coordinate location of framed drawing (24"x 36" minimum size) of building showing device locations at each Fire alarm Annunciator location with the Architect and Owner. Permanently mount in place.
- G. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Field technicians shall be NICET Level 1 (minimum) certified.
- H. The factory trained technician shall install initial data and artwork at each interactive firefighter's display.
- I. The factory trained technician shall design the graphic layout based on area diagrams and floor plans.

3.2 TEST

- A. The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72, Chapter 7.
 - 1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
 - 2. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
 - 3. Verify activation of all waterflow switches.
 - 4. Verify supervisory signal on CO detection activation.
 - 5. Open initiating device circuits and verify that the trouble signal actuates.
 - 6. Open and short signaling line circuits and verify that the trouble signal actuates.
 - 7. Open and short notification appliance circuits and verify that trouble signal actuates.
 - 8. Ground all circuits and verify response of trouble signals.
 - 9. Check presence and audibility of tone at all alarm notification devices.
 - 10. Check installation, supervision, and operation of all intelligent smoke detectors using the walk test.
 - 11. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.

12. When the system is equipped with optional features, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

3.3 FINAL INSPECTION

- A. At the final inspection, a factory trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

3.4 INSTRUCTION

- A. Instruction shall be provided as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.
- B. The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation" to the owner.

END OF SECTION

SECTION 310800 – BUILDING EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENT0053

- A. Concrete – Section 033000
- B. Monitoring – Section 310913
- C. Construction Drawings and Documents

1.2 SUMMARY

- A. General: Perform earthwork in accordance with the Contract Documents.
- B. Work Included: Work of this Section includes all labor, materials, equipment, and services necessary to complete the excavation, foundations, subgrade preparation, filling and grading as shown on the Drawings and specified herein including, but not limited to the following:
 - 1. Removal and replacement beneath the building pad and foundations as detailed in the project geotechnical report.
 - 2. All earth excavation to the bottom of foundations, walls, pits, slabs, manholes, etc. as required and indicated on the Contract Drawings, or to a lower elevation to achieve required bearing capacity, as directed by the Owner's Geotechnical Engineer.
 - 3. Excavation, filling and rough grading of site area at adjacent structures and roadways as required and within the Contract Limit Line.
 - 4. Excavation, filling, grading and compacting to required elevations for all floors, and slabs on grade.
 - 5. Excavation, filling, grading and compacting to required elevations for appurtenances and site work.
 - 6. Legal disposing off the site, of surplus excavated materials unsuitable for filling or backfilling.
 - 7. Pumping and dewatering as required for work of this section and for foundation work.
 - 8. Subgrade preparation for foundations.
 - 9. Protection and monitoring of adjacent structures, structures to remain, utilities, and pavements.
 - 10. Other labor and materials as may be reasonably inferred to be required to make the work under this Section complete.

1.3 REFERENCES

- A. General: All work and materials under this section shall conform to the latest revision of the following standard specifications, where not otherwise required by the Contract Documents.

- B. American Society for Testing and Materials (ASTM) – latest edition.
1. C 136 Test for Sieve Analysis of Fine and Coarse Aggregates
 2. D 422 Method for Particle Size Analysis of Soils
 3. D 1140 Test for Amount of Material in Soils Finer than No. 200 (75 mm) Sieve
 4. D 1556 Test for Density and Unit Weight of Soil in Place by the Sand-Cone Method
 5. D 1557 Test for Moisture-Density Relations of Soils Using 10-lb (4.5 Kg) Hammer and 18-inch (457 mm) Drop (Modified Proctor)
 6. D 2216 Laboratory Determination of Moisture content of Soil
 7. D 2487 Classification of Soils for Engineering Purposes
 8. D 2922 Tests for Density of Soil and Soil- Aggregate in Place by Nuclear Methods (Shallow Depth)
 9. D 3017 Test for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
 10. D 4253 Test Method of Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
 11. D 4254 Test Methods for Minimum Index Density and Unit Weight of Soils and Calculations of Relative Density
 12. D 4318 Test for Plastic Limit, Liquid Limit, and Plasticity Index of Soils
- C. American Association of State Highway and Transportation Officials (AASHTO) – Latest edition.
1. T 88 Mechanical Analysis of Soils
- D. All work shall comply with the requirements of the 2016 Connecticut State Building Code (IBC 2012), and the requirements and regulations of any other Federal, State, or Local ordinances having jurisdiction.
- E. Previous Reports: where discrepancies are present, the more stringent requirement shall apply.
1. Geotechnical Engineering Study, prepared by Langan CT, Inc., dated 27 December 2016.

1.4 SUBMITTALS

- A. Within ten days after award of the contract, the Contractor shall submit to the Architect a schedule detailing the sequence, and time of completion of all phases of work under this section.
- B. At least two weeks in advance of imported fill use, the Contractor shall submit either the following laboratory test data and a 25-pound soil sample to the Owner's Geotechnical Engineer for review and approval:
1. Contractor to submit test reports on on-site material for re-use and imported material as follows:
 - a. Moisture and Density (modified proctor) Relationship: ASTM D1557.
 - b. Mechanical Analysis: AASHTO T-88.

- c. Moisture content in accordance with ASTM D 2216.
 - d. Relative Density: ASTM D2049.
 - e. California Bearing Ratio (CBR): ASTM D1883, if utilized as subgrade material beneath paved areas.
 - f. Plasticity Index: ASTM 4318.
 - g. Test for Sieve Analysis of Fine and Coarse Aggregates: C 136.
2. Include data for all samples indicating the exact location and methods of transportation and placement of all materials.
- C. Submit the name of each material supplier and specific type and source of each material. Any change in source or soil type throughout the job requires approval of the Builder and the Owner's Geotechnical Engineer.
- D. Imported Material: Imported clean fill shall mean "Clean Fill" as defined in the Solid Waste Regulations found at Section 22a-209-1 of the Regulations of Connecticut State Agencies: (1) natural soil or; (2) rock, brick, ceramics, concrete, and asphalt paving fragments which are virtually inert and pose neither a pollution threat to ground or surface waters nor a fire hazard. "Polluted Soils", defined in Section 22a-133k-1 of the RCSA as "soil affected by a release of a substance at a concentration above the analytical detection limit for such substance", shall not be imported to the Site unless and until authorized by the Licensed Environmental Professional and approved by the commissioner of the CT DEEP, in accordance with sections 22a-133k-1 through 22a-133k-3 of the RCSA. Documentation, including, but not limited to laboratory analytical reports and source location, shall be provided for review and approval by owner or owner's Licensed Environmental Professional prior to the importation of clean fill materials.
- E. Samples: Submit a 12 inch by 12 inch sample of geosynthetic filter fabric.
- F. Temporary Excavation Support Shop Drawings:
1. Submit detailed shop drawings and calculations, to be reviewed by the Owner's Geotechnical Engineer, of earthwork procedures and sequences including temporary excavation support systems, if required.
 2. The temporary excavation support system drawings shall bear the signature and seal of a Professional Engineer registered in the State of Connecticut.
- G. Dewatering: The contractor shall prepare dewatering shop drawings. The dewatering plan shall be designed by the contractor's engineer.
- H. Pre-Construction Conditions Survey: The Contractor will perform a pre-construction conditions survey of all on-site structures to remain and adjacent offsite structures, and surrounding critical site features, the results of which will be made available to the Owner and Design Team upon completion of the survey (include digital copies of photographs). The survey shall consist of photographic and video documentation and shall include a plan detailing the limits of the work and any observed damage.
- I. Monitoring: monitoring shall be performed in accordance with Specification Section 310913.

- J. Certification for Examination of Site and Records: Before proceeding with the Work, submit certification in an acceptable form, signed by the Contractor, stating that careful examination has been made of the site, existing structures, records of utility lines, test boring records, test pit records, and subsurface exploration reports by the Owner's Geotechnical Engineer, the Drawings, and all other Contract Documents.
- K. Submit approvals and permits to the General Contractor a minimum of 15 days prior to commencement of construction.

1.5 ENVIRONMENTAL CONSIDERATIONS

- A. Install erosion control measures in the sequence shown of the plans or as directed by the Architect or regulatory agencies to protect adjacent properties and water resources from erosion and sediment damage.
- B. Any off-site soil disposal requirement shall be performed in accordance with all applicable Local, State, and Federal regulations governing soil movement and disposal.
- C. Dust and Erosion Control:
 - 1. The Contractor shall take all necessary measures and provide equipment and/or materials to minimize dust from rising and blowing across the site and also to control surface water throughout the operation so that it does not run onto paved ways without being filtered. In addition, the Contractor shall control all dust created by construction operation and movement of construction vehicles, both on site and on paved ways. Comply with Connecticut Sediment and Erosion Control Guidelines (2002 version or most recent).

1.6 PROJECT CONDITIONS

- A. The 29-acre site at 185 Damascus Road is bound by wooded areas and residential properties to the south, east and west, and Damascus Road and residential properties to the north. The site is occupied by the Francis Walsh Intermediate School, paved parking areas, athletic fields, and utilities in the vicinity of the proposed additions. The school is a 2-story structure and has a footprint of about 140,000 square feet. As shown on the available structural plans, the school has finished-floor between about el. +36 and about el. +40 (unknown datum).
- B. The subsurface conditions generally consist of a surficial layer of either asphalt pavement or topsoil underlain by layers of fill (about 2 to 10 feet thick), sand (about 14 to 40 feet thick), weathered rock (about 2 to 10 feet thick), and finally bedrock (encountered at about 19 to 36 feet below grade). A layer of glacial till was encountered below the sand layer within one boring. Groundwater was encountered at depths ranging between about 7 to 12 feet below existing grades.
- C. The Contractor, by careful examination, shall inform himself as to the nature and location of the work; the conformation of the ground, the nature of the subsurface conditions; the location of the groundwater table; the character, quality and quantity of the materials to be encountered; the character of the equipment and facilities needed preliminary to and during the execution of the

work; the conditions of adjacent structures and utilities and all other matters which can in any way effect the work.

- D. The Contractor shall be held to have visited the site and to have familiarized himself with the existing conditions of adjoining utilities and structures.
- E. The Contractor shall make his own deductions of the subsurface conditions which may affect the methods or cost of construction of the work hereunder, and he agrees that he will make no claims for damages or compensations, except as are provided under the agreement, should he find conditions during the progress of the work different from those as calculated and/or anticipated by him. Additional borings and other exploratory operations may be performed by Contractor, at the Contractor's option and following the Owner's approval. No change in the Contract Sum will be authorized for such additional exploration undertaken by the Contractor.
- F. The Contractor shall investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to, ingress and egress of the site of the work. The Contractor shall conform to all City and State, and Federal regulations concerning the transportation of materials to and from and at the job site and shall secure in advance such permits as may be required.

1.7 PRE-CONSTRUCTION CONDITION SURVEY

- A. The Contractor shall perform a pre-construction conditions survey of the structures and critical site features to remain on-site and adjacent off-site to the work area, prior to the start of work and shall include the results of this survey with their shop drawings submittal to the Owner and Design Team before commencement of said work.

1.8 PROTECTION

- A. Protection of Adjacent Structures, Utilities and Pavements
 - 1. Prior to commencement of any work, consult the records for existing utilities, and note all conditions and limitations, which might affect the work required under this section.
 - 2. The Contractor shall become acquainted with the existence and location of all surface and subsurface structures and utilities within the project area. Contractor shall not damage any of those that are to remain and shall leave them accessible.
 - 3. The work shall be executed so that no damage or injury will occur to existing public and adjoining or adjacent structures, streets, paving, sewers, gas, water, electric or any other pipes. Should any damage or injury caused by the contractor, or anyone in Contractor's employ, or by the work under this Contract occur, the Contractor shall, at his own expense, make good such damage and assume all responsibility for such injury.
 - 4. Provide barricades and warning lights, barriers, etc., to prevent accidents, to avoid all necessary hazards and protect the public, the work, and property at all times, including Saturdays, Sundays, and holidays.
 - 5. The above shall also include the protection of all existing utilities to remain in use within and adjacent to the area affected by the work of this project.

6. Monuments, bench marks and other reference features on streets bounding this project, shall be protected. Should these be disturbed in any manner, the Contractor shall have them replaced at own expense.
7. Excavation work shall be restricted to hours indicated in the Contract Documents.
8. Adjacent structures and utilities shall be monitored in accordance with Specification Section 310913.

B. Protection of Excavation Bottoms

1. Facilities and materials needed to prevent earth at bottom of excavation from becoming frozen or unsuitable to receive the foundations shall be furnished.
2. The excavation shall not be carried to final grades during freezing weather without providing complete protection against freezing of the subgrades as specified hereinafter. Complete protection against freezing shall also be provided if freezing weather sets in after completion of the excavation to final subgrade. This protection shall include adequate heating and coverage of the area to maintain temperatures above freezing until foundations have been concreted and backfilled.
3. Where excavations have been brought to the bottom elevations called for on the drawings, and the bottom of these excavations become unsuitable in the opinion of the Owner's Geotechnical Engineer because of inadequate protection by the Contractor, these excavations shall be carried to lower depths sufficient to provide stable bearing as determined by the Owner's Geotechnical Engineer at no additional cost to the owner.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Structural Fill: Well-graded sand and gravel having no more than 10% by dry weight passing the No. 200 sieve, free of organic material, clay, excessive silt, other deleterious or compressible materials, cinders, frozen material, trash, masonry or rubble and free of particle having dimensions greater than 3-inches in all directions. See geotechnical report for additional comments relative to re-use of on-site fill or the natural sand. Structural fill shall be used as backfilling material within 4 feet laterally of any structure, including footings, slabs, below-grade walls, utilities, manholes, catch basins, in areas greater than 2 feet below pavement subgrade, if acceptable with the project Civil Engineer.
- B. Drainage Fill: Free draining natural clean, crushed durable stone free of deleterious materials and conforming to the gradation requirements commercially known as ¾-inch clean crushed durable stone (Conn DOT No. 6 or approved alternative). Recycled concrete aggregate shall not be acceptable.
- C. The use of recycled concrete aggregate (RCA) is not permitted as a drainage backfill material behind permanent below grade walls and slab areas.
- D. Filter Fabric: Mirafi 140N manufactured by TC Mirafi or approved equivalent woven geotextile filter fabric where specified.

- E. The use of mole rock is not permitted.

PART 3 - EXECUTION

3.1 CODES, PERMITS AND REGULATIONS

- A. Comply with all applicable laws, rules, and ordinances and regulations of the Federal Government, Connecticut, and other jurisdictions.
- B. Obtain and pay for all permits and licenses required to execute and complete the work.
- C. In case of conflict between regulations and specifications, the Contractor shall comply with the most stringent applicable codes, regulations or specifications.

3.2 PUMPING AND DEWATERING

- A. Provide adequate pumps, or other equipment, appurtenances, power, drains, materials and labor necessary to excavation continuously dry during excavation, foundation construction, and backfilling and at such other times as the progress of the work may demand or as necessary to insure safety to the structure shall be provided.
- B. All pumping both inside and outside the areas of the building shall be performed, continued and maintained as required for the completion of all work, including the work of the mechanical trades, throughout the period of the contract.
- C. Contractor shall manage runoff to limit impact on construction.
- D. The dewatering system or systems shall be installed and operated in such a manner as to avoid the movement of fines or loss of ground from below the bearing level and shall not influence the stability of surrounding areas. The facilities needed to eliminate loss of ground shall be included.
- E. The Contractor shall not use any portion of the building foundation units or any part thereof as a sump for drainage resulting from pumping in any other area. The Contractor shall not conduct water to privately owned properties.
- F. Any pumped groundwater which will require off-site disposal shall comply with all Local, State, and Federal Environmental Regulations.

3.3 EXCAVATION

- A. Removal and Replacement
 - 1. The existing fill within the limits of the proposed building are not suitable for foundation or slab support in their current state. In areas where the fill is encountered at proposed bottom of footing elevation, it should be improved prior to foundation construction using

a minimum of six overlapping passes of a 10-ton vibratory roller. The resulting subgrade should be firm, stable, and unyielding as determined by the owner's geotechnical engineer.

2. In areas where unsuitable or yielding soils are encountered, the Contractor shall removal all unsuitable material to the top of natural sand material a horizontal distance equal to the depth of the over-excavation below the proposed footing elevation. The contractor shall minimize disturbance of the natural material using appropriate techniques (i.e., flat plate welded across bucket of backhoe). Contractor shall backfill accordingly to proposed grades with structural fill as defined herein.
3. In lieu of structural fill, the contractor may use drainage fill (stone) to assist with backfilling operations in proximity to the dewatered level of the groundwater. Drainage fill shall be placed in maximum 12-inch thick lifts and compacted with appropriate equipment to achieve densification. A property designed geosynthetic filter fabric (Mirafi 140N or equivalent) shall be placed on the top and sides of the drainage fill to serve as a means of preventing migration of overlying soil fill into the drainage fill layer.
4. The contractor shall proofroll the bottom of the excavation prior to placement of structural fill or drainage stone or excavate in a manner so as to obtain a firm and unyielding condition of the surface of the sand and gravel with excavation techniques which minimize disturbance. The excavation subgrade shall be observed and approved by the Owner's Geotechnical Engineer prior to the placement of any structural fill or drainage fill material. The excavation shall be maintained in a dewatered condition such that observation of the surface of the excavation and subsequent backfilling can be accomplished in a relatively dry condition. Should soft or yielding conditions be observed, the contractor shall remove and replace this material with approved suitable compacted material. If alternative drainage fill material is to be utilized by the contractor based on particular circumstances, the proposed material shall be submitted to the Owner's Geotechnical Engineer for review and approval.

B. General

1. Excavation work shall include removal and disposal of all materials encountered regardless of the nature of the materials and shall be understood to include but not limited to rock, boulders, earth, hardpan, fill, structures, utilities, pavements, curbs, piping and debris, and others. Re-use of existing fill material shall only be permitted if the material meets the requirements for structural fill.
2. All excavation shall extend to the dimensions and elevations required for the installation of the work described herein and as indicated on the Drawings. Excavation shall be made to a depth that will allow installation of full depth of concrete slabs, and sub-base as shown on the Drawings and within a 1 inch tolerance. Excavation lines shall provide sufficient clearance for the proper execution of all concrete work, including allowances for form work, shoring and inspection.
3. Materials that in the opinion of the Owner's Geotechnical Engineer are not suitable for fill and any surplus earth shall be removed from the site and legally disposed off-site.
4. Existing utility lines to be retained that are shown on the drawings or the locations of which are made known to the Contractor prior to excavation operations, shall be protected from damage during excavation and backfilling, and if damaged, shall be repaired by the Contractor, at own expense.

C. Excavation for Foundations

1. Foundation subgrades shall be inspected and approved by the Owner's Geotechnical Engineer before proceeding with the construction of foundations. Bottoms of footings shall be founded on the natural sand, structural fill or fill improved via heavy surface compaction.
2. Subgrade of foundations shall be level and free of loose soil, debris, standing water and frost prior to acceptance for placing concrete. A Geotechnical Engineer shall inspect and approve the foundation subgrade to verify that the subgrade material is adequate to provide the recommended allowable bearing pressure.
3. Unauthorized Excavation: When suitable bearing material is encountered at subgrade elevations shown on Drawings and excavation is made to greater depth, the foundations and foundation walls shall be extended to the lower elevation with concrete of the same strength used for the foundations, at no additional cost to the Owner.

D. Subgrade Preparation

1. Natural undisturbed material shall be graded and compacted to attain a uniform surface. These areas shall be determined by the Owner's Geotechnical Engineer.
2. Prior to constructing foundations, slabs, utilities, utility structures, and paved/hardscape areas, the subgrade shall be proofrolled in the presence of the Owner's Geotechnical Engineer for the following conditions:
 - a. Natural soil foundation subgrades shall be proofrolled with a minimum of six passes of a 1-ton roller.
 - b. Existing fill soil foundation subgrades shall be proofrolled with a minimum of six passes of a 10-ton roller.
 - c. Slab subgrades shall be proofrolled with a minimum of six passes of a 10-ton roller.
 - d. Foundation elements shall not be placed until the subgrade is approved by the Owner's Geotechnical Engineer. All structural fill footing subgrades shall be tested to confirm the top lift of the footing subgrade is compacted to the project specified requirement for structural fill material.
 - e. Soft Areas during Compaction: If any areas show pumping, noticeable weaving, or which are otherwise unsatisfactory, undercut material to competent material within the limits and extent suggested by the Owner's Geotechnical Engineer. These areas shall be replaced with either concrete of the same strength used for the foundation or structural fill, compacted to 95% of maximum dry density by ASTM D1557. The appropriate water content at the time of compaction should be plus or minus 2 percentage points of optimum moisture content as determined by the laboratory compaction test aforementioned, unless otherwise directed by the Engineer of Record. If structural fill is utilized, the excavation shall be oversized to include the zone of influence (1H:1V) beneath and beyond the footing and footing level.
 - f. Subgrades should be excavated level and if any cobbles or boulders are encountered at the footing subgrade level such that a relatively level subgrade is not achieved, the cobbles or boulders should be removed and replaced with compacted structural fill or compacted crushed stone.

- g. Consideration should be given to protecting the subgrades after excavation utilizing either clean, crushed, durable, compacted $\frac{3}{4}$ inch stone, or a mud mat.

E. Excavation for General Grading:

1. Excavations made below the elevations shown or specified, unless authorized by Change Order, shall be filled and compacted as hereinafter specified, at no additional cost.

F. Trench Excavation:

1. Unless otherwise shown or specified, make trenches for piping and utilities not less than 16 inches or more than 24 inches wider than the outside width of the piping or utilities. Accurately grade bottoms of trenches with bell holes scooped out to provide uniform bearing and support of pipe and utilities on undisturbed soil throughout its entire length, except where other means of supporting pipe are indicated.
2. Trenches for underground conduit and piping, where necessary, shall be excavated to the required depth and bell holes shall be provided where necessary to insure uniform bearing. Trench excavation lines shall provide sufficient clearance for the proper execution of underground mechanical work.
3. Trenches shall be by open cut from the surface. No tunneling will be allowed except by consent of the Owner's Geotechnical Engineer. Irregularities at bottom of trench, or where excavation is below required depth, shall be refilled to required grade with compacted granular fill.
4. Pipe trenches shall be excavated and minimum cover shall be provided to required depths as per the Connecticut State Building Code. Excavated materials adjacent to trench as directed shall be neatly banked.
5. Where trenches are in wet or soft ground that in the opinion of the Owner's Geotechnical Engineer is unsuitable for supporting the piping, concrete cradles or approved equivalent shall be installed.
6. Where necessary, the sides of trenches and excavations shall be supported by adequate sheeting and bracing and conform with applicable OSHA regulations to insure proper construction and safety of the workers. The Contractor will be held responsible for the sufficiency of sheeting and bracing and for all damages to property or injury to persons resulting from improper quality, strength, placing, maintaining and removing of same.
7. Prior to utility installation, soil subgrades in the utility trenches should be proofrolled as specified herein. Pipe bedding should be placed and compacted in accordance with the pipe manufacturer's requirements or as indicated in the Drawings, whichever is more stringent.
8. Immediately after piping has been installed, tested, inspected, and accepted, piping shall be filled around with special care to solidly fill voids without causing injury to piping. Up to two feet above the pipe's crown, the utility excavation shall be backfilled using structural fill placed in 4-inch thick loose lifts. For the remainder of trench backfill, the excavation shall be backfilled using structural fill placed in 12-inch thick loose lifts. Each layer shall be compacted before placing the next layer. Backfill shall be in such a manner so as to prevent future settlement.

3.4 FILLING AND COMPACTING

A. General

1. Do not commence filling and backfilling operations until construction below finish grade has been approved, underground utilities and mechanical items inspected and tested, forms removed, waterproofing or damproofing and other improvements installed, trash and debris removed, and temporary and permanent bracing installed.
2. Do not commence backfilling, filling and grading until existing subgrade has been compacted to 95% of the material's maximum dry density as determined by the Modified Proctor Compaction Test (ASTM D1557).
3. Fill all excavations, backfill against all walls, and do all filling and grading necessary to bring the surfaces to the level required.
4. No fill material shall be placed on areas where free water is standing, or frozen subsoil area, or on surface which have not been approved for fill placement by the Owner's Geotechnical Engineer.
5. Do not backfill against concrete elements until the concrete has obtained its specified compressive strength.
6. Perform backfilling around foundation walls when the first floor provides sufficient bracing to withstand the backfill pressure. All other fill, backfill, and rolling to approximately finished grades shall then be completed.
7. Take particular care when rolling over areas where trenches or other excavations have been made and backfilled.
8. Grade bottoms of pavements and area way bottoms toward sediment pits or catch basins to maintain uniform thickness of the slabs.

B. Grading

1. Prior to placing fill or backfill in any area, grading is to be performed as required to provide for drainage. Ditching or filling around the area will be performed to intercept or divert all surface water. Within the area the ground which fill is to be placed will be graded so as to provide for unobstructed drainage from every point to a sump or other disposal point.
2. On completion of grading as specified above, closely examine to determine whether excessive wetness, springs, or other seepage of water can be observed at any point. If such conditions exist, positive drainage in suitable form, such as french drains or tilling, must be provided before placement of fill is undertaken.

C. Placement and Compaction of Controlled Fill and Backfill

1. Placement

- a. Begin fill and backfilling in the lowest section of the area. Spread material evenly by mechanical equipment or by manual means above the approved compacted subgrade in lifts not exceeding 10 to 12 inches for material compacted by heavy machinery and 4 inches for material compacted by hand tamping. Build layers as horizontally as practical to prevent thickness of lift from exceeding that specified but provide with sufficient longitudinal and transverse slope to provide for runoff of surface water from every point.

- b. Moisture Control: The moisture-density curve for the fill use shall be supplied to the Contractor as a guide in controlling moisture to achieve the required degree of compaction. If, in the opinion of the Owner's Geotechnical Engineer, fill material becomes too wet for the required compaction, the fill shall be dried by a method approved by the Owner's Geotechnical Engineer prior to commencing or continuing compaction operations. Likewise, if, in the opinion of the Owner's Geotechnical Engineer, the fill material becomes too dry for the required compaction, the fill shall be moistened by a method approved by the Owner's Geotechnical Engineer prior to commencing or continuing compaction operations. The water content at the time of compaction should be within 2% points of the optimum water content.
2. Compaction: Compact each lift to 95% of the maximum dry laboratory density by ASTM D1557. The degree of compaction shall be checked by the Owner's Geotechnical Engineer and each successive lift shall not be placed or compacted until the previous lift is inspected and approved by the Owner's Geotechnical Engineer. Compact the fill and backfill to elevations and limits shown on Drawings and is subject to final inspection and approval by the Owner's Geotechnical Engineer.
3. Drainage During Fill Operation: At all times, maintain and operate proper and adequate surface and subsurface drainage to the satisfaction of the Owner's Geotechnical Engineer 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.
4. Frost: Do not place fill materials when either the fill materials or the previous lift (or subgrade) on which it is placed is frozen. In the event that any fill which has already been placed on the surface shall become frozen, it shall be scarified and re-compacted, or removed, to the approval of the Owner's Geotechnical Engineer before the next lift is placed. Remove or re-compact any soft spots resulting from frost to the satisfaction of the Engineer before new fill is placed.

3.5 MAINTENANCE

- A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
- B. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.
- C. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.
- D. Settling: Where settling is measurable or observable at excavated areas, remove surface (pavement, lawn, or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.6 QUALITY CONTROL AND INSPECTION

- A. The Owner will employ, at his own expense, a Geotechnical Engineer to review all laboratory test results and submitted reports specified in this Section.
- B. The Owner's Geotechnical Engineer will interpret the tests, state in each report whether or not the test specimens and results comply with all requirements of the Contract Documents and note any deviations.
- C. The Owner's Geotechnical Engineer will determine the conformance of materials to be used for fills.
- D. Field Inspection:
 - 1. Foundation Subgrades: Foundation subgrades shall be inspected by Owner's Geotechnical Engineer to verify the design bearing capacities. The bottom of excavation prior to placement of structural fill shall be observed and approved by the Owner's Geotechnical Engineer prior to placement of structural fill. No foundation shall be constructed unless the Owner's Geotechnical Engineer approves the subgrade.
 - 2. Proofrolling: Proofrolling where required shall be inspected by Owner's Geotechnical Engineer.
 - 3. Paved Area and Building Slab Subgrades: Owner's Geotechnical Engineer shall inspect subgrades for paved areas and building slabs. No pavement or slab shall be constructed unless the subgrade approved by the Owner's Geotechnical Engineer.
 - 4. Backfilling and Compaction: Backfilling and compaction below paved areas, building slabs, behind the foundation walls, and any other backfilling and compaction work shall be inspected by the Owner's Geotechnical Engineer. No fill shall be placed unless the previous lift is approved by the Owner's Geotechnical Engineer. Owner's Geotechnical Engineer will take field density tests of the subgrade for every 2,500 sq- ft. but not less than 3 tests in each compacted fill layer. All footing subgrades within structural fill shall have field density tests. Perform field density tests in accordance with ASTM D2922.
- E. Contractor shall cooperate with the Owner's Geotechnical Engineer in the performance of the required tests.

3.7 DISPOSAL OF EXCAVATED MATERIALS

- A. Legally dispose the excavated material to an off-site disposal facility, in accordance with all Local, State, and Federal Environmental regulations.

3.8 ERRORS IN DEPTH

- A. In the event that any part of the excavation is carried, through error, beyond the depth and the dimensions indicated on the drawings of called for in the specifications, then the Contractor, at his own expense, shall furnish and install gravel or stone with which to fill to the required level, in all locations except beneath footings and piers. At these locations, Contractor shall be required to fill to level of bottom footing with concrete mixed in the proportion of the

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foundations bearing on them. Where established bottoms as shown on drawings have not been maintained or have been disturbed by operations under this contract, they shall be cleaned out and filled with concrete mixed in the proportion of the footings bearing upon them, without additional cost to the Owner.

END OF SECTION 310800

SECTION 310913 – MONITORING OF EXISTING STRUCTURES AND UTILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Earthwork – Section 310800
- B. Construction Drawings & Documents

1.2 SUMMARY

- A. Work Included: The Work of this Section includes, but is not limited to the following:
 - 1. All labor, equipment, and materials to execute the work of this Section as specified herein during earthwork and foundation construction activities.
 - 2. Collection, cataloging, and compilation of the observed conditions of existing on-site structures to remain and adjacent off-site structures.
 - 3. Monitoring of the existing structures to remain throughout construction.
 - 4. Furnish and install optical survey targets, surveying marks, benchmarks and settlement monitoring points as required and as outlined herein.
 - 5. Furnish all equipment and labor to provide continuous vibration monitoring within adjacent buildings and structures.
 - 6. Provide all surveying services required for performing optical survey monitoring as outlined herein.
 - 7. Provide all labor necessary for the periodic measurement of any installed crack gauges installed under this Section.
 - 8. Compilation, interpretation, and transmittal of monitoring data to the Construction Manager, Owner and others during construction.
 - 9. Provide all other labor, equipment, and materials as can reasonably be inferred to make the work of this Section complete.

1.3 QUALITY CONTROL

- A. The Contractor shall retain the services of a Land Surveyor, licensed in the State of Connecticut, to perform all survey monitoring during construction. The Contractor's surveyor shall have at least three years of professional experience or as approved by the Owner's Engineer.
- B. The Contractor shall retain a Professional Engineer, licensed in the State of Connecticut, to perform all other monitoring including measurement of vibration and movement of structures and the ground. The Contractor's Professional Engineer shall have at least five years of professional experience working under similar circumstances, or as approved by the Owner's Engineer.

1.4 SUBMITTALS

- A. Unless otherwise indicated, transmit all submittals to the Construction Manager for review by the Owner's Engineers before proceeding with ordering, fabricating, or any other work of this Section.
- B. Submit product cut-sheets and calibration data and identify the allowable tolerances of all proposed equipment.
- C. The Contractor shall submit resumes for all personnel performing the work of this Section.
- D. Submit example weekly monitoring report and data sheets showing typical presentation of seismograph and crack gauge monitoring data.
- E. Submit sample survey monitoring report.
- F. Submit the results of a Pre-Construction Documentation Report. Documentation will include applicable plans, sketches, notes, and photographs logging the conditions of the existing on-site structures to remain and adjacent off-site structures.
- G. Submit plan showing location of all instruments installed to document movement during construction activities.
- H. Monitoring Plans:
 - 1. The Contractor shall submit drawings showing the plan and vertical locations of all proposed monitoring points. The plan shall graphically identify the type of monitoring point (i.e. optical survey, surface points, seismographs, crack gages, borehole instruments, benchmarks, etc), with each monitoring point bearing a unique identification number. Where required, provide section drawings (i.e. excavation faces, building facades, etc) and identify the elevations (NAVD88 datum) at which monitoring points have been or will be installed.
 - 2. The drawings shall be updated and resubmitted in the event that monitoring points are abandoned, relocated or additional monitoring points are added.
 - 3. The Contractor shall submit a plan, and associated action levels, to monitor existing on-site utilities to remain throughout construction.
- I. Submit all monitoring data directly to the Construction Manager for distribution to the Owner's Architect and Engineers. Measurement data shall be submitted within 24 hours of taking each reading. All data shall be transmitted in electronic format suitable to the Owner's Architect and Engineers. Transmitted data shall show all cumulative measurements recorded as a function of time. Requisite notes shall be included to document construction activities performed during the monitoring increment. The Contractor shall clearly identify any exceedances or trends that could lead to an exceedance, as soon as one is identified.
- J. Submit weekly summary report to the Construction Manager for distribution to the Owner's Architect, Engineers, and others as required.

1.5 SCHEDULING OF WORK

- A. Obtain all necessary permits and access agreements necessary prior to performance of the work.
- B. Crack gauges shall be installed following the performance of the Pre-Construction Conditions Documentation.
- C. Seismographs shall be installed following the performance of the Pre-Construction Conditions Documentation. Seismographs shall be installed to allow for sufficient time (minimum one week) to evaluate background vibration levels resulting from ambient activities prior to construction.
- D. Additional crack gauges or seismographs shall be installed as required by demolition, earthwork, and foundation construction activities.
- E. Survey targets, benchmarks, and settlement monitoring points shall be installed at least 7 days prior to commencing with demolition, earthwork, and foundation construction.
- F. Additional monitoring points shall be established as required during construction.

1.6 MONITORING

- A. Monitoring shall include construction vibrations, strain gauges and periodic measurement of existing cracks. Monitoring shall be performed prior to and during demolition, adjacent earthwork, and foundation construction to evaluate the performance of the Contractor's activities.
- B. The field locations of seismographs and strain gauges shall be coordinated with the Owner and the Owner's Engineers.
- C. The Contractor shall be responsible for all maintenance of equipment as required to maintain monitoring on a continuous basis throughout the duration of construction activities on-site.
- D. Monitoring data shall be transmitted to the Construction Manager for distribution to Owner, and the Owner's Architect and Engineers.

1.7 SURVEY MONITORING

- A. Survey monitoring shall include installation of survey monitoring points and periodic measurement of horizontal and vertical movements at existing structures within and adjacent to the project site.

1.8 ADDITIONS

- A. The Contractor may elect to provide additional types of monitoring not specifically outlined herein, but shall at a minimum conform to the requirements of this Section. Where additional

types of monitoring are proposed, the Contractor shall inform the Construction Manager in writing, and shall provide all information as requested by the Construction Manager and the Owner's Architect and Engineers.

- B. The Contractor shall be solely responsible for all means and methods not specifically addressed herein.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Contractor shall submit all details and other supporting data for materials proposed for use in performing the work of this Section.
 - 1. Optical Survey Targets: Survey targets shall consist of self-adhesive reflective sheet targets suitable for adherence to wood, steel, brick, concrete, etc.
 - 2. Surface Marker 1 (SM1): A ¼-inch by 2-inch PK nails set in paved streets or sidewalks with a 1-½" diameter hub identification tag (or approved equal).
 - 3. Surface Marker 2 (SM 2): Scribe surface of monitoring point as required to maintain permanent demarcation of the location. Scribed locations shall be identified on all drawings.

2.2 EQUIPMENT

- A. Seismographs: Blastmate Series III portable seismograph as manufactured by Instatel Inc. or approved equal. Seismographs shall include a cellular modem (Verizon) or other means to allow for continuous real-time monitoring and alert via email and internet. Geophones and cases shall be affixed to the bench walls by means of concrete anchor bolts as manufactured by Hilti, Redhead, or equal.
- B. Crack Gages: Grid crack cages shall be as manufactured by Avongard Products (USA) Ltd., or approved equal. Anchors, bolts, screws and quick setting epoxy shall be as provided by Avongard Products or approved equal. A minimum of 20 gauges shall be procured prior to execution of Pre-construction Conditions Documentation.
- C. Optical Survey Equipment: Optical surveying equipment shall be suitable for achieving the following accuracies and repeatability:
 - 1. Vertical: at least plus or minus 0.005 ft
 - 2. Horizontal: at least plus or minus 0.005 ft

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Install monitoring systems prior to commencing demolition, earthwork, and foundation construction. Where employed, monitoring websites for data transmittal and alarm notifications must be active a minimum of one week prior to construction.
- B. Install all equipment in accordance with manufacturer's recommendations.
- C. Submit drawings showing the as-built locations for all monitoring points installed, listing unique identifiers for each point and the type of monitoring.
- D. Install additional monitoring points as required as the work progresses. Replace all locations, lost, damaged or vandalized.

3.2 INSTALLATION OF CRACK GAUGES

- A. Installation shall be in accordance with the manufacturer's recommendations.
- B. Write ID # on gauge with permanent marker.
- C. After completion of installation, check that gauge parts are free to move over each other by passing a feeler gauge or thin plastic card between the two sections.
- D. After completion of installation, the as-built location and initial movement (if any) shall be recorded.
- E. Photograph crack gauge following installation and all subsequent readings.

3.3 SEISMOGRAPHS

- A. Installation shall be in accordance with the manufacturer's recommendations.
- B. Seismographs shall be firmly mounted to the ground surface or structures. Where seismographs are placed on undisturbed soil, geophones shall be set with spikes as supplied by the manufacturer and shall be ballasted with sand bags having a minimum weight of 30 pounds.

3.4 MONITORING LOCATIONS

- A. The minimum number of locations and approximate orientation of all monitoring points shall be as outlined below:
 - 1. Existing On-site Structure to Remain:

- a. A seismograph shall be installed at grade on each side of the structure where demolition and new construction work are performed.
- b. Crack Gauges: Monitoring points shall be installed at cracks observed during execution of Pre-construction Conditions Documentation and as required as the work progresses, as determined by the Contractor and as directed the Construction Manager and Owner's Consultants.
- c. Survey Targets or Survey Marks (SM1, SM2): Monitoring locations shall be evenly spaced at 50 ft centers at the base of the structure facing the proposed construction and demolition work, unless otherwise necessary to determine movement in critical areas such as cracked facades, etc.

3.5 BASELINE MEASUREMENTS

- A. Baseline measurements for all monitoring shall be established a minimum of 7 days prior to execution of construction activities on-site.
- B. Establishment of trigger values for vibration monitoring shall consider background vibration levels. Background levels shall be recorded prior to commencing construction activities to determine ambient levels of vibration resulting from rail operations. Trigger values for seismographs shall be maintained at 0.2 inches per sec above that of the peak background levels recorded or 0.5 inches per second (whichever is lower).

3.6 FREQUENCY OF MONITORING

- A. At a minimum, survey monitoring of structures shall be performed monthly. The frequency of monitoring shall be increased or decreased as directed by the Construction Manager and the Owner's Consultants pending the results of recorded monitoring data trends. Survey monitoring shall be performed on the indicated structures before and during demolition, adjacent earthwork, and foundation construction.
- B. At a minimum, crack gauges shall be measured monthly. The frequency of monitoring shall be increased as directed by the Construction Manager, the Owner's Consultants or Owner. Crack gauges shall be measured on the indicated structures before and during demolition, adjacent earthwork, and foundation construction. Crack gauges shall remain in place (and not monitored) until the overall construction of the proposed school is completed. One final measurement shall be collected before removing the crack gauges.
- C. Vibration Monitoring shall be performed on a continuous basis (24/7). The Contractor shall be responsible for evaluating and reporting exceedances of this data in real-time. Vibration monitoring shall be performed on the indicated structures before and during demolition, adjacent earthwork, and foundation construction.

3.7 MONITORING REPORT, DATA FORMAT AND TRANSMITTAL

- A. Weekly monitoring reports shall be prepared and submitted to the Construction Manager, Owner and Owner's Engineers that includes a summary of the measurements for that week,

cumulative total movements, observed trends, changes in the monitoring program and any monitoring points that exceeded the trigger levels. The report shall correlate any observed trends in movement or trigger levels with weather and construction activities.

- B. Data shall be transmitted in an electronic format (MS Excel) and shall include all cumulative readings taken. Data shall include baseline values, offset measurements. Provide coordinates for readings. Include movement trend plots identifying any exceedances or trends that could lead to exceedances. Include the following information for all readings:
 - 1. Instrument Type
 - 2. Date and time of readings
 - 3. Name of observer
 - 4. Monitoring Point ID #
 - 5. Readings, both total and cumulative where appropriate
 - 6. Weather condition and temperature
 - 7. Remark of any visual observations of conditions, construction activities
 - 8. Work performed on-site
- C. Transmit all data to the Construction Manager for distribution to the Owner's Architect and Engineers within 2 days of taking measurements.
- D. The Contractor shall alert Construction Manager and the Owner's Engineers immediately in the event that values exceed review levels specified herein. Such notification shall be made by email and in writing.
- E. Additional reports shall be prepared as directed by the Owner's Engineers in the event that exceedances occur.

3.8 REVIEW AND LIMIT VALUES

- A. The following criteria shall be used to evaluate the necessity for modifying or ceasing construction activities. Where a work stoppage is required, construction activities shall not continue until adequate measures are in place to ensure stability of adjacent structures, excavation support, or utilities. Where movements in excess of the Review level are detected, the frequency of data collection shall be increased to once daily, or as directed by the Construction Manager or Owners Consultants. The criteria provided shall not relieve the Contractor of any responsibility with respect to damage incurred by any structures or utilities.
 - 1. Vibration Monitoring: Peak particle velocities
 - a. Review Level – 0.5-inches per second (ips) or 0.2 ips + background level.
 - b. Limit Level – 2 inches per second
 - 2. Crack Gauge Monitoring: Cumulative movement in any direction
 - a. Review Level – 1/16th inch in any direction
 - b. Limit Level – 1/8th inch in any direction

3. Survey Monitoring:
 - a. Review Level:
 - i) Vertical movement of buildings or other structures: 3/8-inch total movement or 3/16-inch between two consecutive readings.
 - ii) Horizontal movement of building or other surface structures: 3/16-inch total movement or 1/8-inch between two consecutive readings
 - b. Limit Level:
 - i) Vertical movement of buildings or other structures: 1/2-inch total movement or 1/4 -inch between two consecutive readings
 - ii) Horizontal movement of building or other surface structures: 1/4-inch total movement, or 3/16-inch between two consecutive readings

3.9 ACTION ITEMS

- A. Any movement exceeding the criteria outlined above shall be reported immediately to the Construction Manager, the Owner and the Owner's Consultants. Work in the immediate area shall be suspended, unless directed otherwise by the Owner's Engineers. Corrective measures to ensure integrity and stability of adjacent structures shall be the responsibility of the Contractor.
- B. In the event that a Review Level is reached the following shall be required:
 1. Contractor shall meet with the Owner and Owner's Consultants to discuss the need for a response to mitigate the potential for readings exceeding the Review Level.
 2. Where required, submit a detailed plan of action to mitigate the potential for additional movement or vibration.
 3. Install additional instruments as required evaluate the need for any action necessary to prevent reaching the Limit Level.
- C. In the event of an Limit Level for is reached the following shall be required:
 1. Foundation construction, support of excavation system installation, or ground improvement work shall be suspended and the structures shall be inspected by the Owner, Owner's Consultants and the Contractor's Engineer.
 2. The Contractor shall take all actions necessary to protect structures and utilities and maintain integrity and stability of said structures and utilities. The Contractor shall be solely responsible for providing all necessary services in conjunction with developing and applying remedial measures including any required engineering design.
 3. Should vibration levels exceed the Limit Level, construction activities shall be suspended. The adjacent structures shall be visually inspected, and construction methods modified as necessary to maintain vibrations within acceptable levels.

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3.10 DECOMMISSIONING

- A. Upon notice from the Owner or Construction Manager, the Contractor shall remove all instruments installed and shall repair any resulting damage.

END OF SECTION 310913

SECTION 312316 – EARTHWORK (SITE)

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General and Supplementary Conditions, and Division One General Requirements apply to the work specified in this section.
- B. Form 816 shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816-2004 or its latest edition and any supplemental specifications.

1.02 SUMMARY

- A. This Section includes the following: All site excavating, not included under other sections, required for grading, trenching, paving, curbs, or any other subsurface structures. All earthwork related to the building/foundations shall be in accordance with specification 310800 Earthwork (Building) and the Geotechnical Report. The Contractor shall place, compact and dispose of excess excavated materials in accordance with the plans, specifications and directions of the Engineer.
 - 1. Unclassified Excavation shall include the removal of existing pavements, curbs, earth, boulders, buried timber, broken concrete pieces, existing foundations (e.g. concrete block), brick and other materials of any nature that may be encountered.
 - 2. The Contractor shall construct and place fill and backfill material in accordance with this specification.
 - 3. The Contractor shall saw cut existing pavements and/or saw cut existing curbs in accordance with the plans, specifications and direction of the Engineer.
- B. Implement practices and procedures to meet the project's environmental goals, which include complying with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- C. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, June 2017.

1.03 RELATED SECTIONS

- A. Section 018113 - Volatile Organic Compound Limits
- B. Section 310800 – Earthwork (Building)

1.04 DEFINITIONS

- A. “Suitable Material” or “Acceptable Material”
 - 1. ASTM D 2487 soil classification groups GW, GP, GM, SW, SP, and SM; free of rock or gravel larger than 6 inches in any dimension, debris, waste, frozen material, vegetation and other deleterious material.
 - 2. Any mineral (inorganic) soil, blasted or broken rock and similar materials of natural or man made origin, including mixtures thereof, are considered acceptable materials.
- B. “Unacceptable Material” - ASTM D 2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH and PT.

1.05 QUALITY ASSURANCE

- A. Material Standards: As defined in Form 816 inclusive of all supplements.
- B. Testing: Compaction tests may be required by the Owner and will be paid for by the Owner. No specific testing schedule has been established at this time. If tests indicate that density requirements have not been achieved, the Contractor shall continue compacting. All re-testing in unsatisfactory areas shall be paid for by the Contractor.
- C. Density and Compaction Testing: The Contractor is responsible to schedule compaction tests as required by the Owner and to allow adequate time for the proper execution of said tests.

1.06 PROTECTION

- A. Dust Control: Use all means necessary to control dust on and near the construction areas caused by the Contractor's performance of the work in conformance with Form 816.

1.07 PROJECT CONDITIONS

- A. West Nile Virus Precautions: To stem the spread of West Nile Virus, the Contractor shall closely monitor the work of this section to prevent water from collecting and/or ponding within or adjacent to the work for any length of time, thereby reducing the opportunities for mosquitoes to breed.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Backfill, Fill and Embankment Materials: Any acceptable material in accordance with the Geotechnical Report. Onsite material may need to be modified/supplemented in order to be accepted for reuse. Contractor shall submit a sample of onsite material to be reused for approval.
- B. Subbase Material: Conform to Form 816, Section M.02.02 - Subbase.
- C. Processed Aggregate Base: Conform to Form 816, Section M.05.01.

- D. Bedding Material: Sand or sandy soil, all of which passes a 3/8" sieve, and not more than ten percent (10%) passes a No. 200 sieve.
- E. Tank Backfill and Bedding & Pipe Bedding: All backfill material for underground tanks and for piping shall conform to ASTM C-33 paragraph 9.1 for quality and soundness. This material shall consist of washed pea gravel ranging from 1/8-inch to 3/4-inch in diameter, or washed stone crushings between 1/8-inch and 1/2-inch in diameter or a material which has been approved by the tank or pipe manufacturer. Not more than 3 percent of the aggregate shall pass a No. 8 sieve.
- F. Gravel Backfill: Well graded gravel conforming to Form 816, M.02.01 except, M.02.06 Grading C, not Grading A, shall be provided. Use bank run gravel backfill for all excavations where indicated on the plans or wherever specified.

2.02 BORROW SOIL FILL

- A. Conform to Form 816 Section 2.07 "Borrow".

2.03 WARNING TAPE

- A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, minimum 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:
 - 1. Red: Electric.
 - 2. Yellow: Gas, oil, steam, and dangerous materials.
 - 3. Orange: Telephone and other communications.
 - 4. Blue: Water systems.
 - 5. Green: Sewer systems.

PART 3 EXECUTION

3.01 GENERAL

- A. The entire area of work shall be brought to the required lines and grades by excavation and filling. Excavated materials, acceptable in the opinion of the Engineer, shall be used in making embankments and filling the low areas of the work, and at such places as the Engineer may direct.
- B. Excavate to the limits shown on the Drawings to subgrade level. Compact subgrade level before placing fill, base or subbase materials.
- C. Construct base course to required depths and elevations below all concrete pads, foundations and bituminous concrete.
- D. Construct bedding course below all drainage and utility structures.

- E. Place suitable/ acceptable material below all lawn and landscaped areas. No rocks larger than 2 inches in any dimension shall be placed within 4 inches of the finished grade.

3.02 COMPACTION REQUIREMENTS

- A. Compact soil to not less than the following percentages of maximum dry density according to ASTM 1557:
 - 1. Under foundations, concrete pads, and pavements, compact the top 12 inches below subgrade and each layer of backfill or fill material at 95 percent maximum dry density.
 - 2. Under lawn or unpaved areas: see Section 329113 - Topsoil.

3.03 EXCAVATION

- A. Protect Structures, utilities, sidewalks, pavements and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations. Any damage to existing structures or utilities that occurs as a result of the Contractor's operations shall be corrected by the Contractor at no additional cost to the Project.
- B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.
- C. Provide erosion and control measures to prevent erosion or displacement of soils and discharge of soil-bearing water run-off or airborne dust to adjacent properties and watercourses, in accordance with the Sediment and Erosion Control Plan, details and as directed by the Engineer.
- D. Subgrade: All soft, boggy, clayey or other objectionable material below the proposed subgrade elevation shall be removed, and the area refilled with acceptable material.
- E. Boulders: The Contractor shall remove all boulders, stone or pieces of concrete, lumber, iron or other material that project above subgrade. Any stone larger than two (2) cubic feet in volume shall not be placed within two (2) feet of the finished surface.
- F. Excavating for Foundations: All excavations shall be cut accurately to required lines and dimensions for work on drawings and shall be large enough to provide adequate clearance for the proper execution of the work. See Specification 310800 Earthwork (Building) for additional information.
- G. Bottoms of Excavations: Level the bottoms of all excavations, to receive footings or other work supported on soil, accurately, to the lines and levels shown on the plans or as directed by the Engineer.

Where excavation for a foundation has been carried below the indicated level by error, fill the space between the incorrect and required depth with concrete at no additional cost to the Owner.

- H. Storage and Placement: All those excavated materials which in the opinion of the Engineer are suitable for backfill shall be stored or placed within the limits of the Contract, where directed by the Engineer.
- I. Surplus: All surplus materials and materials not suitable for backfill shall be placed within the site as directed by the Engineer. No additional payment will be made for this, but the cost thereof shall be deemed included in the price bid.
- J. Shoring: Wherever necessary to maintain the banks of excavation in a safe and stable condition, the Contractor shall furnish and install temporary sheet piling or planks, braces and shores of good sound timber of adequate strength, and shall remove such piling or shoring as the foundation work progresses.

Sheeting and bracing of a type approved by the Engineer, shall be installed when the Contractor's employees are required to enter into excavations which exceed four (4) feet in depth.

The foregoing shall include the construction and removal of sheeting and bracing, the excavation and maintenance of temporary ditches, and the furnishing and operation of pumps or other appliances needed to properly drain the work. No direct compensation will be made for this work, but payment therefore shall be deemed included in the price bid.

- K. Inspection: When the excavations have been carried to the required depth as shown on the drawings, the Contractor shall do no more work until after inspection by the Engineer, who shall order the foundation or other work to proceed, or further excavation, as the conditions indicate and no foundation or other work shall be done until the excavations have been approved by the Engineer.
- L. Bailing and Draining: The Contractor shall furnish all materials, appliances and labor required to keep the site of the work free from water, ice and snow during construction.
- M. Utilities and Services: When any sewer, water, gas, electric or other utility service connections are encountered in the excavation operations, the service shall not be interrupted or disturbed by the Contractor unless called for on the plans and/or directed by the Engineer. It is the Contractor's responsibility to detect and protect existing utilities (to remain) from damage during construction. The Contractor shall locate buried utilities, to the best of his ability, using electronic probes, or other methods, prior to the start of excavation. The Contractor shall then proceed cautiously and perform hand excavation, as necessary, to protect the utility as directed by the Engineer, at no extra cost to the Owner. If a utility is inadvertently damaged, it is the Contractor's responsibility to restore that utility to operating condition, equal to that existing prior to damage. The Contractor shall remain at the site with the damaged utility until it has been restored and there is no danger to the public (i.e. exposed live electrical wires, etc.).

Should the Contractor need to cut off utilities or services during the performances of the work, he shall notify the City Department or Utility Company owning or controlling services, to cut off these services. It is the Contractor's responsibility to provide sufficient advance notice to the

Utility Company so that work not be delayed. The cost of any such delay in work shall be solely borne by the Contractor.

Any services cut off or interrupted by the Contractor's operations shall be restored at the Contractor's expense.

3.04 FILL

- A. Remove all vegetation, topsoil, debris, wet and unsatisfactory soil materials, obstructions, and deleterious materials from the ground surface prior to placing fills. Unsuitable subgrade material as determined by the Engineer may be removed in accordance with Section 3.3 D of this Specification.
- B. Fill and Compacting shall be carried out as directed by the Engineer, and shall be constructed in successive horizontal layers not over 6 inches in depth. It shall be spread by a "Bulldozer", or other acceptable methods, and shall be thoroughly compacted by rolling with a self-propelling roller weighing not less than ten (10) tons and completed to the satisfaction of the Engineer. In places where the character of the material makes the use of this roller impracticable or where drains or other construction may be damaged a lighter one may be substituted, or the area shall be compacted by vibratory tamping, all with the approval, and to the satisfaction of the Engineer.
- C. All hollows and depressions which develop during the process of rolling and compacting shall be filled with acceptable material, and the subgrade shall again be compacted. This process of filling and compacting shall be repeated until no depressions develop.
- D. Plow, strip or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing surface.
- E. When subgrade or existing ground surface to receive fill has a density less than that required for fill, break up ground surface to depth required, pulverize, moisture-condition or aerate soil and recompact to required density.

3.05 BACKFILL

- A. After inspection and approval of excavation which is to be covered by backfill, the excavated voids shall be filled with clean excavated material, puddled and rammed solid every 6" of depth.
- B. After areas and trenches have been excavated and structures constructed therein, the spaces around and above them shall be carefully backfilled with acceptable material per the Geotechnical Report. Backfill shall be placed on both sides of structures to approximately the same elevation at the same time. All backfill shall be thoroughly tamped and rammed in place in layers not over six (6) inches in depth, using rammers of a weight acceptable to the Engineer. If directed by the Engineer, the backfill shall be thoroughly saturated with water as it is placed.

- C. Backfilling around manholes, catch basins and dry wells shall not take place until the mortar has hardened and the possibility of movement is slight. Backfilling shall take place uniformly around all sides of the structure.
- D. When sheeting is being withdrawn, all cavities left thereby shall be filled with acceptable material, tamped in place so as to fill all voids thoroughly. Backfill inside of sheeting shall be placed before sheeting is removed.

3.06 UTILITY TRENCHES

- A. See Section 312333 - Trenching.

3.07 SAW CUTTING

- A. All saw cutting shall be carried out to the full depth of the pavement, curb or concrete walk to be cut. Saw cutting shall be done to accurate, neat and straight lines marked previous to commencement of work. Saw cutting shall be done with approved power saws specifically designed and manufactured for such a purpose. Compressor, backhoe or spade-cutting of the pavement will not be allowed.

END OF SECTION 312316

SECTION 312333 - TRENCHING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General and Supplementary Conditions, and Division One General Requirements apply to the work specified in this section.
- B. Form 817 shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 817 (latest edition and any supplemental specifications).

1.02 SUMMARY

- A. Implement practices and procedures to meet the project's environmental goals, which include complying with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Construction Services / Bureau of School Facilities' High Performance School Construction Bulletin, November 2012.

1.03 DESCRIPTION OF WORK

- A. Work Included: Trenching, sheeting and dewatering as specified herein, and as needed for installation of storm drainage and appurtenances associated with the Work.

1.04 RELATED SECTIONS

- A. Section 018113 - Volatile Organic Compound Limits
- B. Section 312316 - Earthwork
- C. Section 334000 - Storm Drainage

1.05 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work in this Section.
- B. Use equipment adequate in size, capacity, and numbers to accomplish the work of this Section in a timely manner.

- C. Comply with requirements and regulations of utility companies and governmental agencies having jurisdiction.
- D. Refer to Section 312316 - Earthwork for compaction requirements.

1.06 PROJECT CONDITIONS

- A. Contact Call Before You Dig services for Connecticut (1.800.922.4455) to locate under- ground utilities prior to commencing site preparation operations a minimum of 2 days before beginning any work at the site.
- B. West Nile Virus Precautions: To stem the spread of West Nile Virus, the Contractor shall closely monitor the work of this section to prevent water from collecting and/or ponding within or adjacent to the work for any length of time, thereby reducing the opportunities for mosquitoes to breed.

PART 2 PRODUCTS

2.01 EQUIPMENT

- A. As selected by the Contractor.

PART 3 EXECUTION

3.01 PROJECT CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed with the work of this section until unsatisfactory conditions are corrected.
- B. Finish Elevations and Lines:
 - 1. Locate and protect control points during progress of the Work.
 - 2. Preserve permanent reference points during progress of the Work.
 - 3. Do not change or relocate reference points or items of the Work without written approval from the Engineer.

3.02 EXECUTION

- A. Utilities:
 - 1. Unless shown to be removed, protect active utility lines shown on the Drawings or otherwise made known to the Contractor prior to excavating. If damaged, repair or replace at no additional cost to the Owner.
 - 2. If active utility lines are encountered, and are not shown on the Drawings or otherwise made known to the Contractor, promptly take necessary steps to assure that service is not interrupted. Inform Engineer of existing utility line before proceeding.

3. If service is interrupted as a result of work under this Section, immediately restore service by repairing the damaged utility at no additional cost to the Owner.
4. If existing utilities are found to interfere with the permanent facilities being constructed under this Section, immediately notify the Engineer for review and written direction before proceeding with modifications to the work. Do not proceed with permanent relocation of utilities until written direction is received from the Engineer.

B. Protection of Persons and Property:

1. Barricade open holes and depressions occurring as part of the Work, and post warning lights on property adjacent to or with public access to the work.
2. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
3. Protect existing structures, utilities, sidewalks, pavements, fences and other facilities from damage caused by trenching, settlement, lateral movement, washout, and other hazards created by operations under this Section. All existing features affected and/or damaged by the work of this Section shall be brought back to their original conditions at no cost to the Owner.

C. Dewatering:

1. Remove all water, including rain water, encountered during trench and substructure work to an approved location by pumps, drains, and other approved methods.
2. Keep excavations and site construction free from water.

D. Dust Prevention:

1. Use means necessary to prevent dust becoming a nuisance to the public, to neighbors, and to other work being performed on or near the site in conformance with Standard Specifications.

E. Maintain access to the site at all times.

3.03 TRENCHING PROCEDURES

A. Trench Excavation:

1. Construction methods shall conform to Section 206 of Standard Specifications, where applicable.
2. Excavate trenches to uniform widths to provide a working 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.
3. Clearance: 12 inches minimum each side of pipe or conduit.

4. Trench Bottoms: 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 stones and sharp objects to avoid point loading.
 5. Place and compact bedding material on rock or other unyielding bearing surfaces and to fill unauthorized excavations. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- B. Rock in Trench Excavation:
1. Excavation of trench shall be as described in Standard Specifications, Article 203-3.05, under the "Rock Excavation".
- C. Comply with pertinent provisions of Section 312316 - Earthwork.
- D. Provide sheeting and shoring as necessary for protection of the Work and for the safety of personnel.
1. Prior to backfilling, remove all sheeting.
 2. Do not permit sheeting to remain in the trenches except when field conditions or the type of sheeting or methods or construction such as the use of concrete bedding are such as to make removal of sheeting impracticable. In such cases, portions of sheeting may be cut off and remain in the trench as approved by the Owner.
- E. Miscellaneous:
1. Short sections of a trench may be tunneled, subject to approval of the Engineer, if the conductor conduit and backfill can be installed and compacted properly into such tunnel.
 2. Where it becomes necessary to excavate beyond the limits of normal excavation lines in order to remove boulders or other interfering objects, backfill and compact the voids remaining after removal of the objects in accordance with Section 02300 at no additional cost to the Owner.
 - a. If a void is below the subgrade for the utility bedding, use suitable earth materials and compact to a relative density of no less than 95%.
 - b. If a void is in the side of the utility trench of open cut, use suitable earth or sand compacted or consolidated to a relative density of no less than 90%.
 3. Excavating for appurtenances:
 - a. Excavate for dry wells, hydrants and similar structures to a distance sufficient to leave at least 12" clear between outer surfaces and the embankment or shoring that may be used to hold and protect the banks.

- b. Over depth excavation beyond such appurtenances that has not been directed will be considered unauthorized. Fill with sand, gravel, or lean concrete as approved by the Engineer, and at no additional cost to the Owner.
4. Trench to the minimum width necessary for proper installation of the utility, with sides as nearly vertical as possible. Accurately grade the bottom to provide uniform bearing for the utility.
5. Depressions:
 - a. Dig bell holes and depressions for joints after the trench has been graded. Provide uniform bearing for the pipe on prepared bottom of the trench.
 - b. Except where rock is encountered, do not excavate below the depth indicated or specified.
 - c. Where rock is encountered, excavate rock to a minimum over depth of 4" below the trench depth indicated or specified.
- F. Where utility trenching, piping and/or conduit traverses public property and/or is subject to governmental or utility company jurisdiction, provide depth, bedding, cover, and other requirements and/or regulations as set forth by authority having jurisdiction, but in no case shall the depth be less than that shown in the Contract Documents.
- G. Cover:
 1. Provide minimum trench depth indicated below to maintain a minimum cover over the top of the installed item below the finish grade or subgrade:
 - a. Storm drains: 18"
 - b. Sewer pipes: 36"
 - c. Raceways: 30"
 - d. Water pipes: 48"
 - e. Gas: 36"
 2. Where utilities are under a concrete structure slab or pavement, the minimum depth need only be sufficient to completely encase the conduit or pipe sleeve, provided it will not interfere with the structural integrity of the slab or pavement.
 3. Where the minimum cover is not provided, encase the pipes in concrete as indicated on the Drawings. Provide concrete with a minimum 28 day compressive strength of 3000 psi with entrained air 5 to 7 percent. Mechanically consolidate concrete.

3.04 BACKFILLING AND COMPACTION

- A. Excavations shall be backfilled and compacted in accordance with Section 312316.

END OF SECTION 312333

SECTION 312500 - EROSION AND SEDIMENTATION CONTROLS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Division 1 General Requirements and Specific Requirements, apply to this Section.
- B. "Connecticut Guidelines for Soil Erosion and Sediment Control", Connecticut Council on Soil and Water Conservation, May 2002, inclusive of all supplements and/or its latest revision or edition.

1.02 SECTION INCLUDES

- A. Hay bales, filter fabric fence, sediment barriers and sedimentation structures
- B. Temporary mulch
- C. Temporary sediment basins as required by field conditions
- D. Implement practices and procedures to meet the project's environmental goals, which include complying with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- E. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, June 2017.

1.03 RELATED SECTIONS

- A. Section 018113 - Volatile Organic Compound Limits

1.04 QUALITY ASSURANCE

- A. All erosion and sediment control measures will be constructed in accordance with the standards and specifications of the "Connecticut Guidelines for Soil Erosion and Sediment Control".

1.05 PROJECT CONDITIONS

- A. Land disturbance will be kept to a minimum; re-stabilization will be scheduled as soon as possible. Temporary seeding or permanent hydro-seeding should take place immediately upon completion of grading. Permanent seeding will be scheduled during March 15 - June 15: August 15 - October 15.

- B. Erosion and sediment control measures will be installed prior to construction whenever possible and will be maintained in effective condition throughout the construction period.
- C. Hay bale filters will be installed at the base of all proposed slopes and on the downhill side of any area receiving new planting and as instructed by the Engineer.
- D. Additional control measures will be installed during the construction period as required by field conditions or as requested by the Engineer.
- E. Sediment removed from control structures will be disposed of on site in a manner approved by the Engineer.
- F. Mulch all new slopes 3% or greater. Use straw or hay (70-90 lbs. 1,000 sq. ft.), free of weeds or coarse matter. Chemical binder such as Petroset Terratack Hydro Mulch and Aerospray will be used as recommended by manufacturer to anchor mulch. Mulch must be inspected periodically, in particular, after rainstorms to check for rill erosion. Where erosion is severe, repair the eroded area and place additional mulch as required to control the erosion. Grasses shall not be considered established until a ground cover is achieved, which is mature enough to control soil erosion and to survive severe weather conditions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Hay bales:

- 1. Hay bales shall be made of hay with 40 lbs. minimum weight, and 120 lbs. maximum weight. The hay bales shall be sufficiently bound with either wire or nylon twine to resist breaking apart during their use, shipment or placement.
- 2. Stakes shall be wood, minimum two inches (2") by two inches (2") by three feet (3') long.

B. Filter fabric:

- 1. Synthetic filter fabric shall be a pervious sheet of propylene, nylon, polyester or ethylene filaments and shall be certified by the manufacturer or supplier as conforming to the following requirements:

Minimum Filtering Efficiency: 75%

Minimum Tensile Strength at 20% Elongation

for Extra Strength: 50 lbs./lin. in.

for Regular Strength: 30 lbs./lin. in.

Minimum Flow Rate: 0.3 gal./min./sq.ft.

- C. Temporary mulch: clean oat straw, wheat straw, timothy hay, a mixture of clover and timothy hay or other approved native or forage grasses; well-seasoned before bailing, free from mature seed-bearing stalks or roots of prohibited or noxious weeds.

- D. Crushed stone: crushed or broken stone conforming to the requirements of Section M.02.01-1 “Broken or Crushed Stone” of CTDOT Form 816. Gradation shall conform to No. 8 (1/4” stone) per Section M.01.01.

PART 3 EXECUTION

3.01 PREPARATION

- A. Conduct construction operations in compliance with all terms of regulation agency requirements, including requirements noted on the Contract Drawings.
- B. Retain all sediments within the contract limits, and within designated disposal areas.
- C. Install erosion control measures prior to beginning site disturbance. Maintain erosion control measures throughout construction period, install additional measures if necessary to retain all sediment on site. Install any additional erosion control measures which may be required by local regulatory officials.

3.02 SEDIMENT BARRIERS

- A. Sediment barriers shall be limited to hay bales and silt fencing for sheet flow applications installed in accordance with Item 1.01.B.
- B. Hay Bales:
 - 1. Bales shall be placed in a single row, with ends of adjacent bales tightly abutting one another. Bales shall be oriented lengthwise on the contour for sheet flow applications, perpendicular to the contour for channel flow applications, and in a square or rectangular shape around depressed catch basin inlets.
 - 2. Bales shall be installed so that bindings are oriented around the sides rather than along the tops and bottoms of the bales to prevent deterioration of the bindings.
 - 3. The barrier shall be entrenched and backfilled. A trench shall be excavated the width of the bale and the length of the proposed barrier to a minimum depth of four inches (4"). After the bales are staked and chinked, the excavated soil shall be backfilled against the barrier. Backfill soil shall conform to the ground level on the downhill side and shall be built up to four inches (4") against the uphill side of the barrier.
 - 4. For channel flow applications, the barrier shall be extended to such a length that the bottoms of the end bales are higher in elevation than the top of the lowest middle bale to assure that sediment laden runoff will flow either through or over the barrier but not around it.
 - 5. The areas immediately around catch basins may be excavated slightly to increase ponding of runoff water around catch basins.

6. Each bale shall be securely anchored by at least two stakes driven through the bale. The first stake in each bale shall be driven toward the previously laid bale to force the bales together. Stakes shall be driven deep enough into the ground to securely anchor the bales.
7. The gaps between bales shall be chinked with straw to prevent water from escaping between bales.
8. In sloping areas where surface flow follows the bale line, perpendicular bale checks shall be installed at appropriate intervals (100 feet maximum).

C. Filter Fabric

1. Filter fabric shall be wrapped around all existing and proposed trench drain and catch basin and inlet grates to prevent sediment from entering the storm drainage system. The fabric shall be wrapped tightly around the outside of the grate structure and the grate placed securely back inside the receiving frame.
2. Where soil stockpiles are to be placed directly over trench drains or inlets, the fabric shall be wrapped a minimum of two (2) times around the grate structure.

3.03 TEMPORARY MULCH

- A. Place mulch uniformly in a continuous blanket at a rate of 2½ tons per acre, or two 50 pound bales per 1,000 square feet of area. A mechanical blower may be used for mulch application. Do not spread/apply mulch by mechanical means or by hand on windy or gusty days.
- B. Crimp straw into soil by mechanical means.
- C. On all slopes 4:1 or steeper, anchor mulch with liquid tackifier applied uniformly at a rate of 60 gallons per acre.
- D. Protect buildings, paving, planting and all non-seeded areas from liquid tackifier over-spray.

3.04 INSPECTION AND MAINTENANCE

A. General

1. Inspection shall be frequent, and shall be made after each storm event. Repair or replacement shall be made promptly as needed.

B. Hay Bales

1. Cleanout of accumulated sediment behind the bales is necessary if ½ of the original height of the bales becomes filled with sediment.
2. Hay bales shall be replaced after their expected useful life of 60 days.

3. Bale barriers shall be removed when they have served their usefulness, but not before the upslope areas have been permanently stabilized and the completion of construction activities.

C. Filter Fabric Fence

1. Fabric placed around grates shall be replaced whenever the fabric becomes torn, stretched or otherwise damaged so that it can no longer perform its function.

D. Sedimentation Basins

1. Temporary sedimentation basins shall be cleaned-out once one-half of the basin volume becomes filled with sediment.

END OF SECTION 312500

SECTION 321123 - PROCESSED AGGREGATE BASE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General and Supplementary Conditions, and Division One General Requirements apply to the work specified in this section.
- B. Form 816 shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816-2004 or its latest edition and any supplemental specifications.

1.02 SUMMARY

- A. Implement practices and procedures to meet the project's environmental goals, which include complying with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, June 2017.

1.03 DESCRIPTION OF WORK

- A. Work Included: Provide and install a processed stone aggregate base in two courses on a prepared subgrade as shown on the Drawings or as ordered by the Engineer, and as specified herein.

1.04 RELATED WORK

- A. Section 018113 - Volatile Organic Compound Limits
- B. Section 312316 - Earthwork

1.05 QUALITY ASSURANCE

- A. Material Standards: As defined in Form 816 inclusive of all supplements.
- B. Testing: Compaction tests may be required by the Owner and will be paid for by the Owner. No specific testing schedule has been established at this time. If tests indicate that density

requirements have not been achieved, the Contractor shall continue compacting. All re-testing in unsatisfactory areas shall be paid for by the Contractor.

- C. Density and Compaction Testing: The Contractor is responsible to schedule compaction tests as required by the Owner and to allow adequate time for the proper execution of said tests.
- D. High Performance Building Requirements:
 - 1. Adhesives or sealants used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113 "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Submittal Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Submittal Requirements of this Section.

1.06 SUBMITTALS

- A. Submit certified test reports and materials certificates, for products specified in this Section, indicating compliance of all proposed materials with specified requirements.
- B. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.07 PROTECTION

- A. Dust Control: Use all means necessary to control dust on and near the construction areas caused by the Contractor's performance of the work in conformance with Form 816.

PART 2 PRODUCTS

2.01 PROCESSED AGGREGATE BASE

- A. Conform to Article M.05.01, Form 816.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

- A. Prior to placing the bottom course of processed stone aggregate base, the prepared subgrade shall be maintained true to line and grade, at all times for a minimum distance of 200 feet in advance of the work. No placement of the processed aggregate is to commence until acceptance by the Engineer of the subgrade on which it is to be placed.
- B. The formation and protection of subgrade shall conform to the requirements of form 816.

3.02 MATERIAL PLACEMENT/COMPACTION

- A. Install processed aggregate base material at the locations as shown on the Drawings and in accordance with Article 3.04.03 of Form 816. Dimensions specified are after compaction.
- B. Compact base material with vibratory roller to minimum 95% modified AASHTO laboratory density (ASTM D-1557, Method C).

END OF SECTION 321123

SECTION 321216 - BITUMINOUS CONCRETE PAVEMENT AND MARKINGS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Division 1 General Requirements and Specific Requirements, apply to this Section.
- B. "Form 816" shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816-2004 or its latest edition and any supplemental specifications.

1.02 SUMMARY

- A. This Section includes the materials, labor, installation and incidental costs for the installation of subbase material, base materials, bituminous concrete pavement and markings.
- B. Coordinate the work of this Section with Section 321313 - Portland Cement Concrete.
- C. Implement practices and procedures to meet the project's environmental goals, which include complying with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- D. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, June 2017.

1.03 RELATED SECTIONS

- A. Section 018113 - Volatile Organic Compound Limits
- B. Section 321313 - Portland Cement Concrete Pavement and Curbing

1.04 SUBMITTALS

- A. Material Certificates: Provide material certificates signed by the material producer and the Contractor, certifying that materials and products comply with specified requirements.

- B. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.05 QUALITY ASSURANCE

- A. Material and Methods of Construction: Shall comply with the following standards:
1. American Society for Testing and Materials (ASTM).
 2. American Association of State Highway and Transportation Officials (AASHTO).
 3. Asphalt Institute (AI).
 4. State of Connecticut DOT Standard Specifications, Form 816, inclusive of all supplements.
- B. Testing: Compaction tests may be required by the Owner and shall be paid for by the Contractor. No specific testing schedule has been established at this time. If tests indicate that density requirements have not been achieved, the Contractor shall continue compacting. All retesting in these areas shall be paid for by the Contractor.
- C. Density and Compaction Testing: The Contractor is responsible to schedule compaction tests if required by the Owner and to allow adequate time for the proper execution of said tests.
- D. Allowable Tolerances: Final surface of base materials within 3/8" from a required grade. Final pavement thicknesses shall conform to specified requirements as shown in the Drawings. Test for smoothness using a ten (10) foot long straightedge. Surface shall not vary more than 1/4" from straightedge when placed in any direction. In no case will water be allowed to stand or puddle on any finished pavement.

E. Permits/Approvals: The Contractor shall obtain approval of construction and secure all permits for all work.

F. High Performance Building Requirements:

1. Adhesives or sealants used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113 "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Submittal Requirements of this Section.
3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Submittal Requirements of this Section

1.06 DELIVERY, STORAGE AND HANDLING

A. Transporting shipments of bituminous concrete material shall be made in tight vehicles previously cleaned of all foreign material, and delivered to the site, so that it will not become contaminated in any way.

1.07 PROJECT CONDITIONS

A. Weather Limitations

1. Base material shall not be placed on frozen or saturated subbase material.
2. Bituminous concrete paving material shall not be placed on frozen or saturated base material.
3. Cold weather: Bituminous concrete paving materials shall be mixed and placed in accordance with minimum placement temperature as specified in Article 4.06.03, Item 8 - Placing of Mixture, Form 816.
4. Precipitation or Moisture: Placement of bituminous concrete paving materials shall not be scheduled when weather conditions of fog or rain prevail nor when the pavement surface shows signs of any moisture.
5. Precipitation Probability: Placement of bituminous concrete paving materials shall not be scheduled when the Precipitation Probability, obtained by the Contractor from the U.S. Weather Bureau Within three (3) hours prior to the start of such operations, equals or exceeds fifty (50) percent. The Contractor shall notify the Engineer of the exact time at which the above information was obtained.

B. Grade Control: Establish and maintain the required lines and grades for each course during paving operations.

C. Provide temporary barricades and warning lights as required for protection of project work and public safety.

D. Protect adjacent work from damage, soiling and staining during paving operations.

- E. Inspection Costs: All costs associated with material certifications, plant inspection and laboratory tests shall be borne by the Contractor and shall be deemed included in the price bid for asphalt pavement.

PART 2 PRODUCTS

2.01 BITUMINOUS CONCRETE PAVEMENT

- A. Conform to the requirements of Article M.04.01, Form 816, Class 2.

2.02 TACK COAT

- A. Conform to the requirements of Article M.04.01, Item 1(d), Sub-item (4), Form 816. Tack Coat shall be Grade CSS-1H cationic emulsified asphalt, diluted with water at a 1:1 ratio.

2.03 PROCESSED STONE AGGREGATE

- A. Conform to the requirements of Article M.05.01, Form 816.

2.04 PAINT

- A. Paint shall be hot-applied, fast drying type in accordance with Form 816, Section M.07.21.

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify that all existing utility openings, valves, and other project installations are at their proper finished grade elevations, within areas to be paved. Provide temporary closures and protection over openings until completion of rolling operations. Remove closures at completion of the work. Set covers to grade, flush with the surface of the adjoining pavement.

3.02 SUBGRADE PREPARATION

- A. Prior to placing the bottom course of processed stone aggregate base, the prepared subgrade shall be maintained true to line and grade, at all times for a minimum distance of 200 feet in advance of the work. No placement of the processed aggregate is to commence until acceptance by the Engineer of the subgrade on which it is to be placed.
- B. The formation and protection of subgrade shall conform to the requirements of Article 2.09.01 and 2.09.03, Form 816.

3.03 BASE COURSE MATERIAL PLACEMENT/COMPACTION

- A. Install processed aggregate base material at the locations as shown on the Drawings and in accordance with Article 3.04.03, Conn DOT Form 816. Dimensions specified are after compaction.

- B. Compact base material with vibratory roller to minimum 95% modified AASHTO laboratory density (ASTM D-1557, Method C).
- C. Insure thorough and proper compaction around all yard drains, catch basins, structures, utility valves, and other improvements that project above base material.

3.04 BITUMINOUS CONCRETE PAVEMENT

A. General

1. Install the bituminous concrete pavement to the lines, grades, and details shown on the Drawings. Neatly and cleanly meet and match abutting pavements. Remove all soft or yielding material below grade and replace with suitable material.
2. Thicknesses after compaction shall conform to the details on the Drawings. The pavement shall consist of the number of courses and thickness as detailed. Remove and replace areas showing deficiencies in required thickness with new material as directed by the Engineer.
3. Protect existing abutting pavement during paving operations. Replace any abutting pavement damaged during paving operations. Joint between bituminous pavement and existing portland cement concrete pavement shall be tightly compacted and pavement edge shall be of equal density to other areas of pavement.
4. Provide a cross-pitch of 1/4" per foot for proper drainage. Ensure that there are no "low" spots that may trap water and create a slipping hazard.

B. Forms

1. Provide wood edge forms of an approved type and a minimum length of ten (10) feet for tangents and curves, unless otherwise shown on the plans. Wood forms shall be of a depth equal to the depth of the pavement and shall be securely staked and braced to the required line and grade. Note: Hand tamp edges and bevel if wood forms are not used.
2. Install wood forms along all edges of pavement to produce a clean vertical edge. Secure strips to allow for proper compaction of bituminous concrete. Do not remove edge screed strips until pavement is thoroughly compacted. Raveled edges will not be accepted. Wood forms are to be removed after the bituminous pavement has completely set.
3. All forms shall be straight, free from bends and warps at all times, and shall be cleaned thoroughly and oiled before pavement is placed against them, this cleaning and oiling being repeated daily as the forms are moved ahead.
4. The forms shall rest firmly upon the thoroughly compacted sub-grade throughout their entire length, shall be joined neatly and tightly and staked securely to line and grade, three (3) bracing pins or stakes, each ten (10) foot length of side form, so that they will resist the pressure of the pavement and the impact of the roller without springing.

C. Placing

1. Bituminous concrete pavement shall be constructed and compacted in conformance with Conn DOT Form 816 requirements.
2. Coat the edge of all abutting pavement with tack coat before installing bituminous concrete pavements. Insure that the abutting pavement has a sound, clean, straight edge. Feathering of edges and transitions between new and existing pavements is not acceptable. Protect surfaces of abutting pavement from tack coat overspray.
3. Each mixture shall be furnished and laid by means of a mechanical spreader of approved design to a depth which after final compaction shall be equal to the specified depth. In areas where the use of a mechanical spreader is impractical, as determined by the Engineer, other means of spreading and compacting may be permitted. The use of hand rakes will not be permitted. The Contractor shall use lutes where necessary.
4. After placing and compacting binder course, tack coat shall be applied prior to placement of the wearing (top) course.
5. Each mixture shall be laid only where the surface to be covered is free from loose or foreign material, dry, and only when weather conditions, in the opinion of the Engineer, are suitable.
6. The Contractor shall provide suitable means for keeping all small tools clean and free from bituminous accumulations.
7. Pavement may be laid by hand. Pavement shall be compacted by making multiple passes with a roller weighing not less than 2,000 pounds. After compaction, the thickness shall be that as specified on the drawings.

D. Compacting

1. Upon completion of the spreading of each mixture, the material shall be consolidated thoroughly and uniformly with self-propelled tandem rollers. The top course shall be free from roller marks.
2. Rollers used for compacting the top course shall be well balanced, self-propelled, tandem rollers, weighing between seven (7) and eight (8) tons. The roller shall have a compression under the rear wheel of between 200 and 300 pounds per linear inch of roll at a rate not exceeding 800 square yards per hour per roller. Final compaction shall meet all Conn DOT Form 816 requirements.
3. Locations inaccessible to the roller, the compression shall be effected with iron tampers weighing not less than twenty-five (25) pounds and having a bearing area not exceeding forty-eight (48) square inches, or other impact type equipment.

4. Perform breakdown, second and finish rolling until the bituminous concrete mixture has been compacted to the required surface density and smoothness. Continue rolling until all roller marks are eliminated. Provide a smooth compacted surface true to thickness and elevations required.
5. After final rolling, do not permit vehicular traffic on the pavement until it has cooled and hardened, and in no case sooner than 8 hours.

E. Joints for New Construction and Between Existing Pavement:

1. Carefully make joints between old and new pavements, and between successive day's work, to ensure a continuous bond between adjoining work. Construct joints to have the same texture, density, and smoothness as other sections of the asphalt concrete course.
2. Construction shall be as nearly continuous as is possible. The roller shall pass over the end of the laid mixture only when a practical necessity.
3. When the operation of laying is interrupted, the end of the laid material shall be left unrolled until such time as work is resumed, in order that there be no joints throughout the project.
4. If it is necessary to roll the end of the laid mixture during construction, thus consolidating it, the joint so made shall be cut back before recommencing the operation of laying, in order to present a fresh, clean surface for contact with the newly placed material.
5. The edges of such joints shall be painted with liquid asphalt (RC-70 or MC-70) and the use of hot smoothing irons in finishing such joints, shall not be permitted.

F. Finished Surface

1. The surface of the top course of the pavement after compression shall be smooth and true to crown and grade, free from depressions, waves, bunches, overlapping seams and unevenness in surface. All new surfaces shall meet existing surfaces smoothly and evenly.
2. After the compaction of the top course, the Contractor shall check the entire paved area for depressions, using a ten (10) foot wood or metal straightedge. Any depressions greater than three-sixteenths (3/16) of an inch shall be corrected by removing the top course of the affected areas, and replacing with new material to form a true and even surface.

G. Defects: Where defects in composition, compression or finish appear in the completed work, such finished areas shall be removed to the full depth of the course and the defective material replaced with the required thickness of pavement at the expense of the contractor.

1. Patching: Remove and replace mixtures that become mixed with foreign materials and all defective areas. Cut out such areas and fill with fresh hot asphalt concrete. Compact by rolling to the required surface density and smoothness. Remove deficient areas for the full depth of the course. Cut sides perpendicular and parallel to the directions of traffic with edges vertical. Apply a tack coat before placing asphalt concrete mixture.

3.05 PAINTED PAVEMENT MARKINGS

- A. Existing painted pavement markings shall be removed by sandblasting or milling. Painting over existing markings will not be allowed.
- B. Pavement areas to be painted shall be dry and sufficiently cleaned of sand, dust and road debris so as to provide an acceptable bond between the paint and the pavement.
- C. Fast drying paint shall be applied at a temperature of 120 F to 150 F at the spray gun.
- D. All paint shall be performed in a neat and workmanlike manner, using approved mechanical equipment. Lines shall be sharp and clear with no feathered edging or fogging and precautions shall be taken to prevent tracking by tires of the striping equipment. Paint shall be applied as shown on the plans with no unsightly deviations.
- E. After application, the paint shall be protected from crossing vehicles for a time at least equivalent to the drying time of the paint.

3.06 PROTECTION/CLEAN-UP

- A. Protect all work until acceptance of the project. Replace or repair pavement if damaged prior to acceptance.
- B. Clean up all debris from installation procedures, including but not limited to bituminous concrete and base material overflow into/onto areas indicated to be lawn or other surfaces. Remove from site all excess materials, debris and equipment. Contractor shall dispose of debris material legally.
- C. Repair damage resulting from paving operation to other areas of the work.

END OF SECTION 321216

SECTION 321313 - PORTLAND CEMENT CONCRETE PAVEMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Division 1 General Requirements and Specific Requirements, apply to this Section.
- B. "Form 816" shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816-2004 or its latest edition and any supplemental specifications.

1.02 SUMMARY

- A. This Section includes the materials, labor, installation and incidental costs for the installation of subbase material, base materials, and portland cement concrete as follows:
 - 1. Reinforced concrete pavement
 - 2. Concrete curb ramps
 - 4. Concrete sidewalk
- B. Coordinate the work of this Section with Section 321216 - Bituminous Concrete Pavement and Markings.
- C. Implement practices and procedures to meet the project's environmental goals, which include complying with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- D. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, June 2017.

1.03 RELATED SECTIONS

- A. Section 018113 - VOC Limits volatile organic compound limits
- B. Section 321216 - Bituminous Concrete Pavement and Markings

1.04 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, expansive hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume.

1.05 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Design Mixes: For each concrete pavement mix.
- C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials. Contractor shall pay for all testing of concrete materials.
- D. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:
 - 1. Cementitious materials and aggregates
 - 2. Steel reinforcement and reinforcement accessories
 - 3. Admixtures
 - 4. Curing compounds
 - 5. Applied finish materials (i.e., traffic paint)
 - 6. Joint fillers
- E. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits

of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.06 QUALITY ASSURANCE

- A. Materials and methods of construction shall comply with the following standards:
 - 1. American Society for Testing and Materials (ASTM)
 - 2. American Concrete Institute (ACI)
 - 3. State of Connecticut DOT Standard Specifications (Form 816)
- B. 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.
- C. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
 - 1. Manufacturer must be certified according to the National Ready Mix Concrete Association's Plant Certification Program.
- D. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 shall be paid by the contractor to conduct the testing indicated, as documented according to ASTM E 548.
- E. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant and each aggregate from one source. Do not change source of brands of cement, aggregate materials, or batching plant during course of work.
- F. ACI Publications: Comply with all ACI requirements unless modified by the requirements of the Contract Documents.
- G. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixes.
- H. High Performance Building Requirements:
 - 1. Adhesives or sealants used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113 "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Submittal Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Submittal Requirements of this Section.

1.07 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 PRODUCTS

2.01 FORMS

- A. Forms shall conform to Article 8.11.03-3 and 9.21.03-3 of Form 816, latest revision.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.02 STEEL REINFORCEMENT

- A. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- B. Reinforcement Bars: ASTM A 615, Grade 60, deformed bars.
- C. Plain Steel Wire: ASTM A 82, as drawn.
- D. Joint Dowel Bars: ASTM A 615, Grade 60, plain steel bars.
- E. Tie Bars: ASTM A 615, Grade 60, deformed.
- F. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement bars, welded wire fabric, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:
 - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2.03 CONCRETE MATERIALS

- A. General: Use the same brand and type of cementitious material from the same manufacturer throughout the Project.
- B. Concrete: Conform to the requirements of Form 816, Article M.03.01, Class "C" and ASTM C-94. Batch mixing at project site not acceptable.
- C. Compressive strength: 3,000 psi at 28 days.
- D. Entrained air: 5 to 7%.
- E. Reactive aggregates and calcium chloride are not allowed.
- F. Water: Potable.

2.04 ADMIXTURES

- A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cement and to be compatible with other admixtures.
- B. Air-Entraining Admixture: ASTM C 260.
- C. Water-Reducing Admixture: ASTM C 494, Type A.
- D. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.

2.05 CURING MATERIALS

- A. Conform to Article 4.01.03, Item F7 "Curing", Form 816.

2.06 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B. Premolded Joint Filler Strips: ASTM D-994, premolded, resilient non-extruding joint filler conforming to the requirements of AASHTO M213.
- C. Thickness and depth of expansion- and isolation-joint filler as indicated on the drawings.
- D. Pavement-Marking Paint: Latex, water-base emulsion; ready mixed; complying with FS TT-P-1952.
 - 1. Color: Blue for handicapped requirements, yellow for fire lanes, white elsewhere.

2.07 CONCRETE MIXING

- A. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94 and ASTM C 1116.
 - 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

3.01 SURFACE PREPARATION

- A. Proof-roll prepared subbase surface to check for unstable areas and verify need for additional compaction. Do not begin concrete work until such conditions have been corrected and are ready to receive concrete.
- B. Remove loose material from compacted subbase surface and excavations immediately before placing concrete.

3.02 FORMS

- A. Set, brace, and secure forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so that forms can remain in place at least 72 hours after concrete placement.
- B. Check completed formwork and screeds for grade and alignment to following tolerances:
 - 1. Top of Forms: Not more than 1/8 inch in 10 feet.
 - 2. Vertical Face on Longitudinal Axis: Not more than 1/4 inch in 10 feet.
- C. Clean forms after each use and coat with form release agent as required to ensure separation from concrete without damage.
- D. Form recess to receive brick facing masonry in exposed ramp wall as detailed in the Drawings.

3.03 PLACING REINFORCEMENT

- A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars" for placing and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- D. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.04 JOINTS

- A. General: Construct contraction, construction, and isolation joints true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to the centerline, unless indicated otherwise.
 - 1. When joining existing paving, place transverse joints to align with previously placed joints, unless indicated otherwise.
- B. Contraction Joints: Provide weakened-plane contraction joints, sectioning concrete into areas as shown on Drawings. Construct contraction joints for a depth equal to at least 1/4 of the concrete thickness, as follows:
 - 1. Tooled Joints: Form contraction joints in fresh concrete by grooving and finishing each edge of joint with a radiused jointer tool.

2. Inserts: Form contraction joints by inserting premolded plastic, hardboard, or fiberboard strips into fresh concrete until top surface of strip is flush with paving surface. Radius each joint edge with a jointer tool. Carefully remove strips or caps of two-piece assemblies after concrete has hardened. Clean groove of loose debris.
- C. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than ½ hour, unless paving terminates at isolation joints.
1. Provide preformed galvanized steel or plastic keyway-section forms or bulkhead forms with keys, unless indicated otherwise. Embed keys at least 1-1/2 inches into concrete.
 2. Continue reinforcement across construction joints unless indicated otherwise. Do not continue reinforcement through sides of strip paving unless indicated.
 3. Provide tie bars at sides of paving strips where indicated.
 4. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.
- D. Isolation Joints: Form isolation joints of preformed joint filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
1. Locate expansion joints at intervals of 20 feet, unless indicated otherwise.
 2. Extend joint fillers full width and depth of joint, not less than ½ inch or more than 1 inch below finished surface where joint sealant is indicated. Place top of joint filler flush with finished concrete surface when no joint sealant is required.
 3. Furnish joint fillers in one-piece lengths for full width being placed wherever possible. Where more than one length is required, lace or clip joint filler sections together.
 4. Protect top edge of joint filler during concrete placement with a metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- E. Installation of joint fillers and sealants shall conform applicable sections of Form 814A.
- F. Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one half of dowel length to prevent concrete bonding to one side of joint.

3.05 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.

- B. Remove snow, ice, or frost from subbase surface and reinforcing before placing concrete. Do not place concrete on surfaces that are frozen.
- C. Moisten subbase to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.
- D. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
 - 1. When concrete placing is interrupted for more than ½ hour, place a construction joint.
- E. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- F. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete complying with ACI 309R.
 - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcing, dowels, and joint devices.
- G. Screed paved surfaces with a straightedge and strike off. Use bull floats or darbies to form a smooth surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces prior to beginning finishing operations.
- H. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.
 - 1. Remove and replace portions of bottom layer of concrete that have been placed more than 15 minutes without being covered by top layer or use bonding agent if acceptable to Engineer.
- I. Cold-Weather Placement: Comply with provisions of ACI 306R and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 - 2. Do not use frozen materials or materials containing ice or snow.

3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.
- J. Hot-Weather Placement: Place concrete complying with ACI 305R and as specified when hot weather conditions exist.
1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 deg F. Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
 3. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.06 CONCRETE FINISHING

- A. Float Finish: Begin floating when bleed water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Finish surfaces to true planes within a tolerance of 1/4 inch in 10 feet as determined by a 10-foot-long straightedge placed anywhere on the surface in any direction. Cut down high spots and fill low spots. Refloat surface immediately to a uniform granular texture.
1. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across concrete sidewalk surface perpendicular to line of traffic to provide a uniform fine line texture finish.
- B. Final Tooling: Radius: 3/8 inch. Tool edges of paving, curbs, and joints formed in fresh concrete with a jointing tool to the following radius. Repeat tooling of edges and joints after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.07 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with the recommendations of ACI 306R for cold weather protection and ACI 305R for hot weather protection during curing.
- B. Evaporation Control: In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before floating.
- C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure concrete by curing compound, as follows:

1. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.08 FIELD QUALITY CONTROL TESTING

- A. Employ a qualified independent testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement as follows:
- B. The Contractor will employ a qualified testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement. Sampling and testing for quality control may include the following:
 1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
 - a. Slump: ASTM C 143; one test at point of placement for each compressive-strength test but no less than one test for each day's pour of each type of concrete. Additional tests will be required when concrete consistency changes.
 - b. Air Content: ASTM C 231, pressure method; one test for each compressive-strength test but no less than one test for each day's pour of each type of air-entrained concrete.
 - c. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.
 - d. Compression Test Specimens: ASTM C 31; one set of four standard cylinders for each compressive-strength test, unless directed otherwise. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.
 - e. Compressive-Strength Tests: ASTM C 39; one set for each day's pour of each concrete class exceeding 5 cu. yd. but less than 25 cu. yd., plus one set for each additional 50 cu. yd. Test one specimen at 7 days, test two specimens at 28 days, and retain one specimen in reserve for later testing if required.
 2. When frequency of testing will provide fewer 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.
 3. When total quantity of a given class of concrete is less than 50 cu. yd., the Engineer may waive strength testing if adequate evidence of satisfactory strength is provided.

4. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
 5. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi.
- C. Test results will be reported in writing to the Engineer, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing agency, concrete type and class, location of concrete batch in paving, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day and 28-day tests.

3.09 REPAIRS AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective, or does not meet the requirements of this Section.
- B. Drill test cores where directed by the 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 paving with epoxy adhesive.
- C. Protect concrete from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep concrete paving not more than 2 days prior to date scheduled for Substantial Completion inspections.

3.10 PROTECTION/CLEAN-UP

- A. Protect work completed until acceptance of project. Replace or repair concrete if damaged prior to acceptance.
- B. As work proceeds, maintain premises free of unnecessary accumulation of tools, equipment, surplus materials and debris related to this work.

END OF SECTION 321313

SECTION 32 14 40 - GRANITE BLOCK PAVERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General and Supplementary Conditions, and Division One General Requirements apply to the work specified in this section.
- B. Form 816 shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816-2004 or its latest edition and any supplemental specifications.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Under this item, the Contractor shall furnish and set granite blocks pavers in accordance with the plans, specifications and directions of the Engineer.
 - B. Implement practices and procedures to meet the project's environmental goals, which include complying with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
 - C. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, June 2017.

1.03 RELATED SECTIONS

- A. Section 018113 - Volatile Organic Compound Limits
- B. Section 033001 – Portland Cement Concrete (Site)
- C. Section 31 22 13 - Formation of Subgrade
- E. Section 32 11 23 - Processed Aggregate Base

1.04 SUBMITTALS

- A. Submit certified test reports and materials certificates, for products specified in this Section, indicating compliance of all proposed materials with specified requirements.
- B. Samples: The Contractor shall furnish two (2) samples of blocks before starting work, for approval by the Engineer. Blocks used on the work shall conform to the approved samples, in the opinion of the Engineer.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Granite Blocks

- 1. Granite block shall be comprised of the following:

- Quartz – 27.8%
- Plagioclase Feldspar – 28.1%
- Microcline Feldspar – 40.1%
- Biotite – 1.8%
- Muscovite – 0.9%
- Garnet – 0.2%
- Opagues (Including Magnetite, Pyrite, Limonite, Hematite) – 0.5%
- Chlorite – 0.6%
- Accessory Mineral (Including Zircon, Appatite, Biotite, Epidote, Calcite) – 0.1%

- 2. Physical Testing Specification Values

Specification	Test Method	Test Result	
Water Absorption	ASTM C-97	0.19%	
Density	ASTM C-97	163.1 lbs/ft ²	
Compressive Strength	ASTM C-170	23,124 psi	
Modulus of Rupture	ASTM C-99	1,686 psi	
Flexural Strength	ASTM C-880	1,383 psi	
Abrasion Resistance	ASTM C-1353	299 Wear Index Value	
Static Coefficient of Friction	ASTM C-1028	Dry	Wet
		• Bush Hammer Finish	1.09 1.00
		• Thermal Finish	1.04 0.95

• Honed Finish	1.03	0.84
• Polished Finish	1.17	0.66

2. Blocks shall be new and shall be cut from fine to medium grained sound and durable granite. The granite shall be reasonably uniform in quality and texture throughout and shall be free from an excess of mica and feldspar and from seams, scales, or evidence of disintegration.
3. Blocks shall be fairly rectangular in shape and shall be not less than four inches (4") nor more than twelve inches (12") in length; not less than three (3") nor more than five inches (5") in width; not less than three (3") nor more than five inches (5") in depth. The blocks shall be cut so that opposite faces will be approximately parallel and adjoining faces approximately at right angles to each other. Blocks shall be so dressed that they may be laid with one inch (1") joints. All blocks shall have one reasonably smooth split head.
4. Granite shall be reasonably uniform in quality and texture throughout, free from excess of mica and feldspar, and from seams, scales, or evidence of disintegration. Edges shall be blunted as shown on the drawings.

B. Granite Block Paver Manufacturers/Colors

1. Granite block pavers shall be Stony Creek Classic Granite, as manufactured by Stony Creek Quarry Corporation, 99 Quarry Road, Branford, CT 06405 or approved equal.

C. Filter Fabric

1. Shall conform to Form 817, Section 7.55 - Geotextile.

PART 3. - EXECUTION

3.01 INSTALLATION

A. Preparation of Subgrade

1. The Contractor shall trim and roll the subgrade to smooth, uniform lines to the satisfaction of the Engineer, prior to placing the pavement. The Contractor shall place Non-Woven Filter Fabric over the prepared subgrade, overlapping edges a minimum of six inches (6") to ensure complete coverage prior to placing the sand base.

B. Sand Cushion

1. The blocks shall be laid on a sand cushion of a maximum thickness of one inch (1"). Cushion sand shall consist of clean, hard, durable uncoated stone particles, free of lumps of clay and all deleterious substances and shall be so graded that when dry, one hundred percent shall pass a 1/4-inch square opening sieve; not more than thirty-five percent (35%) by weight shall pass a No. 50 sieve. Cushion sand may be rejected if it contains more than ten percent by weight of loam and silt. The sand cushion shall be compacted

by being rolled with a roller weighing one hundred fifty pounds (150 lbs.) per foot of width or by tamping, as directed by the Engineer.

C. Setting Blocks

1. The blocks shall be carefully laid on a sand cushion according to the patterns shown on the plans or as directed by the Engineer. Joints between blocks shall be a maximum of three-quarters of an inch (3/4") and a minimum of one quarter inch (1/4") in width. All blocks shall be clean when placed in the pavement. Blocks which, in the opinion of the Engineer, are not satisfactorily clean shall be well washed before being placed. Cutting of blocks to meet pattern requirements will be permitted, subject to the approval of the Engineer.
2. After a sufficient area of block pavement has been laid, the surface shall be tested with a ten-foot straight edge laid parallel with the center line and any depression exceeding one-quarter inch (1/4") shall be corrected and brought to the proper grade. All stones disturbed in making replacements or correcting depressions shall be settled into place by carefully ramming or tamping to grade by the use of a hand tamper applied upon a two-inch (2") board. Each section of pavement must be acceptable to the Engineer before the joints in that section are filled.

D. Filling Joints:

1. Where sand joints are called for, the joints shall be filled with cushion sand. The sand shall be firmly packed in the joints between the blocks. Immediately after the joints are filled, the pavement shall be swept clean.

END OF SECTION 321440

SECTION 321613.26 – PRECAST CONCRETE CURB

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. All of the contract documents, including General Agreement and Supplementary Conditions and Division 1 - General Requirements, apply to the work of this Section.

1.02 DESCRIPTION: This Section includes:

- A. Shop drawings, detailing, fabrication, delivery and installation of precast concrete curb units.
- B. Implement practices and procedures to meet the project's environmental goals, which include complying with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- C. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, June 2017.

1.03 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide precast concrete curb units capable of withstanding the design loads for on-grade condition.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each precast concrete mixture. Include compressive strength and water-absorption tests.
- C. Shop Drawings: Detail fabrication and installation of precast concrete units. Indicate locations, plans, elevations, dimensions, shapes, and cross sections of each unit. Indicate reveals, and extent and location of each surface finish.

- D. Material test reports: For aggregates.
- E. Material Certificates: Signed by manufacturers:
- F. Field quality-control test reports.
- G. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.05 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm that assumes responsibility for engineering precast concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
- B. Submit PCI plant certification.
- C. Design Standards: Comply with ACI 318 (ACI 318M) and design recommendations of PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of precast concrete units indicated.
- D. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI Precast Concrete Standards.

- E. Calculated Fire-Test-Response Characteristics: Where indicated, provide precast concrete units whose fire resistance has been calculated according to ACI 216.1/TMS 0216.1, "Standard Method for Determining Fire Resistance of Concrete and Masonry Construction Assemblies," and PCI MNL 124, "Design for Fire Resistance of Precast Prestressed Concrete," and is acceptable to authorities having jurisdiction.
- F. High Performance Building Requirements:
 - 1. Adhesives or sealants used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113 "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Submittal Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Submittal Requirements of this Section.

PART 2 - PRODUCTS

2.01 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
- C. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from galvanized steel wire into flat sheets.
- D. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
- E. For aggressive climates, revise subparagraph below by adding an anchorage device encapsulation system consisting of caps and sleeves.

2.02 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I or Type III, gray, unless otherwise indicated.
 - 1. For surfaces exposed to view in finished structure, mix gray with white cement, of same type, brand, and mill source.
- B. Supplementary Cementitious Materials: No supplementary cementitious materials (i.e. fly ash, silica fume, and ground slag) shall be allowed.

- C. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C 33, with coarse aggregates complying with Class 5S. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.
 - 1. Face-Mixture-Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match selected finish sample.
 - 2. Face-Mixture-Fine Aggregates: Selected, natural or manufactured sand of same material as coarse aggregate, unless otherwise approved by Architect.
- D. Coloring Admixture: ASTM C 979, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading.
- E. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
- F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.

2.03 GROUT MATERIALS

- A. Sand-Cement Grout: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144 or ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

2.04 CONCRETE MIXTURES

- A. Prepare design mixtures for each type of precast concrete required.
- B. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast concrete fabricator's option.
- C. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 (ACI 318M) or PCI MNL 117 when tested according to ASTM C 1218/C 1218M.
- D. Normal-Weight Concrete Mixtures: Proportion mixtures by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:
 - 1. Compressive Strength (28 Days): 4000 psi minimum.
- E. Water absorption indicates susceptibility to weather staining. PCI states that limits in first paragraph below are suitable for average exposures.
- F. Water Absorption: 6 percent by weight or 14 percent by volume, tested according to PCI MNL 117.

- G. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 117.
- H. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.

2.05 FABRICATION

- A. Reinforcement: Comply with recommendations in PCI MNL 117 for fabricating, placing, and supporting reinforcement.
- B. Reinforce precast concrete units to resist handling, transportation, and erection stresses.
- C. Comply with requirements in PCI MNL 117 and requirements in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.
- D. Place face mixture to a minimum thickness after consolidation of the greater of 1 inch or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover specified.
- E. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units.
- F. Place backup concrete mixture to ensure bond with face-mixture concrete.
- G. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air on surfaces. Use equipment and procedures complying with PCI MNL 117.
- H. Place self-consolidating concrete without vibration according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants."
- I. Comply with PCI MNL 117 for hot- and cold-weather concrete placement.
- J. Identify pickup points of precast concrete units, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast concrete unit on a surface that will not show in finished structure.
- K. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.
- L. Discard and replace precast concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 117 and Architect's approval.

2.06 FABRICATION TOLERANCES

- A. Fabricate precast concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished panel complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.

2.07 FINISHES

- A. Surface shall be free of joint marks, grain, and other obvious defects. Corners shall be uniform, straight, and sharp as indicated in the drawings. Finish exposed-face surfaces of precast concrete units to conform to PCI's Precast Concrete Standards.

2.08 SOURCE QUALITY CONTROL

- A. Quality-Control Testing: Test and inspect precast concrete according to PCI MNL 117 requirements. If using self-consolidating concrete, also test and inspect according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants."
- B. Owner will employ an independent testing agency to evaluate precast concrete fabricator's quality-control and testing methods.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Erect precast concrete level, plumb, and square within specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment as units are being permanently installed.
- B. Grouting Connections: Grout connections where required or indicated. Retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces. Keep grouted joints damp for not less than 24 hours after initial set. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.
- C. Erect precast concrete units level, plumb, square, true, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 117, Appendix I.

3.02 REPAIRS

- A. Blemishes occurring after delivery are normally repaired before final joint sealing and cleaning as weather permits.
- B. Repair damaged precast concrete units if permitted by Architect. The Architect reserves the right to reject repaired units that do not comply with requirements.

- C. Precast concrete manufacturer should develop appropriate repair mixtures and techniques during production sample approval process.
- D. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet.
- E. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.
- F. Remove and replace damaged precast concrete units when repairs do not comply with requirements.

3.03 CLEANING

- A. Clean surfaces of precast concrete units exposed to view.
- B. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.
- C. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.
 - 1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's recommendations. Clean soiled precast concrete surfaces with detergent and water, using stiff fiber brushes and sponges, and rinse with clean water. Protect other work from staining or damage due to cleaning operations.
 - 2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 321613.26

SECTION 329113 - TOPSOIL

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the General Conditions, Supplementary Conditions and General Requirements, apply to the work specified in this Section.

1.02 SUMMARY

- A. Testing, screening, amending, placing and finish grading all stockpiled and borrow topsoil as shown on the Drawings and specified herein.
 - 1. Provide all labor, materials, borrow topsoil, soil amendments and conditioners, compost, necessary equipment, and services to furnish and install topsoil for planting operations, for backing-up pavements and curbs installed under this Contract, and for repair of lawns and other areas damaged by construction necessary to properly complete all lawn and planting operations.
 - 2. Provide 6" minimum depth of topsoil in all lawn seeding areas.
- B. Implement practices and procedures to meet the project's environmental goals, which include complying with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- C. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, June 2017.

1.03 RELATED SECTIONS

- A. Section 018113 - Volatile Organic Compound Limits

1.04 QUALITY ASSURANCE

- A. Topsoil
 - 1. Testing: Representative samples of borrow topsoil and stockpiled topsoil shall be completely analyzed/ tested to determine:

- a. Nutrient analysis using the Modified Morgan extractant for soil available P, K, Ca, and Mg.
 - b. Soil pH.
 - c. Organic matter content- determined by loss of weight on ignition.
 - d. Soil texture classification.
 - e. Particle size analysis - sand, silt, and clay - analysis shall be determined using the hydrometer or pipette methods of particle size analysis with size fractions based upon size limits established by USDA.
2. Before delivery of any borrow topsoil, furnish the Landscape Architect with a 1 gallon sample of tested topsoil material.
 3. Topsoil testing costs shall be borne by the Contractor.
 4. Testing laboratory shall be:

Soil Nutrient Analysis Laboratory
University of Connecticut
Department of Plant Science
6 Sherman Place, Box U-102
Storrs, CT 06269-5102
Tel: 860-486-4274

Soil testing performed by a substitute laboratory will not be accepted without prior approval by the Landscape Architect.

B. High Performance Building Requirements:

1. Adhesives or sealants used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113 "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Submittal Requirements of this Section.
3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Submittal Requirements of this Section.

1.05 SUBMITTALS

- A. Submit topsoil test results for approval.
- B. Submit topsoil sample. Submit a 1 gallon sample of tested topsoil material. The topsoil submittal shall be a representative sample of topsoil from the stockpile and shall be a homogeneous mix of uniform material taken from no less than 10 samplings of equal quality from areas similar in color, location and type.
- B. Submit materials certificates and product data for the following items, clearly marked, to indicate proposed materials. Printed data shall state application rates and amount of product to be added, if

applicable.

1. Soil amendments and conditioners
 2. Compost
- C. Submit batch delivery tickets for the following items, indicating the trade name, the supplier/distributor's name and the amount of product delivered to the contracting firm/project site.
1. Soil amendments and conditioners
 2. Compost
 3. Processed sand
- D. Submit materials certificate and certified test report for processed sand and gravel.
- E. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).
- 1.06 PRODUCT HANDLING: Coordinate delivery of borrow topsoil such that it is placed as delivered and no stockpiling is required.
- 1.07 PROJECT CONDITIONS:
- A. Verify that subsurface drains are complete and fully functional prior to beginning work of this Section. Protect subsurface drains from failure.
 - B. Coordinate topsoil placement with irrigation equipment installation (if applicable).

PART 2 PRODUCTS

2.01 TOPSOIL

- A. Shall be clean, fertile, friable, and well draining; not to contain materials harmful to plant life. All topsoil to be free of any subsoil earth clods, sods, stones over 1/2 inch in any dimension, sticks, roots, weeds, litter and other deleterious material. Topsoil shall be uniform in quality and texture and contain specified organic matter and mineral elements necessary for sustaining healthy plant growth. Stones and rock fragments shall not exceed two-percent by volume.
- B. Topsoil shall have a pH of 6.0 to 8.0.
- C. Organic Matter Content: 4 - 8%
- D. Nutrient levels shall be achieved by the Contractor's addition of amendments to the topsoil to meet the optimum nutrient levels specified in the testing laboratory report.
- E. All imported off-site topsoil shall be from a single source for all borrow topsoil required.
- F. Soil texture shall meet the USDA Soils Textural Classification percentage of sand, silt and clay for "loam" or "sandy loam" classifications, with not more than 75-percent sand and not less than 5-percent clay.
- G. Free of any toxic chemical, waste or any material or condition that would prevent the establishment of a suitable lawn.

2.03 AMENDMENTS/CONDITIONERS: Shall be as recommended by the Topsoil Test Report. Amend all topsoil to meet the optimum nutrient levels specified in the Topsoil Test Report.

2.04 COMPOST

- A. Compost shall be either Pioneer Valley Compost or Agresoil Premium Organic Compost as distributed by: Agresource, phone 800-313-3320 or approved equal.
- B. Compost shall be a stable, humus-like material produced from the aerobic decomposition of organic wastes. Compost residues may be derived from organic wastes such as food and agricultural residues, animal manures, yard wastes, source separated municipal solid waste and biosolids (treated sewage sludge) that meet all State Environmental Agency requirements.
- C. The product shall be well composted, free of viable weed seeds and contain material of a generally humus nature capable of sustaining growth of vegetation, with no materials toxic to plant growth. Compost shall contain no visible free water.
- D. 100-percent of the compost material shall pass a 1/2-inch screen.
- E. Compost shall have the following properties:

<u>Parameters</u>	<u>Range</u>
pH	5.5 - 8.0
Moisture Content	35% - 55%
Soluble Salts	4.0 mmhos cm ⁻¹
C:N ratio	10:1 - 25:1
Particle Size	less than 1/2"

Organic Matter Content at least 40% on an oven dray basis
Bulk Density <1000 lbs./cubic yard
Foreign Matter shall not exceed 1% (dry weight)

- F. Compost generator shall also provide testing of minimum available nitrogen and other macro and micro-nutrients to determine fertilizer requirements.
- G. Heavy Metals regulated by EPA measured in parts per million shall not exceed the following limits:

Regulated Metals	Regulated Limits*
Arsenic	41
Cadmium	39
Chromium	1200
Copper	1500
Lead	300
Mercury	17
Nickel	420
Selenium	36
Zinc	2800

*EPA 503 Regulations
Maximum Allowable Exceptional Quality P.P.M.

2.05 SAND: Processed to meet the following particle size criteria:

Description	Sieve Mesh	Diameter of sieve (mm)	Allowable range % retained
Gravel	10	2.00	0- 5%
Very coarse sand	18	1.00	0-20% combined with Gravel
Coarse	35	0.50	at least 60% in this range
Medium	60	0.25	at least 60% in this range
Fine	100	0.15	10% maximum
Very Fine	270	0.05	3% maximum
Silt		0.002	5% maximum
Clay		<0.002	3% maximum

In addition, there shall be 100% passing the No. 5 screen (4mm), and no more than 10% combined very fine sand, silt, and clay.

PART 3 EXECUTION

3.01 TOPSOIL PREPARATION

- A. Provide amendments and conditioners to bring topsoil into compliance with Project requirements to complete the work of this Section. Uniformly blend to produce a homogeneous mixture so that when placed, no layering within the soil profile will occur.

- B. Bulk-mix using an approved mechanical mixer, or fold-mix windrows with a loader.
- C. Mixture shall be kept dry at all times prior to final placement. Topsoil shall not be delivered in a frozen or muddy condition.

3.02 SHAPING AND GRADING OF SUBSOIL AT LAWN AREAS

- A. At completion of rough grading, shape and grade subgrade areas to lines and levels needed to achieve the finished grades indicated on the drawings.
- B. Shape subgrade areas to allow placement of uniform depth of topsoil. Adjustments may be necessary due to field conditions. Provide all shaping adjustments at no additional cost to the owner.
- C. Harrow or otherwise loosen the subgrade soil to a depth of 4 inches. Protect loosened subgrades from compaction. Utilize small tracked equipment with low load bearing capacity.
- D. Remove all sticks, stones, or foreign material one-half (1/2) inch or greater in any dimension from surface. Remove debris and stone off-site.

3.03 SPREADING TOPSOIL AND TOPSOIL/COMPOST MIXES

- A. Do not apply topsoil materials to the scarified subgrade or gravel layer without approval by the Engineer. No vehicular traffic or rubber-tired equipment shall be allowed on finished subgrade. Topsoil materials shall not be spread until topsoil has been amended as required. Topsoil materials shall not be worked in a frozen or muddy condition. Do not handle soils when wet.
- B. Uniformly distribute and spread topsoil materials over all graded lawn areas to conform smoothly to the lines, grades, and elevations shown or otherwise required. Maintain consistent depths of material throughout the project area. Provide for a minimum thickness of 6-inches of topsoil.
- C. Manually supply topsoil around all trees to remain. Avoid damage to root systems. The depth of topsoil placed around existing trees shall be determined in consultation with the Engineer.
- D. Spread topsoil mixtures in two (2) equal lifts in all locations scheduled to receive 8" or more total topsoil thickness. Bottom lift shall be incorporated into the loosened subgrade or gravel layer as applicable, by disking, harrowing, or other approved means.
- E. Place topsoil in layers that will provide the scheduled thickness after natural settlement and light rolling.
- F. Spread topsoil from edges inward toward the middle of areas receiving topsoil. Do not allow equipment directly on the loosened subgrade.
- G. Do not over compact the topsoil. Do not allow rubber-tired equipment on topsoil areas. Use the lightest weight equipment practicable. Sequence operations to minimize the number of equipment

passes required.

- H. Track topsoil slopes -parallel to the fall line.
- I. Place topsoil materials only when it can be immediately followed by seeding operations.
- J. Resupply and place topsoil to eroded, settled or damaged areas until all seeded areas are stabilized. Care shall be taken not to damage grass or pavement areas in the replacement to topsoil.
- K. Compact subgrade soils where fill is required to 80-85% maximum dry density.

3.04 PROTECTION

- A. Remove weeds prior to lawn development operations. No weeds shall be allowed to go to seed.
- B. Keep heavy equipment, trucks, etc. off topsoil areas at all times. Only light tractors will be allowed if necessary.
- C. If over compaction to topsoil occurs, scarify to the full depth of the topsoil and regrade topsoil.

3.05 EXCESS MATERIALS

- A. Excess material, including tailings from screening operations shall be legally disposed of offsite.

3.06 FIELD QUALITY CONTROL

- A. Following spreading of topsoil, and prior to the start of seeding operations, set grades as shown on the plans.

END OF SECTION 329113

SECTION 329200 - LAWN

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. The general provisions of the Contract, including General and Supplementary Conditions, and General Requirements apply to the work specified in this Section.

1.02 SECTION INCLUDES

- A. Contractor to provide all labor, materials, necessary equipment, and services to provide and establish all seeded lawns for backing-up pavements and curbs installed under this Contract, and for repair of lawns and other areas damaged by construction as shown on the Drawings and as specified herein, including:
1. Fine grading and preparing the seed bed.
 2. Repair of seeded lawn areas damaged by the work of other sections of this Contract.
 3. Providing and incorporating soil amendments as indicated for good seeded lawn growth.
 4. Seed all areas identified on the Drawings as lawn.
 5. Providing and installing erosion control systems (erosion control blanket or salt hay mulch) as necessary.
 6. Mowing, watering, and maintaining the seeded lawn until established and accepted by the Owner.
 7. Protection, security and repair of damage to all seeded lawn areas until acceptance of all lawn areas.

Note: Contractor shall note that all chemical treating of all lawn areas to insure that lawn is free of weeds and crabgrass shall comply with State of Connecticut laws and regulations for application of these products on school grounds.

- B. Implement practices and procedures to meet the project's environmental goals, which include complying with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- C. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools and the

Department of Administrative Services / Office of School Construction Grants High Performance
School Construction Bulletin, June 2017.

1.03 RELATED SECTIONS

- A. Section 018113 - Volatile Organic Compound Limits
- B. Section 329113 - Topsoil
- C. Section 329300 - Landscape Planting

1.04 QUALITY ASSURANCE

- A. Qualifications of Installers: Provide at least one person who shall be present at all times during execution of this portion of the Work, who shall be thoroughly familiar with the type of materials being installed and who shall direct all work performed under this Section.
- B. Preventatives and Controls: Prior to the application of the preventatives and controls specified, confirm that each of the materials is permitted in the State of Connecticut. Pesticides shall be applied by Connecticut-Certified Commercial Applicators.

Note: Contractor shall note that all chemical treating of all lawn areas to insure that lawn is free of weeds and crabgrass shall comply with State of Connecticut laws and regulations for application of these products on school grounds.

- C. Installer's Qualifications: Engaged firm must be able to provide evidence to indicated five years documented experience in the installation of work specified herein.
- D. Comply with the requirements of the State Department of Environmental Protection. Hazardous Materials: Section 22A-54 of the Connecticut General Statutes.
- E. Comply with the requirements of the State Department of Agriculture: Commercial Fertilizer Law and Agriculture and Vegetable Seed Law.
- F. High Performance Building Requirements:
 - 1. Adhesives or sealants used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113 "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Submittal Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Submittal Requirements of this Section.

1.05 REFERENCES

- A. American Society for Testing Materials (ASTM) publication: ASTM C602-95a (2001) "Agricultural Liming Materials".
- B. Federal Specifications (FS): FSO-F-241 C (1). Fertilizers: Mixed Commercial.
- C. Connecticut Commercial Fertilizer Law: Chapter 427A (P.A. 73-278) of Connecticut General

Statutes, Revisions and Subsequent Amendments.

- D. Connecticut Agriculture and Seed Law: Chapter 424 of Connecticut General Statutes, Revised to 1979 as amended.

1.06 PROJECT CONDITIONS

- A. All pesticide treatments shall conform to State of Connecticut laws and regulations for application of these products on school grounds.
- B. Notify the Owner's representative and Engineer a minimum of two (2) days prior to scheduled pesticide applications.

1.07 PRODUCT HANDLING

- A. Delivery and Storage:
 - 1. Seed, fertilizer, lime, and other amendments shall be delivered in standard size unopened containers, showing weight, analysis, and name of manufacturer.
 - 2. Delivery and storage of chemical preventatives and controls shall be coordinated with and approved by responsible school officials and representatives prior to delivery. Materials must be delivered in standard size unopened containers, showing weight, analysis, and name of manufacturer. Plan for protection of materials shall be coordinated with and approved by responsible school officials and representatives prior to delivery.
 - 3. Protect materials from deterioration during delivery and while stored at the site.

1.08 GUARANTEE

- A. Duration of guarantee shall be until the completion of the specified maintenance period and until Owner's final acceptance of lawn areas.

1.09 SCHEDULE

- A. Construct seeded lawns between April 1 and June 1 and between August 15 and October 1 unless otherwise permitted by the Owner's Representative.

1.10 EXISTING WORK

- A. Verify that topsoil surface is true to grade, smooth, free of irregularities, properly installed to the scheduled thickness and in good condition to receive the work of this Section.

1.11 SUBMITTALS:

- A. Provide copies of a material certificate signed by the seed vendor and the Contractor, (stating botanical and common names, percentages by weight, and percentages of purity, germination and weed seed for each 'grass' seed species) certifying that the seed mixture complies with the specified requirements. All materials are to be approved by the Owner's representative and the Engineer prior to their use. These certifications shall comply with these specifications and where applicable with the Standards of the Association of Official Agricultural Chemists and Association of Official Seed Analysts.
- B. Submit materials certificates and product data for the following items, clearly marked, to indicate proposed materials. Printed data shall state application rates and amounts of product to be added, if applicable. All materials are to be approved by the Owner's representative and the Engineer prior to their use. These certifications shall comply with these specifications and where applicable with the Standards of the Association of Official Agricultural Chemists.
 - 1. Fertilizers
 - 2. Lime
 - 3. Chemical preventatives and controls: Selection and submittal of materials certificates and product data for chemical preventatives and controls shall conform to State of Connecticut laws and regulations for application of these products on school grounds.
- C. Submit batch delivery tickets for the following items, indicating the trade name, the supplier/distributor's name and the amount of product delivered to the contracting firm/project site. All material certificates and invoices on quantities of all materials delivered to the project site shall be submitted to the Owner's representative and the Engineer prior to their use for examination and approval of such materials.
 - 1. Fertilizers
 - 2. Seed mixes
- D. Test Results: Submit tests of determining bulk density (density) of the topsoil once in place using an appropriate method outlined in C.A. Black (ed.) Methods of Soil Analysis, Part I, American Society of Agronomy. 1965.
- E. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.

- b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.12 TOPSOIL TESTING

- A. Insure that topsoil has been tested in accordance with Section 32 91 13.
- B. Provide testing of bulk density (density) of the topsoil once in place using an appropriate method outlined as indicated above in Article 1.11 Submittals, Item D. Contractor shall be responsible for contracting and payment of testing.

1.13 INSPECTION AND ACCEPTANCE OF LAWN AREAS

- A. Submit written notice requesting inspection at least 10 days prior to the anticipated date.
- B. Maintenance responsibilities end with final acceptance which shall be a minimum 90 consecutive calendar days from the date of seeding. Seeded areas will not be accepted in 'pieces' unless otherwise shown on the Drawings or specifically agreed to by the Owner. No seeded areas will be accepted prior to the substantial completion of this Contract and prior to the completion of a minimum of 5 mowings.
- C. A satisfactory stand of acceptable grass is defined as:
 1. Consisting of a uniform dense stand of established permanent grass species. Engineer will be the judge. Any part of the seed lawn that does not show a uniform dense lawn grass shall be reseeded. Lawns must be free of weeds, crabgrass, and other undesirable plants, and with no diseases present.
- D. Final acceptance will not be made until all damaged areas, including areas outside the property limits, have been restored to their original conditions by topsoiling, seeding, and other necessary operations.
- E. Upon stabilization of seeded lawn areas, erosion control devices and protection fencing shall be removed and disposed of off-site.

1.14 PROTECTION AND SECURITY

- A. Provide protection and security as necessary to prevent damage to lawn areas by any cause, including malicious vandalism and unauthorized usage, prior to acceptance of lawn by Owner.

PART 2 PRODUCTS

2.01 LIME: ground dolomitic limestone, 98% passing through a number 20 mesh screen and at least 75% passing through a 100 mesh screen. Limestone shall have a calcium carbonate equivalency of 85% or higher. Application rate to be determined by the topsoil testing.

2.02 FERTILIZER:

- A. Topsoil Fertilizer: complete at the ratios recommended in the topsoil test reports.
- B. Starter Fertilizer: guaranteed analysis of 10.20.10.
- C. Secondary Fertilizer: guaranteed analysis of 15.15.15.

2.03 LAWN SEED

- A. Provide fresh, clean, new-crop seed; blue tag certified complying with the tolerance for purity and germination established by the Office of Seed Analysis of North America. Provide seed of the grass species, proportions and maximum percentages of weed seed. Provide seed in cleaned, sealed, properly labeled containers.
 - 1. Grass seed delivered to the site must be fully labeled according to the seed laws and regulations of the State of Connecticut.
 - 2. A letter from the seed supplier is to accompany the seed mixture delivered to the site certifying that the seed in the bags are the cultivars listed on the label.
 - 3. The seed mixture is to be inspected by the Owner or the Owner's representative prior to its acceptance. Seed that is wet, moldy, or otherwise damaged will not be accepted.
- B. Seed shall be handled in accordance with the manufacturer's recommendations for exposure to extremes of heat, cold, or moisture.
- C. LAWN SEED QUALITY:
 - 1. Weed Seed: maximum of 0.50%, no noxious weed seed.
 - 2. Purity: minimum 97% pure.
 - 3. Crop: maximum 0.50%
 - 4. Germination Rate: minimum 80%
- D. SEED MIXTURE: "Hart's Wear 'n Tear" prepared and packaged by the Chas. C. Hart Seed Co., P.O. Box 9169, Wethersfield, CT 06129. Tel: 860-529-2537. Grass seed mix is listed below showing percent by weight:
 - 35% Kentucky Bluegrass

- 35% Creeping Red Fescue
- 20% Fiesta 3 Perennial Ryegrass
- 10% Express Perennial Ryegrass

- 2.04 SALT MARSH HAY: Air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Provide only salt marsh hay for lawn areas.
- 2.05 HYDROMULCH: "Hydro Mulch" manufactured by Conwed Fibers, Soil Guard Bonded Fiber Matrix as manufactured by Weyerhaeuser or approved equal.
- 2.06 EROSION CONTROL BLANKET: DS150 Erosion Control Blanket manufactured by North American Green, 14649 Highway 41 North, Evansville, IN 47711. Include staples as required by manufacturer for complete installation.
- 2.07 CHEMICAL PREVENTATIVES AND CONTROLS: Selection of materials and products for chemical preventatives and controls shall conform to State of Connecticut laws and regulations for application of these products on school grounds.
- 2.08 PRE-EMERGENCE CRABGRASS CONTROL: Selection of materials and products for pre-emergence crabgrass control shall conform to State of Connecticut laws and regulations for application of these products on school grounds.
- 2.09 WATER: Potable.

PART 3 EXECUTION

3.01 SEEDED LAWN: RATES OF APPLICATION

<u>Material</u>	<u>Application Rate</u>
Topsoil Fertilizer, Lime and Topsoil Conditioners	As recommended by the topsoil test report.
Grass Seed	5 lbs./1,000 S.F. (250 lbs./acre)
Hydromulch	As recommended by manufacturer.
Starter Fertilizer	10 lbs./1,000 S.F.
Secondary Fertilizer	6.5 lbs./1,000 S.F.
Crabgrass Preventative	See the State of Connecticut laws and regulations for application of these products on school grounds.
Lawn Pest/Disease Control	See the State of Connecticut laws and regulations for application of these products on school grounds.

<u>Material</u>	<u>Application Rate</u>
Soil Insect Control	See the State of Connecticut laws and regulations for application of these products on school grounds.
Broad Leaf Weed Control	See the State of Connecticut laws and regulations for application of these products on school grounds.

3.02 SEEDED LAWN: BED PREPARATION

- A. Apply lime, topsoil fertilizer, and other recommended conditioners at the rates recommended by the topsoil tests in all areas where topsoil and topsoil/compost mix have been installed. Cultivate topsoil to a 4" depth by spring-toothed harrow or other approved methods to thoroughly incorporate amendments into the topsoil. Maintain a loose friable seed bed. At no time will rubber tired loaders or graders having greater compaction than a small farm tractor be allowed on topsoil. Keep all heavy equipment and trucks off prepared topsoil. Do not prepare while ground is wet or frozen.
- B. Provide additional topsoil where and as required to properly meet all proposed finish grades.
- C. Remove any weeds, debris, foreign matter and stones having any dimension greater than 3/4". Remove from property.
- D. Fine grade to a smooth uniform surface. The entire area shall present an even grade with no depressions where water will stand. Grades shall be within 1/2" of designated elevation. Any protective fencing around existing trees shall be removed and disposed of by the Contractor at this time. Topsoil shall be smoothly blended to existing finish grades around trees, erosion control devices and adjacent existing conditions, maintain existing surface drainage patterns. Smoothly round-off all top and toe of slopes. Reinstall erosion control devices and protective fencing as required.
- E. Approval of surface by Engineer shall be obtained before seeding operations begin.
- F. All areas to receive seed shall be compacted evenly and uniformly using a two-hundred-pound (200 lb.) roller.
- G. Perform bulk density and compaction tests to monitor degree of soil compaction/seed bed friability where directed. Where required, loosen the seed bed to obtain no greater than 70% of the ASTM D-1557 modified optimum density.

3.03 SEEDED LAWN: DEVELOPMENT

- A. All disturbed areas not developed otherwise shall be developed as lawn with six (6) inches of topsoil as indicated on the drawings and as specified.

3.04 SEEDED LAWN: SEEDING PROCEDURE

- A. Seeding shall be done when wind does not interfere with uniform distribution of hydroseeding mixture.
- B. Apply starter fertilizer, seed and maximum 10% of mulch in one operation by the use of an approved spraying machine. Avoid spraying mix on adjacent surfaces, walks, building walls, and curbs.
- C. Apply remaining 90-100% of the mulch in a second separate application.
- D. Mix materials with water. Keep in an agitated state so that the materials are uniformly suspended in the water. Apply all materials at the specified rates.
- E. Do not overseed with unapproved quick-germinating species.

3.05 SEEDED LAWN: ESTABLISHMENT

- A. Maintain a moist seed bed at all times. Water seed bed so that the topsoil is wet to a depth of 2". Apply complete coverage to the seeded area as necessary to insure proper germination conditions.
- B. Protect all lawn areas with barricades, if necessary, to keep all traffic off the area. Repair all damage to lawn areas including topsoil replacement, at no additional cost to owner.
- C. Re-seed all areas which have failed to show a uniform stand of grass after the initial plants have appeared. All areas disturbed/prepared for reseeding in spring or summer shall receive crabgrass preventative.

3.06 SEEDED LAWN: MAINTENANCE

- A. Maintenance Period Required: Contractor shall maintain lawn from immediately after seeding and shall continue maintenance until final acceptance.
- B. Provide all reseeding, watering, mowing, weeding, insect or disease control, re-fertilizing, repair of washouts and other maintenance procedures which are necessary to produce a uniform stand of grass. The contractor shall provide all irrigation equipment and water as necessary to irrigate the seeded areas daily with ¼ acre inch of water per day using three (3) sets to keep the surface moist and to maintain soil moisture at or near field capacity so that the seed bed does not dry out and adequate rooting takes place. The amount of water and the number of sets may be adjusted at the request of the Owner. The irrigation schedule shall further be adjusted with the approval of the Owner after the seedling plants are well rooted. The quantity of water used per day shall be recorded and reported in writing daily to the Owner and Engineer for the first three weeks from

seeding and weekly thereafter.

C. Grass shall be maintained at a height of 1 1/2" using a reel mower set at the height of 1 1/2" (bench setting) in which the clip of the reel matches the mowing height. The reel blades and bed knife shall be kept sharp and evenly matched to provide a clean cut. The mower shall be operated within the speed range recommended by the manufacturer. Mowing frequency shall be at five (5) day intervals commencing as soon as the seedlings in the seeded areas reach 2 inches high and must be adequate to insure that no more than 1/4 of the grass blade height is removed at any one time. Remove heavy clippings.

D. Secondary Fertilization: Apply secondary fertilizer 14 days after seeding. Apply per manufacturer recommendations.

3.07 EROSION PREVENTATIVES: Install erosion control system in any seeded areas which receive concentrated run-off water and areas as required by the Owner or Owner's Representative. Erosion control materials shall be secured as recommended by the manufacturer or as indicated on the Drawings.

3.08 CRABGRASS AND BROADLEAF WEED CONTROL

A. Treat any lawn areas infested with crabgrass or broadleaf weeds with weed control products in conformance with State of Connecticut laws and regulations for application of these products on school grounds.

3.09 DISEASE CONTROL

A. Treat any diseased lawn areas with disease control product, as required after diagnosis of disease organisms in conformance with State of Connecticut laws and regulations for application of these products on school grounds.

3.10 PROJECT CLEAN-UP

A. Upon completion of all lawn areas, remove all excess soil, debris, and other materials resulting from work operations of this Section. Restore all improvements to original condition. Broom clean all walks and pavements. All clean-up shall be completed at the end of each working day.

B. Upon stabilization of lawn areas, remove all erosion control systems. Re-seed as required.

END OF SECTION 329200

SECTION 329300 - LANDSCAPE PLANTING

PART 1 GENERAL

1.01 CONDITIONS AND REQUIREMENTS

- A. The General Conditions, Supplementary Conditions, and Division 1 – General Requirements apply.

1.02 SUMMARY

- A. Implement practices and procedures to meet the project's environmental goals, which include complying with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, June 2017.

1.03 SECTION INCLUDES

- A. Provide all labor, materials, equipment, services etc. necessary and incidental for the completion of all landscape work as shown on the drawings and specified herein.
- B. The Contractor shall be liable for any damage to property caused by landscaping operations and all areas and construction disturbed shall be restored to their original condition to the satisfaction of the Engineer.
- C. The Contractor shall carefully correlate his work with that of other Contractors.
- D. The Contractor is required to install and maintain his finished work at his expense as specified.

1.04 RELATED SECTIONS

- A. Section 018113 - Volatile Organic Compound Limits
- B. Section 329113 - Topsoil
- C. Section 329200 - Lawn

1.05 SUBMITTALS

- A. Manufacturer's Data: Submit copies of the manufacturer's and/or source data for all materials specified, including soils.

- B. Samples: Submit samples of all topsoil, soil mixes, mulches, and organic materials. Samples shall weigh 1 kg (2 lb) and be packaged in plastic bags. Samples shall be typical of the lot of material to be delivered to the site and provide an accurate indication of color, texture, and organic makeup of the material.
- C. Plant Photographs: Submit color photographs of representative specimens of each type of tree and shrub on the plant list. Photos shall be 75 x 125 mm (3 x 5 in.) taken from angle that depicts the size and condition of the typical plant to be furnished. A scale rod or other measuring device shall be included in the photograph. For species where more than 20 plants are required, include a minimum of three photos that show the average plant, the best quality plant, and the worst quality plant to be provided. Label each photograph with the plant name, plant size, and name of the growing nursery.
- D. Nursery Sources: Submit a list of all nurseries that will supply plants, along with a list of the plants they will provide and the location of the nursery.
- E. Soil Test: Submit soil test analysis report for each sample of topsoil and planting mix per submittal requirements Section 329300 - Topsoil.
- F. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letter-head, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.06 MATERIALS STORAGE AND CLEAN-UP

- A. The Contractor shall keep the premises free from rubbish and all debris at all times and shall arrange his material storage so as not to interfere with the operation of the project. All unused materials, rubbish and debris shall be removed from the site.

1.07 COMPLETION AND ACCEPTANCE

- A. The Contractor shall notify the Engineer when the work of this section is substantially complete. The Engineer shall then review the work and prepare the "punch list" of items remaining or work that is unacceptable. At this time the Engineer may issue the "Notification of Substantial Completion" if the majority of the work is complete to the satisfaction of said Engineer.
- B. The completion of the contract will be accepted and Notice of Completion recorded only when the entire contract is completed to the satisfaction of the Engineer.
- C. Work under this Section will be accepted by the Owner's Construction Representative upon satisfactory completion of all work including "punch list" items.

1.08 WARRANTY

- A. All plant material (tree, shrubs, etc.) and planting supplies (edging, bark mulch, etc.) shall be guaranteed for a period of one (1) year from the date of "Notification of Substantial Completion" of the landscaping installation.

1.09 LANDSCAPE MAINTENANCE

- A. The Landscape Contractor shall maintain his finished work for a period of not less than one (1) year commencing from the time the installation is complete to the satisfaction of the Engineer.
- B. IMPORTANT: It is the Contractor's responsibility to determine water application rates. Water if rainfall does not exceed 3/4" in any 8 day period.
- C. The Landscape Contractor shall maintain the landscaping until final acceptance.

1.10 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives or sealants used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113 "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Submittal Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Submittal Requirements of this Section.

PART 2 PRODUCTS

2.01 TOPSOIL

- A. Refer to Section 329113 - Topsoil

2.02 PLANTING SOIL MIXTURE

- A. Topsoil for backfilling plant pits and shrub bed areas shall be mixed with well rotted manure in the following proportions:

Seven (7) cubic yards of topsoil to two (2) cubic yards of manure. They shall be thoroughly mixed by placing the manure evenly over the topsoil piles and turning the piles at least three (3) times or until thoroughly mixed to the satisfaction of the Engineer.

2.03 PLANT STOCK

- A. Plant material shall be first quality stock and shall conform to the code of standards set forth in the current edition of the American Standards for Nursery Stock sponsored by the American Association of Nurserymen, Inc.
- B. Species and variety as specified on the drawings and delivered to the site shall be certified true to their genus, species and variety and as defined within the current edition of International Code of Nomenclature for Cultivated Plants, issued by the International Union of Biological Sciences. Substitutions are not permitted without Engineer's written approval.
 - 1. For plant size and types see Drawings for plant list.
- C. Plants shall be nursery grown and shall be of varieties specified in the plant list bearing botanical names.
- D. Planting stock shall be well-branched and well-formed, sound, vigorous, healthy, free from disease, sun-scale, windburn, abrasion, and harmful insects or insect eggs; and shall have healthy, normal unbroken root systems. Deciduous trees and shrubs shall be symmetrically developed, of uniform habit of growth, with straight trunks or stems, and free from objectionable disfigurements. Evergreen trees and shrubs shall have well-developed symmetrical tops with typical spread of branches for each particular species or variety. Plants shall have been grown under climatic conditions similar to those in the locality of the project. Plants budding into leaf or having soft growth shall be sprayed with an anti-desiccant at the nursery before digging.
- E. Stock Sizes: All stock measurements - caliper, height branching level, number of canes, ball sizes shall be in strict accordance with the latest edition of the American Standard for Nursery Stock. Minimum acceptable sizes as specified on the Drawings.
- F. All stock shall be balled and burlapped or container grown stock. Bareroot stock of any kind is unacceptable unless otherwise indicated on the Drawings.

2.04 MULCH FOR PLANTING PITS/BEDS (SHREDDED CEDAR BARK)

- A. Shredded cedar bark mulch shall be a natural forest product composed of shredded bark or wood not exceeding three inches (3") in length and one inch (1") in width. Mulch shall be derived from tree material, not from wood waste or by-products like sawdust, shredded pallettes, or other debris. It shall be of a uniform grade and dark brown color with no additives or any other treat-

ment. Mulch with leaves, twigs, and/or debris shall not be acceptable. The pH factor should range from 5.8 to 6.2.

2.05 WATER

- A. Water shall not contain elements toxic to plant life.

2.06 ANTI-DESICCANT

- A. Anti-desiccant shall be an emulsion that will provide a film over plant surfaces permeable enough to permit transpiration, and not damage the plant.

2.07 TREE WOUND DRESSING

- A. Tree wound dressing shall be a black asphalt-base antiseptic paint.

PART 3 EXECUTION

3.01 GENERAL PREPARATION

- A. Prior to beginning the work of this section, verify that site grading and preparation have been properly completed.
- B. Clearing shall consist of the satisfactory removal and disposal of brush and rubbish occurring within all lawn and planting areas.

3.02 UNDERGROUND OBSTRUCTIONS TO PLANTING

- A. If underground utilities, are encountered, other locations for planting may be selected by the Engineer. Damage to utility lines shall be repaired at the Contractor's expense at no additional cost to the Owner.
- B. Remove all miscellaneous debris below the ground surface and dispose of according to the specifications.

3.03 PREPARATION OF PLANTING MIXTURE

- A. Before mixing, clean topsoil of roots, plants, sod, stones, clay lumps and other extraneous materials harmful or toxic to plant growth, by screening.
- B. To prepare planting mixture mix recommended soil amendments and fertilizers with topsoil at rates specified. Delay addition of fertilizer if planting mixture will not be used within two (2) days.

3.04 TREE AND SHRUB PLANTING

- A. All planting shall be performed by personnel familiar with the accepted procedure of planting and under the constant supervision of a qualified planting foreman.

B. All planting is to be done as shown on drawings and as specified herein and in strict accordance with standard horticultural practices.

C. PLANTING SEASONS AND CONDITIONS

1. Planting shall be done only when the ground is not frozen, snow covered, or in an otherwise unsuitable condition for planting.
2. Unless otherwise directed by the Engineer, deciduous material shall be planted from March 1st to May 1st and from October 15th to December 15; evergreen material shall be planted from April 1st to May 15th and from September 1st to October 15th, or as approved by the Engineer.

D. LAYOUT: Plant material locations and bed outlines shall be staked on the project site by the Contractor and approved by the Engineer before any plant pits or beds are excavated. Plant material locations may be adjusted by the Engineer to meet field conditions.

E. INSTALLATION OF TREES AND SHRUBS

1. Setting Plants:

- a. Balled and burlapped and container-grown plants shall be handled and moved only by the ball or container. Place stock on setting layer of compacted planting soil. Plants shall be set plumb and held in position until sufficient soil has been firmly placed around roots or ball. Plants shall be set in relation to surrounding grade so that they are even with the depth at which they are grown in the nursery, collecting field, or container. Fertilizer in tablet form shall be placed prior to backfilling and in accordance with the manufacturer's specifications. Do not use planting stock if ball or container is cracked.
- b. Balled and burlapped stock shall be backfilled with planting soil mixture to approximately half the depth of the ball and then tamped and watered. Burlap, wire baskets, and tying materials shall be carefully removed or opened and folded back from top 1/3 of root ball. The remainder of backfill of planting soil mixture shall be tamped and watered. Earth saucers or water basins shall then be formed around the base of each plant.
- c. Container-grown stock shall be removed from containers without damaging plant or root system. Planting shall be completed as specified for balled or burlapped plants.

2. Mulching:

- a. Organic bark mulch for planting beds shall be installed to a minimum depth of four inches (4") in all areas specified on the landscaping plans. Do not place mulch against trunks or stems.
- b. Prior to the installation of bark mulch all areas to be covered shall be weed free and shall be treated with pre-emergent herbicide.

- c. Mulching shall take place within 48 hours after planting.
 - d. Mulch shall be kept out of the crowns of shrubs and off buildings, sidewalks, light standards, and other structures.
 - e. The top of all areas of bark cover shall be 1" below the top of adjacent curb, walk or edge of pavement.
3. Pruning: New plant material shall be pruned in the following manner: Dead and broken branches shall be removed. Pruning of deciduous trees and shrubs shall be minimal. Evergreen plants shall not be pruned except to remove dead or broken branches. Typical growth habit of individual plants shall be retained with as much height and spread as is practicable. Cuts shall be made with sharp instruments, and shall be flush with trunk or adjacent branch to insure elimination of stubs. "Headback" cuts at right angles to line of growth shall not be permitted. Trees shall not be poled or the leader removed, nor shall the leader be pruned or "topped off". Trimmings shall be removed from the site.
4. Plant Sizes: For plant size and types see Drawings for plant list.

3.05 LANDSCAPE EDGING INSTALLATION

- A. Preparation: Ensure that all underground utility lines are located and will not interfere with the proposed edging installation before beginning work. Locate border line of edging with string or other means to assure border straightness and curves as designed. Dig trench 1 inch deeper than set of edging bottom.
- B. Install edging in accordance with manufacturer requirements/recommendations.
- C. Where edging sections turn at corners and at angled runs, cut edging partially up through its height from bottom and turn back to desired angle to form rounded exposed radius.
- D. Backfilling and Cleanup: Backfill both sides of edging, with material as indicated on the Drawings. Confirm and adjust if necessary that sections are securely held together, and compact backfill material along edging to provide top of edging at 1/4 inch +/- above lawn/gravel mulch/stone strip finish grade. Cleanup and remove excess material from site.

END OF SECTION 329300

SECTION 331000 - WATER DISTRIBUTION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General and Supplementary Conditions, and Division One General Requirements apply to the work specified in this section.
- B. Form 816 shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816-2004 or its latest edition and any supplemental specifications.
- C. Town of Branford requirements and Aquarion Water Company Specifications, latest edition, which document shall be considered as a part of these specifications.

1.02 SUMMARY

- A. Implement practices and procedures to meet the project's environmental goals, which include complying with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, June 2017.

1.03 DESCRIPTION OF WORK

- A. Work under this item shall consist of the installation of a new cement-lined ductile iron water main, connection to existing water mains and installation of new water services where shown on the plans or as directed by the Engineer. Work shall also include the installation of blow-offs and hydrants where shown on the plans or as directed by the Engineer.
- B. Work under this item shall include, but not be limited to:
 - 1. Furnishing and installation of new water main
 - 2. Connecting to existing water main
 - 2. Furnishing and installation of corporation stops
 - 3. Furnishing and installation of curb stops and curb boxes

4. Furnishing and installation of ductile iron or copper piping
 5. Furnishing and installation of new fire hydrants
 6. Testing and disinfection
 7. Bituminous pavement repair
- C. Coordinate the Work of this section with Section 312316 - Earthwork and Section 312333 - Trenching.

1.04 RELATED WORK

- A. Section 018113 - Volatile Organic Compound Limits
- B. Section 312316 - Earthwork
- C. Section 312333 - Trenching
- E. Section 321123 - Processed Aggregate Base

1.05 SUBMITTALS

- A. Manufacturer's data sheets with specifications for ductile iron piping, copper tubing, corporation stops, backflow preventers, and curb stops shall be submitted to the Engineer for approval.
- B. Alternative methods of water service installation shall be submitted to the Engineer for approval.

PART 2 PRODUCTS

2.01 GENERAL

- A. All materials including corporation stops, service saddles, couplings, curb stops, curb boxes shall conform to water company standard specifications.

2.02 WATER MAIN

- A. Water main lines shall be various diameter cement-lined ductile iron pipe as shown on the plans.

2.03 PE FILM, PIPE ENCASEMENT

- A. ASTM A 674 or AWWA C105; PE film, tube, or sheet; 8-mil (0.2-mm) thickness.

2.04 DUCTILE IRON PIPE AND FITTINGS

- A. AWWA C151, Class 56. Fittings shall be ductile iron or cast iron, AWWA C110, 250 PSI, mechanical joint or AWWA C153, ductile iron compact fittings, 350 PSI, mechanical joint.
- B. Lining: AWWA C104, cement mortar, seal coated.
- C. Gaskets: AWWA C111, rubber.
- D. Encasement: AWWA C105, polyethylene film tube.

2.05 WATER METER: Coordinate the furnishing and installation of water meters with the Town of Branford and Aquarion Water Company.

2.06 FIRE HYDRANTS: Coordinate the furnishing and installation of hydrants with the Town of Branford and Aquarion Water Company.

PART 3 - EXECUTION

3.1 TRENCHING

- A. Sawcutting, trenching, bedding and backfilling are covered under Sections 312316 "Earthwork." And 312333 "Trenching".
- B. Minimum cover over pipe shall be 4 ½ feet deep – **NO EXCEPTIONS. ALL SERVICES SHALL BE INSPECTED BY THE AUTHORITY BEFORE THEY ARE BACKFILLED.** Services not visually inspected shall be pressure tested before the meter is set. The test will check to see if the service can hold the distribution systems static pressure.

3.2 INSTALLING PIPE

- A. Installation shall conform to Town of Branford and Aquarion Water Company standard guidelines and specifications.
- C. Service taps must be done in a minimum 7' x 4' trench. There must be six (6) inches of clearance below and behind water main. Trench must be dewatered and in compliance with OSHA trench requirements. Service pipes are to be left uncovered so that a representative from the Town of Branford Water Department can make an inspection to see that the installation conforms to the Rules and Regulations.
- D. Pipe shall be laid to the lines and grades approved. Water service line shall run perpendicular to the water main from top to curb valve and in a straight line from the curb valve to the point of entrance to the building. Where the pipe crosses existing utilities, a minimum vertical clearance of 12 inches shall be maintained, except for storm and sanitary sewer pipes, where a minimum vertical clearance of 18" shall be maintained. A minimum horizontal distance of 12-18 inches shall be maintained at all times between the water pipe and sewer pipe. Water pipe shall be laid at least 5 feet away from electric lines and natural gas lines, and shall be 10 feet from leaching fields, oil tanks, gas tanks and any associated lines.
- E. In accordance with current state laws, rules and regulations, metallic warning tape is required on all water service installations. Warning tape will be installed no less than 12 inches and no more than 18 inches above each service pipe.

3.3 FIRE HYDRANT

- A. Fire hydrant assembly shall be installed according to Town of Branford/Aquarion Water Company Rules and Regulations.

3.4 TAP TO EXISTING MAIN

- A. Prior to tap, clean outside of existing main thoroughly. Use suitable lubricant to assure proper seal. Trenching must conform to OSHA regulations.
- B. Contractor shall provide and install the tapping sleeve and tighten bolts in accordance with manufacturer's recommendations. Contractor shall install tapping valve and test apparatus as recommended by manufacturer and required by Town of Branford Water Department. The tapping shall be done by Town of Branford Water Department after testing the tapping sleeve.
- C. Support tapping machine during operation. Support new service pipe to be attached to the valve.
- D. All work shall be coordinated with and conform with the Town of Branford Water Department Rules and Regulations.

3.5 WATER METER INSTALLATION

- A. All meter settings shall be subject to the approval of the Town of Branford Water Department. Meters must be set in an accessible place which will permit reading and resetting without necessary delay.
- B. Meters should be located far enough away from street to provide sufficient protection from traffic.
- C. The water table must be at least 3 ½ feet below finish grade of installation.
- D. Pressure regulators shall be located inside the building.

3.6 DISINFECTION AND PRESSURE TESTING

- A. All water service pipes shall be leakage tested by the installer according to Town of Branford Water Department Rules and Regulations and NFPA 24. Documentation of testing and flushing in the Contractor's Material and Test Certificate for Underground Piping (as found in NFPA 24) shall be provided.
- B. All water pipe shall be disinfected by the installer according to Town of Branford Water Department regulations.
- C. It shall be the contractor's responsibility to dispose of all chlorinated water used to disinfect a water main. This shall be accomplished in accordance with the federal Clean Water Act and Connecticut D.E.P. standards for disposal. It may involve running the water through a burlap bag containing a dechlorinating agent. The Water Authority must be notified prior to any dechlorinating operations.

END OF SECTION 331000

SECTION 333000 - SANITARY SEWER

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. The General Provisions of the Contract, including General and Supplementary Conditions, and Division One General Requirements apply to the work specified in this section.
- B. Form 816 shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816-2004 or its latest edition and any supplemental specifications.

1.02 SUMMARY

- A. Work Included: Furnish and install gravity sewer pipe from a point five (5) feet outside of any building construction to the point of tie-in at the existing point of tie-in to the existing public sewer system. This section also includes the following:
 - 1. Trenching, including dewatering and shoring.
 - 2. Backfill and compaction.
 - 3. Connecting to existing sanitary manhole and main line as shown on the Drawings.
- B. Implement practices and procedures to meet the project's environmental goals, which include complying with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- C. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, June 2017.

1.03 RELATED SECTIONS

- A. Section 018113 - Volatile Organic Compound Limits
- B. Section 312316 - Earthwork
- C. Section 312333 - Trenching

D. Section 312500 - Erosion and Sediment Controls

1.04 QUALITY ASSURANCE

- A. Environmental Compliance: Comply with applicable portions of local environmental agency regulations pertaining to sanitary sewerage systems.
- B. Utility Compliance: Compliance with local utility regulations and standards pertaining to sanitary sewerage systems.
- C. All work shall be in accordance with the local/regional sanitary sewer authority.

1.05 SUBMITTALS

- A. Product data for drainage pipes and specialty products.
- B. Records drawings at project closeout of installed sanitary sewer in accordance with the requirements of Division 1.

PART 2 PRODUCTS

2.01 SEWER PIPE AND FITTINGS

- A. PVC Drainage Pipe and Fittings conforming to the following:
 - 1. PVC Drainage Pipe and Fittings, NPS 15 (DN375) and Smaller: ASTM D 3034, SDR 35, for solvent-cemented or gasketed joints.
 - 2. Gaskets: ASTM F 477, elastomeric seals.

2.02 CEMENT MASONRY

- A. Cement masonry for plugging existing sanitary force main shall conform to Article M.08.02, Form 816.

2.03 IDENTIFICATION

- A. Plastic Underground Warning Tapes: Polyethylene plastic tape, 6 inches wide by 4 mils thick, solid green in color with continuously printed caption in black letters "CAUTION - SEWER LINE BURIED BELOW".

PART 3 EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 312316 - Earthwork.

3.2 INSTALLATION, GENERAL

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of sanitary sewer piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line, and pull past each joint as it is completed.
- C. Install gravity-flow piping and connect to building's sewer lines, of sizes and in locations indicated. Terminate piping as indicated.
 - 1. Install piping to grade and elevations as shown on plans.
 - 2. Install piping with minimum cover as recommended by the manufacturer.

3.5 INSTALLATION OF IDENTIFICATION

- A. Install continuous plastic underground warning tape during backfilling of trench for underground water service piping. Locate 6 to 8 inches directly over piping.

3.6 CLOSING ABANDONED SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
 - 1. Close open ends of piping with at least 8-inch thick, brick masonry bulkheads or with at least 8-inch thick, cast-in-place concrete plug.
 - 2. Close open ends of piping with threaded metal caps, plastic plugs, cast-in-place concrete plugs or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Abandoned Structures: Excavate around structure as required and use one procedure below:
 - 1. Remove structure and close open ends of remaining piping.
 - 2. Remove top of structure down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
 - 3. Backfill to grade according to Division 2 Section "Earthwork."

3.7 FIELD QUALITY CONTROL

- A. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed.
 - 1. In large, accessible piping, brushes and brooms may be used for cleaning.
 - 2. Place plug in end of incomplete piping at end of day and when work stops.
 - 3. Flush piping between manholes and other structures to remove collected debris, if required by authorities having jurisdiction.

- B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project. If inspection indicates poor alignment, debris, displaced pipe, infiltration, or other defects, correct such defects and re-inspect.

END OF SECTION 333000

SECTION 334000 - STORM DRAINAGE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Form 816 shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816-2004 or its latest edition and any supplemental specifications.

1.02 SUMMARY

- A. This Section includes the installation of storm drainage outside the building and the abandonment and removal of existing storm drainage as indicated on the Drawings.
- B. Implement practices and procedures to meet the project's environmental goals, which include complying with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- C. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September, 2011, with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, June 2017.

1.03 RELATED SECTIONS

- A. Section 018113 - Volatile Organic Compound Limits
- B. Section 033001 - Portland Cement Concrete (Site)
- C. Section 312213 - Formation of Subgrade
- D. Section 312316 - Earthwork
- E. Section 321123 - Processed Aggregate Base

1.04 SUBMITTALS

- A. Shop Drawings: Include plans, elevations, details, and attachments for the following:

1. Precast concrete manholes and other structures, including frames, covers, and grates.
2. Cast-in-place concrete manholes and other structures, including frames, covers, and grates.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic structures, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle precast concrete manholes and other structures according to manufacturer's written rigging instructions.

1.06 PROJECT CONDITIONS

- A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.
- B. Locate existing structures and piping to be closed and abandoned.
- C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 1. Notify Architect not less than two days in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without Architect's written permission.

PART 2 PRODUCTS

2.01 PIPING

- A. Drainage Pipe: Drainage Pipe and Fittings conforming to the following:
 1. PVC Drainage Pipe and Fittings, NPS 15 (DN375) and Smaller: ASTM D 3034, SDR 35, for solvent-cemented or gasketed joints.
 2. Gaskets: ASTM F 477, elastomeric seals.
 3. Polyethylene Pipe: Corrugated smooth-lined high density polyethylene pipe, type N-12 as manufactured by Advanced Drainage Systems, Inc (ADS). Pipe coupler connections shall be watertight type "Pro-Link WT" by ADS.
- B. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76, Class III, Wall B, for gasketed joints.
 1. Gaskets: ASTM C 443, rubber.

2.02 MANHOLES

- A. Precast Concrete Manholes:

1. Precast Units shall conform to Form 816A, Article M.08.02, 4- Precast Units for Drainage Structures and ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints.
2. Diameter: 48 inches minimum, unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
6. Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
7. Gaskets: ASTM C 443, rubber.
8. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch diameter frame and cover.

B. Manhole Frames and Covers:

1. Frames and Grates shall conform to 816, Article M.08.02, 5- Metal for Drainage Structures.
2. ASTM A 536, Grade 60-40-18, ductile-iron castings designed for heavy-duty service. Include 24-inch ID by 7 to 9-inch riser with 4-inch minimum width flange, and 26-inch diameter cover. Include indented top design with lettering "STORM SEWER" cast into cover.

C. Manhole Steps:

1. Steps shall be fiberglass, individual steps or ladder. Include width that allows worker to place both feet on one step and is designed to prevent lateral slippage off step. Cast or anchor into base, riser, and top section sidewalls with steps at 12- to 16-inch intervals. Omit steps for manholes less than 60 inches deep.

2.03 CATCH BASINS

A. Precast Concrete Catch Basins:

1. Precast Units shall conform to Form 816, Article M.08.02, 4- Precast Units for Drainage Structures and ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints.
2. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.

B. Masonry Catch Basins:

1. Masonry Units shall conform to Form 816, Article M.08.02, 1- Brick or 2- Concrete Building Brick or 3- Masonry Concrete Units for Catch Basins, Manholes or Drop Inlets.

2. Mortar shall conform to Form 816, Article M.11.04.

C. Catch Basin Frames and Grates:

1. Frames and Grates shall conform to Form 816, Article M.08.02, 5- Metal for Drainage Structures.

2.04 CONCRETE FOR CAST-IN-PLACE STRUCTURES

A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water-cementitious ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed steel.

C. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water-cementitious ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed steel.

PART 3 EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 02300 - Earthwork.

3.2 INSTALLATION, GENERAL

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of storm drainage and sanitary sewer piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line, and pull past each joint as it is completed.

C. Install gravity-flow piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.

1. Install piping to grade and elevations as shown on plans.
2. Install piping with minimum cover as recommended by the manufacturer.

D. Join and install PVC pipe in accordance with ASTM D 3212.

3.3 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Set tops of frames and covers flush with finished surface of manholes that occur in pavements.
- C. Construct cast-in-place manholes as indicated.

3.4 CATCH-BASIN/YARD DRAIN INSTALLATION

- A. Construct catch basins / yard drains to sizes and shapes indicated.
- B. Set frames and grates to elevations indicated.

3.5 INSTALLATION OF IDENTIFICATION

- A. Install continuous plastic underground warning tape during backfilling of trench for underground water service piping. Locate 6 to 8 inches directly over piping.

3.6 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
 1. Close open ends of piping with at least 8-inch thick, brick masonry bulkheads or with at least 8-inch thick, cast-in-place concrete plug.
 2. Close open ends of piping with threaded metal caps, plastic plugs, cast-in-place concrete plugs or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Abandoned Structures: Excavate around structure as required and use one procedure below:
 1. Remove structure and close open ends of remaining piping.
 2. Remove top of structure down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

3. Backfill to grade according to Division 2 Section "Earthwork."

3.7 FIELD QUALITY CONTROL

- A. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed.
 1. In large, accessible piping, brushes and brooms may be used for cleaning.
 2. Place plug in end of incomplete piping at end of day and when work stops.
 3. Flush piping between manholes and other structures to remove collected debris, if required by authorities having jurisdiction.
- B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project. If inspection indicates poor alignment, debris, displaced pipe, infiltration, or other defects, correct such defects and re-inspect.

END OF SECTION 334000

SECTION 337119 - ELECTRICAL UNDERGROUND DUCTS AND HANDHOLES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Rigid steel conduit.
 - 2. Plastic conduit.
 - 3. Plastic duct.
 - 4. Reinforced resin conduit.
 - 5. Precast concrete manholes.
 - 6. Handholes.
 - 7. Underground duct markers.
 - 8. Cast-in-place manhole accessories.
- B. Related Sections:
 - 1. Section 31 23 16 - Excavation: Product and execution requirements for excavation and backfill required by this section.
 - 2. Section 31 23 33 - Trenching: Execution requirements for trenching required by this section.
 - 3. Section 31 23 33 - Fill: Requirements for backfill to be placed by this section.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
- B. ASTM International:
 - 1. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
 - 2. ASTM C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
 - 3. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures.
 - 4. ASTM C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures.
 - 5. ASTM C1037 - Standard Practice for Inspection of Underground Precast Concrete Utility Structures.
- C. Institute of Electrical and Electronics Engineers:
 - 1. IEEE C2 - National Electrical Safety Code.
- D. National Electrical Manufacturers Association:
 - 1. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
 - 2. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
 - 3. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.
 - 4. NEMA TC 6 - PVC and ABS Plastic Utilities Duct for Underground Installation.
 - 5. NEMA TC 9 - Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation.
 - 6. NEMA TC 10 - PVC and ABS Plastic Communications Duct for Underground Installation.
 - 7. NEMA TC 14 - Filament Wound Reinforced Thermosetting Resin Conduit and Fittings.
- E. Underwriters Laboratories Inc.:
 - 1. UL 651A - Type EB and A Rigid PVC Conduit and HDPE Conduit.

1.5 SYSTEM DESCRIPTION

- A. Interconnected system of encased conduits, ducts, manholes and handholes to distribute medium-voltage power, telephone, data communications, exterior branch circuit wiring, and exterior lighting branch circuit wiring.
- B. Conduit and duct routing and handhole locations are shown in approximate locations unless dimensions are indicated. Route and locate to complete duct bank system.
- C. Ducts and conduits routed to the future building site shall be terminated 5'-0" from the building foundation line. All ducts terminated in this fashion shall be capped and provided with nylon drag lines

- D. Medium-voltage: Comply with Utility Company requirements for primary service ducts and conduits.
- E. Exterior branch circuit and lighting: Use rigid plastic underground conduit. Provide rigid steel conduit sweeps up into bases and structures.
- F. Telephone: Comply with Utility Company requirements for primary service ducts and conduits.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit for metallic conduit, nonmetallic conduit, ducts, and handholes.
- C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
- D. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 - 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 - 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 - 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 - 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.7 SUSTAINABLE DESIGN SUBMITTALS

- A. Section 01 81 13 - Sustainable Design Requirements: Requirements for sustainable design submittals.

- B. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.
 - 1. Materials Resources Certificates:
 - a. Certify source and origin for salvaged and reused products.
 - b. Certify recycled material content for recycled content products.
 - c. Certify source for local and regional materials and distance from Project site.
- C. Product Cost Data: Submit cost of products to verify compliance with Project sustainable design requirements. Exclude cost of labor and equipment to install products.
 - 1. Provide cost data for the following products:
 - a. Salvaged products.
 - b. Reused products.
 - c. Products with recycled material content.
 - d. Local and regional products.

1.8 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual routing and elevations of underground conduit and duct, and locations and sizes of handholes.

1.9 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.10 QUALIFICATIONS

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

1.11 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Coordinate Work with existing underground utilities and structures.

PART 2 PRODUCTS

2.1 RIGID STEEL CONDUIT

- A. Manufacturers:
 - 1. Allied Tube and Conduit.
 - 2. Western Tube and Conduit.
 - 3. Wheatland Tube Company.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Rigid Aluminum Conduit: ANSI C80.5.
- D. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.2 PLASTIC CONDUIT

- A. Manufacturers:
 - 1. Carlon Electrical Products.
 - 2. Thomas & Betts Corp.
 - 3. Allied Tube and Conduit.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Fittings and Conduit Bodies: NEMA TC 3.
- C. Rigid Plastic Conduit: NEMA TC 2, Schedule 40/80 PVC, with fittings and conduit bodies to NEMA TC 3.

2.3 HANDHOLES

- A. In-Ground Handholes: Stackable 18"x16"x12", open bottom as manufactured by Qauzite Co.:
 - 1. Material: Precast concrete.
 - 2. Cover: Traffic rated precast concrete.
 - 3. Cover Legend: "ELECTRIC" or "TELEPHONE".
 - 4. Provide size as required for primary electrical and telco circuits.
- B. Description: Molded composite handhole comprising modular, interlocking sections complete with accessories.
- C. Loading: ASTM C857, Class A-16.
- D. Covers: Molded composite with tamperproof fasteners. Furnish cover marked to indicate utility.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify routing and termination locations of duct bank prior to excavation for rough-in.
- C. Verify locations of handholes prior to excavating for installation.

3.2 INSTALLATION

- A. Install Work in accordance with the requirements of the Town of Enfield and the State of Connecticut DOT standards.

3.3 INSTALLATION - DUCT BANK

- A. Install duct to locate top of ducts at depths as indicated on Drawings.
- B. Install conduit and duct with minimum slope of 4 inches per 100 feet (0.33 percent). Slope conduit and duct toward manholes and away from building entrances.
- C. Cut conduit and duct square using saw or pipe cutter; de-burr cut ends.
- D. Insert conduit and duct to shoulder of fittings; fasten securely.
- E. Join nonmetallic conduit and duct using adhesive as recommended by manufacturer.
- F. Wipe nonmetallic conduit and duct dry and clean before joining. Apply full even coat of adhesive to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
- G. Install no more than equivalent of three 90-degree bends between pull points.
- H. Install fittings to accommodate expansion and deflection.
- I. Terminate conduit and duct at manhole entries using end bell.
- J. Stagger conduit and duct joints vertically in concrete encasement 6 inches minimum.
- K. Use suitable separators and chairs installed not greater than 4 feet on centers. Secure separators and chairs to trench bottom prior to concrete pour.
- L. Band conduits and ducts together before backfilling or placing concrete.
- M. Securely anchor conduit and duct to prevent movement during concrete placement.
- N. Place concrete in accordance with Section 03 30 00.
- O. Install ducts with minimum 3 inch concrete cover at bottom, top, and sides.

- P. Install steel reinforcing bars in top of bank under paved areas per civil specifications and details.
- Q. Connect to existing concrete encasement using dowels.
- R. Connect to manhole wall using dowels.
- S. Provide suitable pull string in each empty duct except sleeves and nipples.
- T. Swab duct. Use suitable caps to protect installed duct against entrance of dirt and moisture.
- U. Backfill trenches in accordance with Section 31 23 33.

3.4 INSTALLATION - PRE-CAST HANDHOLE

- A. Excavate for handhole installation in accordance with Section 31 23 16.
- B. Install and seal precast sections in accordance with ASTM C891.
- C. Install handholes plumb.
- D. Backfill handhole excavation in accordance with Section 31 23 33.

END OF SECTION

SECTION 337900 - SITE GROUNDING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Rod electrodes.
 - 2. Active electrodes.
 - 3. Exothermic connections.
 - 4. Mechanical connectors.
 - 5. Wire.

1.2 HIGH PERFORMANCE BUILDINGS GENERAL REQUIREMENTS

- A. Implement practices and procedures to meet the project's environmental goals, which include compliance with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools. Specific project goals which may impact this and the other sections of this specification include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; use of certified wood products; construction waste recycling; and the implementation of a construction indoor air quality management plan. Ensure that the requirements related to these goals, as defined in this Section and other Sections of the contract documents, are implemented to the fullest extent. Substitutions or other changes to the work shall not be allowed if such changes substantially compromise the stated High Performance Building criteria.
- B. Comply with Connecticut Standard Guidelines Compliance Manual for High Performance Buildings, September 2011 with additional mandatory building project requirements for schools and the Department of Administrative Services / Office of School Construction Grants High Performance School Construction Bulletin, September 2015.

1.3 ROOM NUMBERING REQUIREMENTS

- A. All system programming and labeling utilizing room numbers shall follow the room numbering plans provided by the Architect. Room numbers shown on contract documents for individual trades are not to be considered final numbers and shall not be utilized.

1.4 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
 - 1. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
 - 2. IEEE C2 - National Electrical Safety Code.
- B. International Electrical Testing Association:

1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.5 SYSTEM DESCRIPTION

- A. Rod electrodes for local grounding at utility transformer, generator and exterior metallic poles.

1.6 PERFORMANCE REQUIREMENTS

- A. Overall Resistance to Ground: 25 ohms.

1.7 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawings: Indicate layout and installation details of grounding components.
- C. Product Data: Submit data for grounding electrodes and connectors.
- D. Test Reports: Indicate overall resistance to ground.
- E. High Performance Building Submittal Requirements: The contractor or subcontractor shall submit the following High Performance Building certification items:
 1. A Connecticut High Performance Building Compliance letter shall be provided verifying agreement with relevant High Performance requirements. Information to be supplied includes, but is not limited to:
 - a. The percentage by weight of recycled content in the product(s). Identify post-consumer and/or pre-consumer recycled content.
 - b. The manufacturing location for the product(s); and the location (source) of the raw materials used to manufacture the product(s).
 - c. Provide material costs for the materials included in the contractor's or subcontractor's work. Material cost does not include costs associated with labor and equipment.
 2. Letters of Certification, provided from the product manufacturer on the manufacturer's letterhead, to verify the amount of recycled content.
 3. Product Cut Sheets for all materials of this Section that meet High Performance Building Requirements.
 4. Material Safety Data Sheets (MSDS), for all applicable products. Applicable products include, but are not limited to adhesives, sealants, carpets, paints and coatings applied on the interior of the building. MSDS shall indicate the Volatile Organic Compound (VOC) limits of products submitted (If an MSDS does not include a product's VOC content, then product data sheets, manufacturer literature, or a letter of certification from the manufacturer can be submitted in addition to the MSDS to indicate the VOC content).

1.8 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of electrodes and connections.

1.9 QUALITY ASSURANCE

- A. High Performance Building Requirements:
 - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
 - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
 - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

1.10 QUALIFICATIONS

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

PART 2 PRODUCTS

2.1 ROD ELECTRODES

- A. Manufacturers:
 - 1. Copperweld, Inc.
 - 2. Erico, Inc.
 - 3. O-Z Gedney Co.
 - 4. Thomas & Betts, Electrical
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description:
 - 1. Material: Copper-clad steel.
 - 2. Diameter: 3/4 inch.
 - 3. Length: 10 feet.
- C. Connector: Connector for exothermic welded connection.

2.2 EXOTHERMIC CONNECTIONS

- A. Manufacturers:
 - 1. Cadweld, Erico, Inc.
 - 2. Copperweld, Inc.
 - 3. ILSCO Corporation.
 - 4. O-Z Gedney Co.
 - 5. Thomas & Betts, Electrical.
 - 6. Substitutions: Section 01 60 00 - Product Requirements
- B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

2.3 MECHANICAL CONNECTORS

- A. Manufacturers:
 - 1. Copperweld, Inc.
 - 2. Erico, Inc.
 - 3. ILSCO Corporation
 - 4. O-Z Gedney Co.
 - 5. Thomas & Betts, Electrical.
 - 6. Substitutions: Section 01 60 00 - Product Requirements
- B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

2.4 WIRE

- A. Material: Stranded copper.
- B. Horizontal Electrodes: 4/0 AWG, minimum size.
- C. Connections to Electrodes: 2/0 AWG, minimum size.
- D. Bonding Other Objects: 2 AWG, minimum size.
- E. Mechanical Connector: Bronze.
- F. Grounding Boxes: Bronze.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify final backfill and compaction has been completed before driving rod electrodes.

3.2 INSTALLATION

- A. Install rod electrodes in vertical position with bottom at least 5 feet below frost line.
- B. Install interconnecting wire 2 feet below frost line.
- C. Provide chemical treatment at each vertical electrode site.
 - 1. Saturate treatment chemicals with water following application.
 - 2. Dig circular trench centered on electrode. Make trench 12 inches deep with 18 inch inside diameter. Uniformly distribute 50 lb of treatment material in bottom of trench and cover with topsoil.

3.3 FIELD QUALITYCONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.13. Make final grounding system measurements three or four days after chemical treatment.

3.4 DEMONSTRATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate location of each accessible grounding connection and each chemical treatment well.

END OF SECTION