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SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes surface preparation and the application of paint systems on the following interior substrates:

1. Concrete masonry units (CMUs).
2. Steel and iron.

1.3 DEFINITIONS

A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.

B. MPI Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

C. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

D. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

E. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

F. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

G. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.

2. Indicate VOC content.

B. Samples for Initial Selection: For each type of topcoat product.

C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.

1. Submit Samples on rigid backing, 8 inches square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the following:

1. Benjamin Moore & Co.; AURA Interior paint.
2. ICI- Paints.
3. Sherwin-Williams Company (The).

B. Products: Subject to compliance with requirements, provide one of the products listed in the Interior Painting Schedule for the paint category indicated.

2.2 PAINT, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Dry-Fog Coatings: 400 g/L.
4. Primers, Sealers, and Undercoaters: 200 g/L.
5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Floor Coatings: 100 g/L.
9. Shellacs, Clear: 730 g/L.
10. Shellacs, Pigmented: 550 g/L.

D. Colors: As indicated in a color schedule.

1. 5-10 percent of surface area will be painted with deep tones.

2.3 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from

previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Masonry (Clay and CMUs): 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:

1. SSPC-SP 2.
2. SSPC-SP 3.
3. SSPC-SP 7/NACE No. 4.

4. SSPC-SP 11.

E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed in equipment rooms:

a. Equipment, including panelboards and switch gear.
b. Uninsulated metal piping.
c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.
g. Tanks that do not have factory-applied final finishes.
h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

2. Paint the following work where exposed in occupied spaces:

a. Equipment, including panelboards.
b. Uninsulated metal piping.
c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.
g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
h. Other items as directed by Architect.

3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

A. CMU Substrates:

1. Latex System MPI INT 4.2A:

a. Block Filler: Block filler, latex, interior/exterior, MPI #4.

b. Intermediate Coat: Latex, interior, matching topcoat.

c. Topcoat: Latex, interior (MPI Gloss Level 2), MPI #44.

B. Steel Substrates:

1. Acrylic Enamel over Acrylic Primer System:

a. Prime Coat: Primer, acrylic, for metal.
b. Prime Coat: Shop primer specified in Section 051200 "Structural Steel Framing" where substrate is specified.
c. Intermediate Coat: Acrylic Enamel, interior, matching topcoat.
d. Topcoat: Acrylic enamel, interior, gloss, (Gloss Level 6, except minimum gloss of 65 units at 60 degrees).
e. Topcoat: Acrylic Enamel, interior, semi-gloss (Gloss Level 5 Semi-Gloss): Hollow Meal Frames and Doors.

END OF SECTION 099123

SECTION 104413 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fire-protection cabinets for the following:

a. Portable fire extinguishers.

B. Related Requirements:

1. Section 104416 "Fire Extinguishers."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing surface-mounting method and relationships of box and trim to surrounding construction.

B. Shop Drawings: For fire-protection cabinets. Include plans, elevations, sections, details, and attachments to other work.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

1.5 COORDINATION

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

PART 2 - PRODUCTS

2.1 FIRE-PROTECTION CABINET

A. Cabinet Type: Suitable for fire extinguisher.

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

a. American Specialties, Inc.
b. Guardian Fire Equipment, Inc.
c. JL Industries, Inc.; a division of the Activar Construction Products Group.
d. Kidde Residential and Commercial Division.
e. Larsens Manufacturing Company.

B. Cabinet Construction: Nonrated.

1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.043-inch-thick cold-rolled steel sheet lined with minimum 5/8-inch-thick fire-barrier material. Provide factory-drilled mounting holes.

C. Cabinet Material: Cold-rolled steel sheet.

1. Shelf: Same metal and finish as cabinet.

D. Surface-Mounted Cabinet: Cabinet box fully exposed and mounted directly on wall with no trim.

E. Cabinet Trim Material: Steel sheet.

F. Door Material: Steel sheet.

G. Door Style: Vertical duo panel with frame.

H. Door Glazing: Tempered float glass (clear).

I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

1. Provide projecting door pull and friction latch.
2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.

J. Accessories:

1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
2. Lettered Door Handle: One-piece, cast-iron door handle with the word "FIRE" embossed into face.

3. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle.
4. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate.

    a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."

        1) Location: Applied to cabinet glazing.
        2) Application Process: Pressure-sensitive vinyl letters.
        3) Lettering Color: Red.
        4) Orientation: Vertical.

5. Alarm: Manufacturer's standard alarm that actuates when fire-protection cabinet door is opened and that is powered by batteries.

K. Materials:

1. Cold-Rolled Steel: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

    a. Finish: Baked enamel or powder coat.
    b. Color: As selected by Architect from full range of industry colors and color densities.

2. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.2 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

1. Weld joints and grind smooth.
2. Provide factory-drilled mounting holes.
3. Prepare doors and frames to receive locks.
4. Install door locks at factory.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.

1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
2. Fabricate door frames of one-piece construction with edges flanged.
3. Miter and weld perimeter door frames.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.3 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire-protection cabinets after assembly.

D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.

1. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.

C. Identification: Apply vinyl lettering at locations indicated.

3.3 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.

E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104413

SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

B. Related Requirements:

1. Section 104413 "Fire Protection Cabinets."

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to fire extinguishers including, but not limited to, the following:

a. Schedules and coordination requirements.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher.

1.5 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

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

1.7 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of hydrostatic test according to NFPA 10.
b. Faulty operation of valves or release levers.

2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.

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

a. Guardian Fire Equipment, Inc.
b. JL Industries, Inc.; a division of the Activar Construction Products Group.
c. Kidde Residential and Commercial Division.
d. Larsens Manufacturing Company.

2. Valves: Manufacturer's standard.
3. Handles and Levers: Manufacturer's standard.
4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.

B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 3-A:40-B:C, 5-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install fire extinguishers in locations indicated and in compliance with requirements of authorities having jurisdiction.

END OF SECTION 104416

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SECTION 221410 - PLUMBING PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Water Piping.

B. Soil, Waste and Vent Piping.

C. Compressed Air Piping.

D. Testing.

1.2 PRODUCTS INSTALLED BUT NOT FURNISHED IN THIS SECTION

A. Solenoid valves for evaporative cooling systems specified in Section 237400 - Air Handling Systems on Roof.

1.3 RELATED REQUIREMENTS

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.

B. Section 230500 - Basic Mechanical Requirements.

1.4 RELATED SECTIONS

A. Section 230529 - Basic Mechanical Materials and Methods.

B. Section 230540 - Mechanical Sound and Vibration Control.

C. Section 230548 - Mechanical Seismic Control.

D. Section 230700 - Mechanical Insulation.

E. Section 221411 - Disinfecting Water Supply System.

F. Section 221430 - Plumbing Specialties.

G. Section 224440 – Plumbing Fixtures.

H. Section 224450 – Plumbing Equipment.

I. Section 224460 - Special Plumbing Equipment Systems.

J. Section 232120 - Process Piping.

1.5 SUBMITTALS

A. Submit Product Data for the following items under provisions of the General Conditions of the Contract:

1. Water Piping, Fittings, and Joints.

PART 2 - PRODUCTS

2.1 WATER PIPE, TUBE, FITTINGS AND JOINTS

A. Interior Buried:

1. Provide type K annealed (soft) copper water tube conforming to ASTM B-88 with 95% tin 5% antimony solder joints using wrought fittings. No joints below grade. Provide continuous tube for all buried tubing using tube bends in lieu of fittings. Exterior tube may be coupled where requirements are in excess of standard mill lengths by using wrought pressure couplings with stops and silver solder brazed Joints. Lengths coupled in this manner, where necessary and acceptable to the Engineer, will meet the intent of the no fitting requirement of this Specification. Interior buried tube shall meet the same criteria and requirements.

B. Interior Tube Supported by Hangers and Clamps:

1. Provide ASTM B88 Type L hard drawn copper tube for all water distribution piping inside building/structure, with wrought copper fittings and couplers up to 6", cast brass or bronze fittings and couplers for sizes 6" and larger. Joints shall be made with copper ProPress fittings conforming to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117 or 95-5 Class SnSb solder or Victaulic CTS roll-grooved couplers and fittings for 3” and larger tube.
2. Provide crosslinked polyethylene tubing in accordance with ASTM F 876 and ASTM F 877 for all water distribution piping inside building/structure. Piping to be rated for 140°F maximum temperature and 80 psig maximum pressure. Pipe to be rated for recirculation (continuous). Pipe to be plenum rated, conform to ASTM E84 listing, or pipe larger than ¾ to be insulated, pipe to be not less than 4” spacing, see specification section 230700. Joints shall be made with ASTM F 1960 cold expansion fittings, PEX manufactured by Uponor, Viega or equal.

a. Manifolds:

Material:
1) Type L copper body with UNS 3600 series brass PEX outlet connections.
2) Engineered Plastic (EP) bodywith PEX outlet connections.

Manifold Type:

1) 1" copper manifold.
2) 1" EP manifold.
3) All manifolds manufactured with the appropriate sized PEX fittings on the manifold supply inlets.

b. Accessories:

1) Angle stops and straight stops that are compatible with PEX tubing shall be supplied by the PEX tubing manufacturer.
2) Bend supports designed for maintaining tight radius bends shall be supplied by the PEX tubing manufacturer.
3) PEX expander tool to install the ASTM F 1960 compatible fittings shall be supplied by the PEX tubing manufacturer.
4) The tubing manufacturer will provide clips and/or PEX rails for supporting tubing runs.
5) All horizontal pipe hangers and riser clamps shall be epoxy-coated material.

2.2 SOIL DRAIN WASTE, VENT AND FITTINGS AND JOINTS

A. General:

1. Cast iron pipe centrifugally cast service weight (SV) soil pipe with cast iron drainage fittings conforming to ASTM A 74. Joint materials and systems may be hub and spigot with neoprene gaskets and lubricant conforming to ASA-021 and ASTM C-564 SV pattern. Gaskets shall be equal to U.S. Pipe Company Veri-tite conforming to ASTM-C564 and pipe and fittings be certified in writing to the Engineer that the following criteria has been met, thru testing by a recognized independent testing laboratory. Cast iron hubless pipe and fittings conforming to ASTM A 888, CISPI 301. Hubless couplings shall conform to ASTM C 1277 for standard and ASTM C 1540 for heavy duty or CISPI 310. Pipe and fittings shall be marked with the collective trademark of the cast iron soil pipe institute or receive prior approval of the engineer.

   Criteria: Sizes 2" thru 6" shall withstand 15 psig hydrostatic pressure for 10 minutes with unrestrained joints, and no leakage, and using restrained joints must be able to withstand 25 psig air pressure and 40 psig hydrostatic pressure with no leakage. Offset joints shall withstand 1056 pounds of horizontal force without joint separation or detectable leakage.

2. a. Polyvinylchloride (PVC) sewer pipe and fittings shall conform to DR-35, ASTM D3034, bell and spigot type with reinforced rubber ring gasket integral with bell joint, minimum pipe stiffness at 5% deflection is 46, material to meet ASTM D1784, D2444 and joint tightness in accordance with ASTM D3212.
   b. Solvent cement to be low volatile organic compound (VOC) to meet South Coast Air Quality Management District (SCAQMD) Rule #1168. Product: IPS Weld-On #2700 or equal.

B. Buried Pipe:

1. Provide SV hub and spigot cast iron pipe and fittings to 5'-0" beyond building excavation line, continue past this point with SV cast iron or XS vitrified clay to termination points with hub and spigot joints. At Contractor's option and where approved by local

jurisdiction, No-Hub standard weight cast iron pipe with either M-G couplings or heavy-duty stainless steel shielded couplings may be used in lieu of hub and spigot with Ty-Seal neoprene gaskets. The heavy-duty shielded couplings shall comply with ASTM C1540, with ASTM C564 neoprene gaskets, minimum 0.008" stainless steel shields with transverse corrugations across longitudinal corrugations, standard 304 stainless steel clamps and 305 stainless steel screws. Entire assembly shall be suitable for direct burial, be corrosion resistant, and accommodate pipe deflection.

C. Interior Pipe Supported By Hangers and Clamps:

1. Provide hubless cast iron pipe using hubless cast iron soil pipe couplings certified to withstand a minimum of 50 psi internal pressure. Where stack pressures may theoretically exceed 50 psi, use clamp all or heavy-duty couplings with restrained joints horizontal and vertical up to 80 psig. For pressures above 80 psi, use Schedule 40 ASTM A-120 galvanized steel pipe with threaded cast iron drainage fittings. Roll grooved schedule 40 pipe with Victaulic Style 77M galvanized couplers may be used on horizontal and vertical stacks and mains. Use Teflon tape or compound for all threaded joint make-up.
2. Sump pump discharge from the pump to the point the waste stream flows continuously via gravity shall be Schedule 40 galvanized steel pipe with NPT threaded joints and fittings.
3. Copper Waste, Vent and Soil Pipe and Fittings shall be prohibited on this project.

2.3 PLASTIC DRAIN, WASTE AND VENT PIPING

A. Plastic drain, waste and vent piping may be installed when in compliance with jurisdictional codes and this specification.

B. Plastic DWV may be either P.V.C. or A.B.S. as required by code and utilizing drainage pattern fittings.

C. P.V.C. (polyvinylchloride) pipe and fittings shall conform to ASTM D2665 with a flame spread rating of 25 or less and shall consist of Schedule 40 DWV pattern.

D. A.B.S. (acrylonitrile - butadiene - styrene) pipe and fittings shall conform to ASTM D2661, CS 270-65, Schedule 40 DWV pattern.

E. All plastic DWV piping shall bear the seal of the National Sanitation Foundation (N.S.F.). None will be accepted without this seal.

2.4 SOLVENTS FOR PLASTIC PIPING

A. Solvents for plastic piping joints shall be certified low volatile organic compound (VOC) to meet SCAQMD Rule #1168/316A. This includes but is not limited to PVC, CPVC, and ABS piping, all grades and sizes. Product: IPS Weld-On #2700 or equal.

2.5 COMPRESSED AIR

A. Provide Type L Copper tubing and wrought copper fittings with "95-5" Class Sn Sb, soldered joints or Schedule 40 black steel piping with welded joints. Screwed joints may be used on piping under 4" diameter. Press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117.

2.6 DISTILLED AND DEIONIZED WATER

A. Provide Schedule 40 natural polypropylene, having no pigments or plasticizers, pipe and fittings with socket fusion joints.

PART 3 - EXECUTION

3.1 WATER TUBE, FITTINGS AND JOINTS

A. General:

1. All copper tube and fittings shall be reamed and buffed prior to soldering or brazing.
2. The use of lead solder of any class, for joint make-up or back-up for finishing is prohibited.
3. Refer and conform to the Copper Development Association instructions for proper preparation and actual installation practice for all soldered and brazed joints.
4. Support water tube in accordance with Section 230529.
5. Pull tee (T-drill) fittings are forbidden.

B. Through Penetration Firestop:

1. Ensure compliance of one- and two-hour rated through penetration assemblies in accordance with ASTM E 814.

C. Related Products Installation: Refer to other sections listed in Related Sections paragraph herein for related products installation.

3.2 CLEANING

A. Remove temporary coverings and protection of adjacent work areas.

B. Repair or replace damaged installed products.

C. Clean installed products in accordance with manufacturer’s instructions prior to owner’s acceptance.

D. Remove construction debris from project site and legally dispose of debris.>>

3.3 PROTECTION

A. Protect installed work from damage due to subsequent construction activity on the site.

3.4 SOIL, DRAIN, WASTE, VENT AND STORM PIPE FITTINGS AND JOINTS

A. General:

1. Provide bedding, restraints and hangers as appropriate and in accordance with manufacturers recommendations based upon type of pipe, fittings, joints, and bury depth using final finished grading as the basis.

2. Piping shall be run true, plumb, and straight, with all restraints and hangers adjusted to carry their proportional load and locked to prevent pipe "wag" misalignment, movement or shear.
3. Provide anchors for piping risers on every floor using riser clamps, wall brackets, knee brackets, and foot blocks for all vertical piping over 20 feet straight height.
4. Furnish and install all soil, waste and vent piping for the complete sanitary system in accordance with jurisdictional code requirements.
5. All soil and waste piping shall be run at the following minimum slope unless otherwise indicated on drawings.

Slope of Horizontal Drainage Pipe	
Size (In.)	Min. Slope (In./Ft.)
2-1/2 or less	1/4
3 to 6	1/8
8 or larger	1/16

6. Bushings in soil waste or vent piping shall be prohibited. Tapped spigots or tees shall be used when changing from cast iron pipe to steel waste or vent piping, and for appropriate cleanout plugs.
7. Vertical Piping: All vertical soil and vent stacks shall be supported with riser clamps at each floor slab. When soil stacks over two stories in height terminate at the bottom on slab fill or native soil, provide stack base elbows set on 24" x 24" x 8" thick minimum poured reinforced concrete pads set directly on undisturbed native soil or fill compacted to same density as undisturbed earth.
8. Horizontal Piping (suspended):
    a. Supports - Horizontal piping shall be supported at sufficiently close intervals to keep it in alignment and prevent sagging.
    b. Cast iron soil pipe - Where joints occur, suspended cast iron soil pipe shall be supported at not more than five (5) foot intervals; except that pipe exceeding five (5) feet in length, may be supported at not more than ten (10) foot intervals. Supports shall be adequate to maintain alignment and prevent sagging and shall be placed within eighteen (18) inches of the hub or joint. Hubless or compression gasket joints must be supported at least at every other joint except that when the developed length between supports exceeds four (4) feet, they shall be provided at each joint. Supports shall also be provided at each horizontal branch connection. Supports shall be placed on or immediately adjacent to the coupling. Suspended lines shall be suitably braced to prevent horizontal movement.
    c. Threaded pipe - Threaded pipe (IPS), shall be supported in accordance with Section 230529.
    d. Rigid support sway bracing shall be provided at changes in direction greater than 45 degrees for pipe sizes 4 inches and larger.
    e. For pipe sizes greater than 4 inches, axial restraints shall be provided for drain pipes at all changes in direction and at all changes in diameter greater than two pipe sizes.
9. The waste connections between fixtures and their respective collection and venting systems shall consist of galvanized steel nipples and cast iron drainage fittings.
10. All interior waste, soil, and vent piping up to 1-1/2" shall consist of galvanized steel with cast iron drainage fittings, all piping 1-1/2" and over shall consist of S.V. cast iron soil pipe and fittings.

11. All pipe and fittings shall have affixed thereon the CISPI grade mark of identification.
12. All vents shall be installed through the roof of at least the minimum size as required by jurisdictional code and shall be cast iron.
13. All vents protruding through the roof shall be not less than 2" size and extended to not less than 12 inches above the finished roof. Vents through built-up roofing shall be flashed with 24" x 24" x 4 lb. sheet lead. The flashing shall extend to top of vent and the edges turned down into a cast iron vent pipe. Single ply rubberized roofing systems shall be flashed around vent with top edge of roofing clamped to vent pipe and sealed with compatible sealant.
14. All vents shall be located in accordance with jurisdictional code and in no case less than two (2) feet from roof edge or parapet, or wall line of an "on the roof structure". Vent terminations shall not occur within twenty-five (25) feet of any outside air intake.
15. Vandal proof vent caps shall be installed on all sanitary vents extending through roofs which are accessible from ground level and on all roofs of elementary or secondary schools.
16. Provide all expansion joints, braces, earthquake restraints as required by the contract documents (Section 230548) and jurisdictional authority.

3.5 PROHIBITED PIPE ROUTING

A. Plumbing piping, regardless of contents (water, sewer, vent, etc.) shall not be routed through or above the following locations:

1. Electrical panel rooms
2. Electrical switch gear rooms
3. Electrical transformer rooms
4. Elevator shafts
5. Elevator equipment rooms
6. Data Centers
7. File Server Rooms / MDF / IDF

B. Should there be a conflict with the plans and the above paragraph, notify the Engineer immediately for corrective action prior to starting work.

3.6 PLASTIC DRAIN WASTE AND VENT PIPING

A. Plastic piping shall be installed with caution towards expansion and contraction characteristics. The piping shall be free to flex and move without bindings. The pipe shall be securely anchored at the roof to prevent movement at the roof penetrations.

B. Roof penetrations shall be made with self-sealing neoprene boots with integral lead or copper flashing pans.

C. Provide solvent weld joints.

D. Solvent cement to be low volatile organic compound (VOC) to meet South Coast Air Quality Management District (SCAQMD) Rule #1168. Product: IPS Weld-On #2700 or equal.

E. Support vertical soil, waste, drainage stacks and vents from building structure with padded riser clamps.

3.7 COMPRESSED AIR

A. Provide compressed air piping pitched to low points at 1" per 40 ft (min.) with drain valve at all low points. All branch line takeoffs from CA main shall be made from top of main.

B. Provide filters and separators for all spray paint supply branches.

C. Provide lubricators and filters for all pneumatic hand tools requiring lubrication.

D. Provide ball valves for all main line and branch shut-offs.

E. Provide all gauges, accessories and connectors required to match new or existing system and components.

D. Provide quick disconnect fittings compatible with owner's equipment at each branch line termination. Terminations shall be at 4 ft. A.F.F. unless noted otherwise.

3.8 TESTING

A. Schedule of Testing:

Service	Allowable Test Methods H_2O	CA	N_2	V	Minimum Test Pressure (psig)	Minimum Test Period (minutes)	Allowable Pressure Variance (psig)
1. Potable Water Pipe Valves & Fittings	X	X			125 100	60 60	-0- +1/2
2. Sanitary, Storm & Acid Waste and Vent System:							
*Stack Height:							
0-23 FT.	X				10	30	-0-
24-34 FT.	X				15	30	-0-
35-46 FT.	X				20	20	-0-
3. Compressed Air:							
Single Stage Compressor		X	X		100	30	+ 1/2
Two Stage Compressor		X	X		200	30	+ 1/2
5. Distilled and Deionized			X		60	30	-0-

B. Testing connections for hydrostatic tests shall be made at the base of the system, CA, N2 and vacuum testing can be made from connections anywhere in the system tested.

C. In the event that tests fail, use a standard soap and brush inspection using "Trouble Bubble" Liquid high density soap as manufactured by Jersey Meter Co., Patterson N.J. Formula ST-1. After source of failure is discovered, correct and retest system. Repeat procedure until system sustains required testing successfully.

D. Testing contractor shall give at least 16 working hours notice to the General Contractor/Construction Manager so that arrangements for witnessing tests can be made. The General Contractor/Construction Manager shall witness and SIGN the required test form.

E. All joints, valves, fittings and piping accessory items shall be exposed to view during tests whether pipe is above or below ground. "Closed in" or "Buried" piping shall be re-exposed during testing.

F. Proper restraining of piping and test plugs shall be accomplished prior to test.

END OF SECTION 221410

SECTION 221411 - DISINFECTING WATER SUPPLY SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Disinfection of Domestic Water Supply System.

1.2 RELATED WORK

A. Requirements: Provide Disinfecting Water Supply System in accordance with the Contract Documents.

B. Section 230500 - Basic Mechanical Requirements.

C. Section 221410 - Plumbing Piping.

1.3 DEFINITIONS

A. Disinfectant residual means the quantity of disinfectant in treated water.

B. pH factor means the measure of alkalinity and acidity in water.

C. ppm means parts per million.

1.4 CONTRACTOR'S QUALIFICATIONS

A. Water Treatment Contractor: At least three years experience performing work specified herein.

B. Bacteriological Laboratory: Certified by Serving Water Board or District and be in compliance with the State and U.S. Safe Drinking Water Act.

1.5 REGULATORY AGENCY REQUIREMENTS

A. Comply with requirements of Local and State Regulations.

1.6 SUBMITTALS

A. Submit for review and acceptance the following items under provisions of the General Conditions of the Contract:

1. Water treatment contractor's evidence of experience.
2. Bacteriological laboratory's evidence of certification.

B. Submit printed data for the following items under provisions of Operating and Maintenance Data paragraph in Section 230500:

1. Disinfection Report:

a. Include the following:

Date issued.

Project name and location.

Treatment Contractor's name, address, and phone number.

Type and form of disinfectant used.

Time and date of disinfectant injection start.

Time and date of disinfectant injection completion.

Test locations.

Initial and 24 hour disinfectant residuals in ppm for each outlet tested.

Time and date of flushing start.

Time and date of flushing completion.

Disinfectant residual after flushing in ppm for each outlet tested.

2. Bacteriological Report:

a. Include the following:

Date issued.

Project name and location.

Laboratory's name, certification number, address and phone number.

Time and date of water sample collection.

Name of person collecting samples.

Test locations.

Time and date of laboratory test start.

Coliform bacteria test results for each Outlet tested. Certification that water conforms or fails to conform to bacterial standards of State and Federal Safe Drinking Water Act.

Bacteriologist's signature.

1.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Protect against damage and discoloration.

B. Maintain caution labels on hazardous materials.

C. Maintain storage room dry and with temperatures as uniform as possible between 60 deg.F and 80 deg.F.

D. Do not store Caustic Soda directly on floor colder than 55 deg.F.

1.8 PROTECTING WORK OF OTHER TRADES

A. Provide necessary signs, barricades, and notices to prevent any person from accidentally consuming water or disturbing system being treated.

B. Protect against damage and discoloration caused by work of this Section.

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS

A. Prior to starting work, verify that Domestic Water System is completed, flushed and clean.

B. Prior to starting work, notify Construction Manager/General Contractor of any defects requiring correction.

C. Do not start work until conditions are satisfactory.

3.2 PREPARATION OF WATER FOR TREATMENT

A. Verify pH factor of water to be treated.

B. If pH factor is less than 7.4, introduce sufficient alkali during disinfectant injection to produce 7.4 to 7.6 pH level.

C. If pH factor is greater than 7.6, introduce sufficient acid during disinfectant injection to lower pH to 7.4 to 7.6 level.

3.3 SYSTEM TREATMENT

A. Inject disinfectant throughout system to obtain 50 to 80 ppm residual.

B. Starting at outlet closest to water sources, bleed water from each outlet until water produces odor of disinfectant. Repeat process at each outlet throughout system.

C. Test for disinfectant residual at each of the following locations:

1. Ends of piping runs.
2. Remote outlets. (Ends of each multiple fixture branch line)
3. Tanks and domestic water heaters.
4. At least 15% of outlets on each floor as directed by Architect/Engineer.

D. Maintain disinfectant in system for 24 hours.

E. If resultant disinfectant residual test is less than 25 ppm, repeat System Treatment.

3.4 FLUSHING

A. Flush disinfectant from entire system; permit no more than residual rate of supplied incoming water.

3.5 BACTERIOLOGICAL TEST

A. Instruct Bacteriological Laboratory to take water samples no sooner than 24 hours after flushing system.

B. Take water samples at each of the following locations:

1. Where water enters system.
2. Ends of piping runs.
3. Remote outlets.
4. Tanks.
5. At least 10% of outlets on each floor other than those used for testing disinfectant residual, where directed by Architect/Engineer, but in no case less than 2 outlets per floor.

C. Analyze Water Samples in accordance with Standard Methods for the examination of Water & Waste Water, published by American Water Works Assoc., 6666 W. Quincy Ave., Denver, CO 80235.

D. If Bacteriological Test proves water quality to be unacceptable, repeat System Treatment.

3.6 PRODUCT CLEANING & REPAIRING

A. Including work of other trades, clean, repair and touch-up, or replace when directed, products which have been soiled, discolored, or damaged by work of this Section.

B. Remove debris from Project Site upon work completion or sooner, if directed.

END OF SECTION 221411

SECTION 221430 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Cleanouts.
B. Safe pans and drain flashings.
C. Sillcocks, hose bibbs and hose stations.
D. Pressure gauges, thermometers, and test plugs.
E. Shock arrestors.
F. Backflow preventers.
G. Pressure reducing valves.
H. Pressure and temperature relief valves.

1.2 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

A. Furnish electrical outlets installed in Washer Wall Box for Division 26 power wiring installation.

1.3 RELATED WORK

A. Requirements: Provide Plumbing Specialties in accordance with the Contract Documents.

B. Section 230500 - Basic Mechanical Requirements.

C. Section 230529 - Basic Mechanical Materials and Methods.

1.4 SUBMITTALS

A. Submit Product Data for the following items under provisions of the General Conditions of the Contract:

1. Sillcocks (SC)
2. Hose bibbs (HB) and Hose Stations (HV)
3. Pressure gauges (PG)
4. Thermometers (T)
5. Shock Arrestors (SA)
6. Backflow Preventer (BP)
7. Pressure Reducing Valve (PRV)
8. Washer Wall Box (WWB)
9. Dryer Vent Wall Box (DVWB)

B. Submit printed Operating Instructions and Maintenance Data for the following items under provisions of Operating and Maintenance Data paragraph in Section 230500:

1. Backflow Preventer (BP)
2. Pressure Reducing Valve (PRV)

1.5 WARRANTIES

A. Provide original copies of all warranties for specific equipment where specified and in accordance with Section 230500.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Where acceptable manufacturers are listed, these manufacturers must submit products that are in fact equivalent in all respects of materials, design, function, and appearance to the manufacturer listed as the base manufacturer in the specification body or drawing schedules. Deviations of any type will not be acceptable.

B. Where other acceptable manufacturers are not listed, only the base manufacturer will be accepted.

C. All items of like nomenclature shall be supplied by one manufacturer only.

2.2 FLOOR DRAINS (FD)

A. Acceptable manufacturers: Wade series 1100, JR Smith series 2005, Josam series 30000, Zurn series Z-415, Watts FD-100 series, MIFAB series F-1100.

B. Schedule: See Drawings

2.3 FLOOR DRAINS, HEAVY DUTY

A. Acceptable manufacturers: Wade series 1240, JR Smith series 2330, Josam series 31200, Zurn series Z-512, Watts FD-340 series, MIFAB series F-1340C.

B. Schedule: See Drawings

2.4 FLOOR SINKS (FS)

A. Acceptable manufacturers: Wade series 9110/9140, JR Smith series 3100/3150, Josam series 49000/49040, Zurn series Z-1900/Z-1910, Watts FD-860 series, MIFAB series FS-1520/FS-1730.

B. Schedule: See Drawings

2.5 GARAGE DRAINS (GD)

A. Acceptable Manufacturers: Wade series 1210, JR Smith series 2230, Josam series 32320, Zurn series Z-541, Watts FD-340-Y series, MIFAB series F-1340.

B. Schedule: See Drawings

Plan Code	GD-1
Style	Round

Plan Code	GD-1
Material	Cast Iron
Pipe Size	2”-8”
Top Size	12”
Grate	Ductile Iron
Load Class	over 10,000 lb.
Vandal Proof Security Screws	No
Sediment Bucket	Yes
Seepage Flange	Yes
Flashing Clamp	Yes
Deck Clamp	Yes
Sediment Bucket	Yes

2.6 TRENCH DRAINS, HEAVY DUTY

A. Acceptable manufacturers: Wade series 2920, JR Smith series 2710, Josam series 76010, Zurn series Z-665, Watts TD-920 series, MIFAB series T-1350.

B. Schedule: See Drawings

2.7 TRENCH DRAINS, MEDIUM DUTY

A. Acceptable manufacturers: Wade series 2950, JR Smith series 2850, Josam series 76000, Zurn series Z-667, Watts TD-940 series, MIFAB series T-1320.

B. Schedule: See Drawings

Plan Code	TD-##
Style	Modular
Material	Cast Iron
Grate Width	6”
Length	Note 1
Grate Material	Ductile Iron
Load Class	2,000 - 4,999 lbs.
Vandal Proof Security Screws	No
Dome Strainer	No
Flashing Clamp	No

Note 1: Provide length as indicated on drawings.

2.8 TRENCH DRAINS, FRAME AND GRATE

A. Acceptable manufacturers: Wade series 2902/2908, JR Smith series 2970/2940/2910, Josam series 76700/76500/76300, Zurn series Z-793/Z-792/Z-784, Watts TD-920 series, MIFAB series T-1200/T-1150.

B. Schedule: See Drawings

2.9 TRENCH DRAINS, POLYESTER CONCRETE

A. Acceptable manufacturers: ACO series K 100S, Smith/ACO series 9818, ABT Polydrain, MEA-Josam Meadrain.

B. Schedule: See Drawings

Note 1: Provide interlocking sections to achieve total length as indicated on drawings, maximum 30 meter continuous length.

Note 2: Provide pipe connections, catch basins, end caps, and other accessories as shown and as required to achieve a complete drainage system.

2.10 TRENCH DRAINS, FIBERGLASS

A. Acceptable manufacturers: ACO series FG 200, Smith/ACO series 9812, MEA-Josam Mearin, Zurn series 800.

B. Schedule: See Drawings

Note 1: Provide interlocking sections to achieve total length as indicated on drawings.

Note 2: Provide pipe connections, catch basins, end plates, and other accessories as shown and as required to achieve a complete drainage system.

2.11 EXPANSION JOINTS

A. Acceptable manufacturers: Wade series 3900, JR Smith series 1710, Josam series 26200, Zurn series Z-190, Watts RD-900 series, Metraflex, MIFAB series R-1900, Hyspan.

B. Schedule:

Plan Code	EJ
Material	Cast Iron
Sleeve	Bronze/Brass
Gasket	Neoprene or Graphite
Size	2”-10”

2.12 FLOOR CLEANOUTS

A. Acceptable manufacturers: Wade series 6000, JR Smith series 4020/4100/4200, Josam series 56000, Zurn series Z-1400, Watts CO-200-R/200-RX/200-US series, MIFAB series C1100-R/C1100-XR/C1100-UR.

B. Cast iron adjustable body, ABS plug, vandal-proof security screws.

1. Provide flange and flashing clamp for Cleanouts in areas with waterproof membrane and all cleanouts above slab-on-grade.

2. Provide nickel bronze top to match floor finish as indicated in the Architectural finish schedule. Provide heavy duty nickel bronze top for cleanouts in storage rooms, kitchens and similar areas. Provide heavy duty cast iron or ductile iron top for cleanouts in equipment rooms, traffic areas, parking areas and similar unfinished areas.

2.13 WALL CLEANOUTS

A. Acceptable manufacturers: Wade series 8560 with 8480R, JR Smith series 4530, Josam series 58790, Zurn series 1446, Watts CO-460-RD series, MIFAB series C-1460.

B. Cast iron clean out tee, ABS plug, vandal proof security screws, stainless steel cover with screw.

2.14 GRADE CLEANOUTS

A. Acceptable manufacturers: Wade series 8300 MF with 6000 spigot outlet, JR Smith series 4250, Josam series 58850, Zurn series Z-1474 with Z-1449, Watts CO-300 series, MIFAB series C-1300.

B. Heavy duty cast iron clean out housing, heavy duty cast iron or ductile iron cover, cast iron ferrule, ABS plug, vandal proof security screws.

1. Provide piping system identification cast into cover; "SAN" for sanitary waste cleanouts, "STORM" for storm drainage cleanouts.

2.15 VENT CAPS

A. Acceptable manufacturers: JR Smith series 1748, Josam series 26700, Zurn series Z-193, Watts RD-680 series, MIFAB series R-1930.

B. Cast iron body and dome, vandal proof screws.

2.16 SAFE PANS AND DRAIN FLASHINGS

A. Provide one of following systems:

1. #24 B&S gauge (0.021") minimum sheet copper with l5 lb. asphaltic felt sub pan (underliner).
2. 0.040" non-plasticized chlorinated polyethylene sheet with 30 lb. felt underliner.
3. 3 ply 15 mil polyvinylchloride sheet with 30 lb. felt underliner.

2.17 WATER HEATER SAFETY PAN (WHSP)

A. Provide Shamrock Industries Inc. or equivalent gray polyethylene pan 2" larger than heater on all sides and minimum 1-1/2” deep with side or bottom drain fitting on electric water heaters installed above ceilings, under counters or on wood flooring.

B. Provide Ruud Mfg. Co. "Heater Pan", Canplas or equivalent spun aluminum pan 2” larger than heater on all sides and minimum 1-1/2” deep with side or bottom drain fitting on gas fired water heaters installed on combustible foundations with 3/4" thick fire proof liner between pan and combustible construction.

2.18 SILLCOCK, EXPOSED, NON-FREEZE

A. Acceptable manufacturers: Woodford series 65, JR Smith series 5609, Josam series 71050, Zurn series Z-1310, Wade series 8600, Watts HY-420 series.

B. Schedule: See Drawings

2.19 HOSE BIBBS

A. Acceptable manufacturers: As listed in schedule.

B. Schedule: See Drawings

2.20 MIXING UNIT AND HOSE STATION (HV)

A. Acceptable Manufacturers: T&S Brass, Leonard.

B. Schedule:

Plan Code	HV-1
Type	Exposed
Mix	Cold/Hot Water
Temp. Control	Manual
Valve Material	Bronze
Finish	Chrome
Thermometer	Yes
Shut-Off Valves	Yes
Vacuum Breaker	Yes
S.S. Hose Rack	Yes
Hose	50 ft.
Nozzle	Trigger Operated

2.21 STATIONARY PRESSURE GAUGES

A. Acceptable manufacturers: Trerice 600C Series, Weksler Regal Series, Weiss Instruments.

B. Schedule:

Type	4-1/2" Dial
Bourbon Tube/Socket	Stainless Steel Tube 316 Stainless Steel Socket
Accuracy	ANSI B40.1 Grade 1A 1% F.S. over middle half of range
Case	Cast Aluminum
Window	Clear Glass
Snubber	Yes
Coil Syphon	For Steam Service
Gauge Cock	Yes
Set Hand	No
Silicone Filled	No
Weatherproof	No

C. Range: Select gauges for the following standard ranges unless otherwise indicated on drawings, or as required for special systems.

1. Domestic Water 0 to +160 psi

2.	Compressed Air	0 to +160 psi
3.	Vacuum	-30 in Hg to +15 psi
4.	Pump Gauges	-30 in Hg to +100 psi

2.22 STATIONARY THERMOMETERS

A. Acceptable manufacturers: Trerice Industrial Series, Ametek Industrial Series, Weiss Instruments, Miljoco, Weksler.

B. Schedule:

Type	Adjustable angle
Case	9" cast aluminum
Window	Clear acrylic
Tube	Lens front, magnifying
Stem	Aluminum, insertable
Separable Socket	Brass
Fill Type	Spirit: Blue colored, organic

C. Range: Select thermometers, for the following standard ranges unless otherwise indicated on Drawings, or as required for special systems.

1.	Condenser water	0 to 100 °F
2.	Heating water	30 to 240 °F
3.	Domestic cold water	0 to 100 °F
4.	Domestic hot water	30 to 240 °F

2.23 TEMPERATURE AND PRESSURE TEST PLUGS (T&PTP)

A. Manufacturer: Trerice, Fairfax, Flow Design, Peterson Equipment, Weksler.

B. Plugs suitable for vacuum to 600 psig and temperatures of -20 deg.F to 300 deg.F with cap and extension for insulated pipe where required.

C. Provide one pressure gauge(s), gauge adapter, and two thermometers in shock-proof case.

D. Schedule:

PLAN CODE:	MAKE:	MODEL:	PRESSURE & TEMPERATURE TEST KIT
T&PTP	Trerice	D3741	Trerice D3752 (0-300 psig)

2.24 SHOCK ARRESTORS FOR WATER (SA)

A. Manufacturer: Precision Plumbing Products Co., Wade Shokstop, J.R. Smith series 5000, Josam series 75000, Zurn Z-1700, Watts SS series.

B. Schedule:

"P.D.I." SIZE	FIXTURE UNITS
A	1-11
B	12-32
C	33-60
D	61-113
E	114-154
F	155-330

2.25 REDUCED PRESSURE BACKFLOW PREVENTER

A. Acceptable manufacturers: Conbraco Series 40-200, Watts series 009 and 909, Febco series 825Y, Hersey series FRP-II.

B. Bronze body, independent spring loaded check valves, diaphragm type differential pressure relief valve, shut-off ball valves, strainer, test cocks. Suitable for water temperature range of 33-140 °F.

C. Approved under ASSE 1013 and AWWA C511.

D. Backflow preventer test kit: Provide complete test kit including pressure gauge, test valves, high pressure hoses, adaptor fittings, mounting strap, and instructions, in a corrosion resistant carrying case.

2.26 PRESSURE REDUCING VALVE (PRV)

A. Acceptable manufacturers: Watts series LF223, Conbraco, Hoffman.

B. 300 psi bronze body, replaceable seat, strainer, adjustable outlet pressure, thermal expansion by-pass. Suitable for water temperature up to 160 °F.

C. Approved under ASSE 1003 and IAPMO.

2.27 TEMPERATURE AND PRESSURE RELIEF VALVES (T&P)

A. Acceptable Manufacturers: Kunkle, Watts, Conbraco, McDonnell and Miller.

B. Schedule:

TYPES	SIZE	MAKE	MODEL	SERVICE	MAX PRESS	ASME MAX TEMP	ASME RATING BTUH MAXIMUM
T & P	3/4"	Kunkle	137	Water Pressure Vessel	125 psig	250 F	2,230,000
Press	3/4"	Kunkle	84-45	Air	125 psig	300 F	NA

Vac	3/4"	Kunkle	80-45	Vacuum	15" Hg	300 F	NA
T & P	3/4"	Watts	40XL8	Water Heater	125 psig	210 F	777,600

PART 3 - EXECUTION

3.1 DRAINS

A. Coordinate drain placement with Contractor for Division 3 - Concrete.

B. Drain, strainer, and grate finishes shall be as specified, cover all finished surfaces during construction to prevent damage.

C. Install drains with "P" pattern traps and vents as required.

D. All drain bodies shall be plugged during construction to prevent foreign objects, dirt, concrete, etc. from entering the drain and drainage piping.

E. Planter drains shall not receive domes until final landscaping is accomplished. Provide closure plugs until landscaping and dome installation is furnished.

F. Drains shall be set flush and level with finished surfaces, with grate pattern parallel or perpendicular to adjacent walls or floor patterns.

G. Flash all drains on roofs, upper floors, and floor over crawl spaces with 24"x24" minimum flashing pans. Shower pans shall be turned up in walls to a minimum of 6" above the shower receptor threshold.

H. Clean and polish all drain bowls, rims, strainers, and grates prior to final inspection.

3.2 CLEANOUTS

A. Provide cleanouts in waste, soil, and storm piping at each change in direction greater than 45°, as required by Jurisdictional Code.

B. Provide cleanouts at 50 feet on center for all interior sanitary and storm piping, and at each base of waste, soil or storm pipe stack or drop, 100 feet on center for all exterior sanitary and storm piping or as required by jurisdictional code.

C. Provide appropriate access tops for imposed construction.

D. Coordinate interior floor cleanout locations with contractor for Division 3 - Concrete.

E. Cleanouts to be provided with ABS or Delrin plugs. Lead sealed, brass, or cast iron plugs will not be acceptable unless specifically required by jurisdictional code authority.

F. Provide 24"x24" minimum flashing pans and clamp devices for all cleanouts located on upper floors or floors over crawl spaces.

G. Where cleanout arms extend horizontally and/or vertically more than 15 feet from the sewer main which they are serving, provide 2" minimum vent off the end of the arm and connect to the building vent system.

H. Clean and polish all cleanout access covers prior to final inspection.

I. Cleanout access covers shall be flush and level with finished building surfaces.

J. Install cleanout plugs on exposed or accessible piping. Plugs shall be line size up to 3" and over 8", 4" plugs for sizes 4" thru 8".

K. Provide wall cleanouts where piping is concealed in walls or non-accessible chases, use tapped cleanout tee or tapped extension to within 4" of wall face. Do not use no-hub type blind plugs for wall cleanouts.

L. Provide 12"x12"x8" thick 3000 lb. concrete pads for all grade cleanouts. Concrete shall be in accordance with Division 3 - Concrete. Tops of pads to be 1" above finish grade and cleanout access flush and level and centered in pad surface.

3.3 STORM DRAIN EXPANSION JOINTS (EJ)

A. Install vertical expansion joints at the roof drain outlet for all drains having straight vertical run directly from the drain of 10 feet or more.

B. Install special horizontal expansion joints at center of runs for horizontal storm piping having one hundred feet of straight run. Anchor ends of run. Provide expansion joints where storm drains cross a building expansion joint. Anchor both sides of building joint or provide adequate swing joints with appropriate anchors.

3.4 SANITARY VENT CAPS

A. Install where shown on drawings, vandal resistant vent caps a minimum of 14" above the roof surface.

B. Provide 24"x24"x4 lb. sheet lead flashing up 12" above roof to vent flashing collar.

C. Secure dome and entire assembly tight to pipe.

3.5 SAFE PANS AND DRAIN FLASHINGS (no plan code)

A. Provide safe pans for all shower bases, shower rooms, wet rooms and kitchen areas. Pans shall extend wall to wall and turn up at least 6" above finish floor level or receptor rims into wall construction. Pans shall be laid over non-puncturing base such as heavy asphaltic felt, fine sand that bears no silica, or other acceptable material.

B. All drains on upper floors or over crawl spaces shall be flashed with flashing extending a minimum of 12" beyond the drain top dimensions.

C. Seams to be folded and shaped as required:

1. Solder lead seams.

2. Solder sheet copper seams with 50/50 (50% tin, 50% lead) or 45/55 (45% tin, 55% lead) commercial grade solder.
3. Solvent weld PVC and un-plasticized chlorinated polyethylene seams.

3.6 WATER HEATER SAFETY PAN (WHSP)

A. Install safety pans for all electric water heaters installed above ceilings, under counters or on wood flooring. Route drain to floor sink/drain with indirect connection.

B. Install safety pans for all gas fired water heaters installed on combustible foundations or where leakage will cause damage. Route drain to floor sink/drain with indirect connection.

C. Provide structural supports, air gapped pan drains, drain extensions and pan drain connections as required.

3.7 SILLCOCKS (SC)

A. Provide sillcocks at 100 feet maximum spacing around building perimeter, and at other locations shown on Drawings.

B. Provide all sillcocks with accessible stop and drain valves in heated areas, provide access panels where required.

C. Provide flush or surface mounting, square and plumb to building walls, with supply tube pitched for complete drainout.

D. Anchor all sillcocks with anchor flange provided by manufacturer.

E. Caulk annular space between walls and sillcock and sillcock piping with non-hardening silicone base sealant.

F. Mount sillcocks at 24" above finished grade or surfacing.

G. Where mounting heights other than 24" are shown on the Drawings, the Drawings shall supercede the Specifications.

H. Vacuum breakers to be non-removable.

I. Clean all surfaces including faceplate, box, access door, cam lock and interior of box prior to final inspection.

J. Sillcocks shall not be operated by hand tools, provide 2 keys per sillcock. Units found to be marred due to hand tool operation or other causes, shall be replaced at no increase to the Contract Sum.

K. Clean and polish entire sillcock prior to final inspection.

3.8 HOSE BIBBS (HB)

A. Provide hose bibbs in each equipment room, toilet room and kitchen area equipped with floor drainage systems and where shown on drawings, maximum spacing shall accommodate 50 feet of hose to any point within the drainage area measured around obstructions and equipment, in lieu of straight line measurement. Hose bibbs in toilet rooms mounted under standard lavatory, do not install near ADA lavatory where it could impede access.

B. Anchor hose bibb within wall for rigid flush flange mounting.

C. Install bibb true and plumb with wall flange flush to surface, caulk annular space between wall and flange.

D. Mounting height to be 18" above floor in toilet rooms and immediately under furthest lavatory from entry, 60" above floor in equipment rooms or as shown on drawings.

E. Hose bibbs shall not be operated with hand tools, use only tee handle, furnish one tee handle per bibb. Units found marred due to hand tool operation or other causes will be replaced at Contractors expense.

F. Clean and polish hose bibbs prior to final inspection.

3.9 MIXING UNIT AND HOSE STATION (HV)

A. Anchor stations with 3/8" mounting bolts and expanders or toggles as appropriate.

B. Install stations true and plumb, complete with hose rack.

C. Mounting height shall be 60" above finished floor unless otherwise specified on drawings.

D. Mount hose and nozzle to station and clean entire unit prior to final inspection.

3.10 STATIONARY PRESSURE GAUGES (PG)

A. Provide gauges for steam, water, air and vacuum systems, complete with gauge cocks and snubbers, where required by Drawings.

B. Install in semi or upright position, tilted so as to be readable from floor level.

C. Clean gauge, and glass, and calibrate by test prior to final inspection.

3.11 STATIONARY THERMOMETERS (T)

A. Install thermometers where indicated on Drawings in upright position with case tilted to be readable from floor level.

B. Clean case and glass prior to final inspection.

3.12 TEMPERATURE AND PRESSURE PLUGS (T&PTP)

A. Provide plugs where periodic temperature and/or pressure indication is required as shown on drawings. Provide 1/4" MPT tapping, cap and seal for plug and extension for insulated pipe as applicable.

3.13 SHOCK ARRESTORS FOR WATER (SA)

A. Provide shock arrestors in accordance with Plumbing Drainage Institute (PDI) Standard WH-201 and as shown on drawings.

B. Provide 8"x8" minimum access panels centered on each shock arrestor that is otherwise inaccessible.

C. Shock arrestors shall be mounted as close to the line or quick closing valve as possible. Remote mounting or excessive (over 6") nipple mounting will not be acceptable.

D. Provide ball valve at each shock arrestor to allow units to be easily removed/replaced.

E. Each shock absorber piston shall be exercised at least once prior to final installation. (Physically move the piston up into chamber from throat of unit. Use wooden push rod only in the performance of this exercise.)

3.14 REDUCED PRESSURE BACKFLOW PREVENTER (BP)

A. Provide reduced pressure type backflow preventers on all connections between the domestic water system and make-up supplies to any non potable system, i.e.: Heating, Boilers, Cooling Towers, Chiller, Evaporative Coolers, and the like.

B. Anchor backflow preventer in place.

C. Clean and test assembly in place in accordance with State Health Code.

D. Provide funnels and attach to unit per manufacturers instructions, in true, level and plumb position.

E. Provide IPS to solder adaptor to funnel outlet and run type M copper tubing in an unobtrusive manner routed to an approved drain receptor.

F. Hang and anchor drain tubing so as to be rigid and stable.

G. Permanently affix drain outlet at drain receptor so as to be rigid and unmovable.

3.15 PRESSURE REDUCING VALVE (PRV)

A. Provide unistrut or similar frame for mounting all components of the pressure reducing valve station.

B. Arrangement shall be as shown on Drawings including by-pass.

C. Provide drain valves both sides of station on headers on low points.

D. Provide unions, strainer, valves, petcocks, gauges, straps and other accessories as detailed on Drawings.

E. Set each pressure reducing valve using full system pressure and flow individually to outlet pressures specified.

F. All gauges shall be installed to be readable from floor level. Provide petcocks on each gauge connection.

3.16 TEMPERATURE AND PRESSURE RELIEF VALVES (T & P)

A. Provide temperature and pressure relief valves, with full size drains extended and air gapped to floor drains or approved receptor. Provide relief valves on all water heaters, pressure vessels and closed piping systems.

END OF SECTION 221430

SECTION 224450 - PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Water Heaters and Accessories
B. Storage Tanks
C. Specialty Pumps
D. Air Compressor and Accessories
E. Vacuum Pump System
F. Manifolds for Acetylene and Oxygen Gas

1.2 RELATED WORK

A. Requirements: Provide Plumbing Equipment in accordance with the Contract Documents.

B. Section 230500 - Basic Mechanical Requirements.

C. Section 230529 - Basic Mechanical Materials and Methods.

D. Section 230540 - Mechanical Sound and Vibration Control.

E. Section 230548 - Mechanical Seismic Control.

F. Section 221410 - Plumbing Piping.

G. Section 221430 - Plumbing Specialties.

H. Section 231123- Natural Gas Systems.

I. Section 235100 - Breechings, Chimneys, Stacks and Flues.

1.3 SUBMITTALS

A. Submit product specification data for the following items under provision of The General Conditions of the Contract:

1. Water Heaters, Accessories and Controls.
2. Storage Tanks.
3. Pumps.
4. Air Compressor and Accessories.
5. Vacuum Pump System
6. Manifolds for Acetylene and Oxygen Gas

B. Submit printed Operating Instructions and Maintenance Data for the following items under provisions of Operating and Maintenance Data paragraph in Section 230500:

1. Water Heaters and Accessories.
2. Pumps.
3. Air Compressor and Accessories.

4. Vacuum Pump System
5. Manifolds for Acetylene and Oxygen Gas

1.4 WARRANTIES

A. Provide original warranties for specific equipment of term specified and in accordance with Section 230500.
B. Factory training by knowledgeable technician for 8 hrs on site for all items specified below with an additional 8 hrs 6-8 months after occupancy for follow-up training.

PART 2 - PRODUCTS

2.1 PRODUCT ACCEPTANCE

A. Acceptable Manufacturers are listed for each product, and manufacturers shall submit products that are in fact equivalent in all respects of material, design, function, size, and appearance to the manufacturer specified. Deviations of any type will not be acceptable.

B. Where acceptable manufacturers are not listed, only the manufacturer specified will be accepted.

C. All equipment of like use and nomenclature shall be supplied by one manufacturer only.

2.2 GAS FIRED STORAGE TYPE WATER HEATERS AND ACCESSORIES

A. Acceptable Manufacturers: A.O. Smith, Hatco, Lochinvar, P.V.I. Industries, Rheem, Ruud, State Industries, Bradford White, Thermal Solutions, Armstrong International.

B. Description and Schedule:

1. Provide glass lined tank rated for 150 psi, 300 psi test, ASME Code Construction , AGA Certified, and in conformance with ASHRAE 90.1 Energy Conservation Standards.
2. Provide ASME certified pressure and temperature relief valve, power burner, 100% pilot and main burner safety shut off, electronic spark ignition.
3. Provide barometric damper corrosion resistant enameled steel jacket, blanket or approved foam insulation with minimum insulation factor of R=16, Dielectric Unions for water connections, heavy magnesium anode rod, drain valve, combustion chamber access and manhole as applicable.
4. Schedule: See Drawings
5. Provide three year standard warranty.
6. Burners shall be orificed for equivalent BTUH at altitude of, and calorific value of, gas at point of installation.

2.3 DOMESTIC HOT WATER CIRCULATING PUMPS

A. Acceptable Manufacturers:

1. Taco
2. Bell and Gossett

3. Grundfos
4. Armstrong
5. Patterson

B. Provide in-line type circulating pumps, all bronze construction, bronze face bracket, cast bronze one piece enclosed type impeller hydraulically and dynamically balanced, alloy steel shaft with cupro-nickel shaft sleeve, carbon/ceramic mechanical shaft seal, non-metallic noiseless coupler, resilient mounted dry proof motor with sleeve bearings and over load protection, pump bearing and seal assembly shall be replaceable cartridge design, one cartridge and seal to fit all pumps supplied, provide two extra cartridges and seals, oil level dip sticks (one for each pump), and oil drain plug, 125 psig @ 240 deg.F rating.

C. Provide one contactor per pump to allow the 230900 controls system to start/stop each pump.

D. Schedule: See Schedule on Drawings.

2.4 VACUUM PUMP SYSTEMS– OWNER FURNISHED EQUIPMENT. CONNECTIONS BY GC.

A. Existing Vacuum pump to be brought over from existing facility. Requirements for connections to existing product are as follows.

B. Description: Vacuum pumps are to be packaged central vacuum system capable of passing fluids and soft solids through the vacuum pump directly to waste. Units are to be factory tested prior to shipment. Certified test data, performance curves and spare parts list are to be included in the operation and maintenance manuals. Include the following:

1. Single stage, oil-lubricated, rotary vane.

2. An electrical control panel in a NEMA 1 enclosure with starters; automatic lead-pump alternator; sequencing controls to prevent more than one pump from starting at any one time; a hand-off automatic selector switch; a 115 volt control transformer and a fused disconnect.

3. An external display including indicator lights to show each pump “ON” and warning lights with horn and reset buttons to show thermal overload, high receiver water level and high separator water level.

4. For each pump, include inlet check valve, a discharge separator silencer, a vacuum switch, strainer, flow control valve, 115 volt solenoid valve and an anti-siphon fitting (may be common to multiple pumps).

5. An ASME and National Board Stamped painted steel vacuum control tank with vacuum gauge, relief valve and gauge glass.

2.5 THERMOSTATIC MIXING VALVE MANIFOLD WITH CIRCULATING PUMP

A. Acceptable Manufacturers: Leonard Megatron, Bradley Recirculation Station, or equal.

B. Description: Factory-fabricated, exposed-mounting, thermostatically controlled, water-mixing-valve assembly in two-valve parallel arrangement, with domestic hot water circulating pump and pump contactor, of capacity, voltage, and phase as indicated on schedules.

C. Large-Flow Parallel: Thermostatic water mixing valve and downstream pressure regulator with pressure gages on inlet and outlet. Provide with adjustable high temperature limit stop, color-coded

dial, locking temperature regulator, inlet union angle strainer checkstops. Full port ball valve, pressure gauge on mixed water outlet piping of large mixing valve.

D. Small-Flow Parallel: Thermostatic water mixing valve. Provide with adjustable high temperature limit stop, color-coded dial, integral checkstops on inlets. Full port ball valve on outlet of small mixing valve.

E. Thermostatic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff ball valve on outlet.

F. Water Regulator(s): Comply with ASSE 1003. Include pressure gage on inlet and outlet.

G. Component Pressure Ratings: 125 psig minimum, unless otherwise indicated.

H. Provide with dial thermometer and pressure gauge on mixed water outlet of the system. Outlet Test Connection with ball valve and ¾" hose connection with cap. Full port ball valve mounted downstream of test connection. Inlet piping manifold with full port ball valves and dial thermometers on hot and cold supply inlets.

I. Domestic hot water circulating return piping, ¾", with circulator contactor, circulator of all bronze construction, dial thermometer, balancing valve, and check valve. Provide with bypass piping, ¾", with check valve and isolation ball valve to bottom port of small mixing valve in addition to circulator line back to domestic water heaters. Pump manufacturers as selected by mixing valve manifold system manufacturer

J. System mounted on galvanized steel strut, vibration isolated, with brackets for mounting on wall and legs for bolting to floor. Factory pre-assembled and tested.

K. Circulator electrical connections factory wired to H-O-A switch with status lights and contactor. Division 230900 controls system will signal pump to start and stop based on programmed time schedule.

2.6 AIR COMPRESSOR AND ACCESSORIES

A. Provide locally fabricated wired, piped and assembled or factory assembled wired and piped units complete with all accessories and compressor mounted or remote mounted panels and controls as required by contract documents.

B. Acceptable Compressor Manufacturer/Fabricator/Supplier:

1. Ingersoll-Rand Air Center
2. Air Mac Manufacturing Company
3. Sullair Rocky Mountain Inc.
4. Atlas Copco Inc.
5. Gardner-Denver Cooper Industries
6. Pace Industries of Colorado

C. Acceptable Compressor Manufacturers:

1. Ingersoll Rand
2. Quincey
3. Atlas Copco
4. Energair
5. Gardner-Davis

6. Worthington

D. Provide variable speed air cooled, electric ODP Motor, belt drive duplex compressor tank mounted on a 120 and/or 200 gallon vertical receiver with cast iron or steel subbase.

E. Provide energy efficient motors altitude rated at 40 deg.C rise, continuous duty with 1.15 service factor, squirrel cage design with sleeve bearings, adjustable "V" belt drive, low starting current, normal torque and in compliance with prevailing energy code.

F. Provide two year full non prorated warranty covering parts and labor and one year full service policy. Factory trained personnel to supervise start up and sign for start of warranty and service policy period.

G. Schedule: See Schedule on Drawings

H. Provide automatic "start stop" control with "Hand-Off-Automatic" Switch for each compressor equipped with automatic unloaders. Set start switch at 75 psig and stop switch at 150 psig, provide necessary pressure switches.

Provide the following accessories, installed, piped and/or wired as appropriate:

1. O.S.H.A. acceptable fully enclosed belt guard.
2. Motor starters, controls, alternators for duplex compressors, overload and phase protection for each motor, panel mounted on compressor. Panels to be NEMA type 4 enclosure.
3. Low oil level, for splash lubricated compressors, low oil pressure for force feed type compressors, complete with indexed yellow light and audible alarm.
4. Loadless starting and unloading feature on shut down regardless of reason for shutdown.
5. ASME Code and Labeled receivers for 150 psig.
6. Braided flexible connector at least twelve (12) inches long between receiver discharge valve and system. Connector to be bronze and copper with dielectric protection both ends.
7. Pressure gauges with gauge cocks and snubbers on receiver and pressure regulating valve discharge, 0 to 300 psig.
8. Pressure regulating valve on receiver discharge to system complete with isolation 300 psig air rated ball valves, strainer, and full size by-pass with 300 psig air rated ball valve.
9. Automatic float type receiver condensate drain with isolation valve.
10. Dry type inlet filter silencer on each compressor. Filter to be removable and washable, provide two filters for each compressor.
11. Air cooled after cooler for each compressor sized for maximum compressor discharge volume and pressure.
12. Provide ASME labeled oil filter and water separator on each compressor discharge to receiver.

    a. Provide branch coalescing filter for each paint spray branch line to remove oil, hydrocarbon and moisture.
    b. Provide lubricators for each branch line to pneumatic equipment requiring lubrication.

I. Refrigerated Air Dryers:

1. Schedule: See on Drawings

PART 3 - EXECUTION

3.1 GAS FIRED STORAGE TYPE WATER HEATERS

A. Set level and plumb, adjust burners to proper flame, set temperature, and verify, to 135 deg.F minimum setting.

B. Provide an expansion tank on the hot water side of all water heaters.

C. Coordinate installation of flue, draft divertor and flue accessories with Contractor for Section 235100 - Breechings, Chimneys, Stacks and Flues.

D. Provide ASME temperature and pressure relief valve with full size discharge piped and air gapped to nearest floor drain or other acceptable receptacle.

E. Provide hose and drain valve, mixing valve, blending chamber, shut off valves and dielectric connections as required and appropriate.

F. Provide gas connection with gas valve, dirt leg and cap, pressure regulator and pilot control in accordance with Section 231123 – Natural Gas System.

G. Sealed combustion water heaters installed in a negative pressure room will require a ¼” vinyl hose run from the pressure switch to the outdoor atmosphere.

3.2 DOMESTIC HOT WATER CIRCULATING PUMPS

A. Coordinate contactor for pump and electrical power requirements with Division 26 Contractor in accordance with Section 230529 - Basic Mechanical Materials and Methods.

B. Set pump level, plumb and square where indicated on contract documents on vertical pipe leg extended to and supported by floor, provide floor plate and capped leg at floor.

C. Provide drain valve on pump support leg at 18" above floor.

D. Anchor vertical pump leg pipe so as to prevent movement and vibration.

3.3 VACUUM PUMP SYSTEM

A. Equipment Mounting: Install vacuum pump system on concrete inertia base.

B. Orient equipment so controls and devices are accessible for servicing.

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Install the following devices on vacuum equipment:

1. Thermometer, Vacuum Gage, and Pressure Relief Valve: Install on each vacuum pump receiver.
1. Drain Valves: Install on receivers. Discharge receiver condensate over nearest floor sink.

E. Provide startup service by factory authorized technician. Provide copy of start-up report in O&M manuals. Start-up services to include start-up list provided by factory, plus the following items:

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check for lubricating oil in lubricated-type equipment.
3. Check belt drives for proper tension.
4. Verify that vacuum producer outlet piping is clear.
5. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
6. Check safety valves for correct settings.
7. Check for proper seismic restraints.
8. Drain receiver tank.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

H. Test and adjust controls and safeties.

I. Verify that vacuum equipment is installed and connected according to the Contract Documents.

J. Verify that electrical wiring installation complies with manufacturer’s submittal and written installation requirements in Division 26 Sections.

K. Prepare written report documenting testing procedures and results.

3.4 THERMOSTATIC MIXING VALVE MANIFOLD

A. Follow all manufacturer’s installation recommendations.

B. Adjust PRV settings and thermostatic valve settings so the factory assembly provides 110°F water to the plumbing fixtures it serves at all flow rates.

C. Provide spring check valves in the cold water supply and hot water inlet ports of the factory assembly.

3.5 AIR COMPRESSOR AND ACCESSORIES

A. Install OSHA required accessories, water connections and drain extensions.

B. Provide filters, separators, dryers and lubricators as appropriate. Each accessory shall be installed with isolation valves and unions for removal without disassembly of the connecting piping system.

C. Install compressor with inertia base and isolation mountings and connected piping in accordance with Section 230540 - Mechanical Sound and Vibration Control.

D. Coordinate electrical control and power requirements with Division 26 Contractor in accordance with Section 230529 - Basic Mechanical Materials and Methods.

E. All components and accessories shall be installed to full capacity of systems on which they are installed with absolute minimum pressure drop or loss.

END OF SECTION 224450

SECTION 230080 - SELECTIVE MECHANICAL DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Demolition and removal of selected portions of building or mechanical systems.
2. Salvage of existing items to be reused or recycled.

B. Related Sections include the following:

1. Section 230500 - Basic Mechanical Requirements
2. Section 230529 - Basic Mechanical Materials and Methods

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and reinstalled.

B. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.

C. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed or removed and reinstalled.

1.4 SUBMITTALS

A. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of removal work, with starting and ending dates for each activity.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Means of protection for items to remain and items in path of waste removal from building.

1.5 PROJECT CONDITIONS

A. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. Hazardous materials will be removed by Owner before start of the Work.
2. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. Owner will remove hazardous materials under a separate contract.

B. Storage or sale of removed items or materials on-site is not permitted.

C. Utility Service: Maintain existing utilities in service and protect them against damage during selective demolition operations.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

B. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

3.2 UTILITY SERVICES AND MECHANICAL SYSTEMS

A. Existing Services/Systems: Maintain all services and systems and protect them against damage during selective demolition operations.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Comply with requirements for access and protection specified in Section 015000 - Temporary Facilities and Controls.

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people.

1. Comply with requirements of Section 017419 - Temporary Facilities and Controls.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Remove existing mechanical systems only to the extent required and as indicated. Use methods required to complete the Work within limitations of governing regulations.

B. Removed and Reinstalled Items:

1. Clean items to functional condition adequate for intended reuse.
2. Protect items from damage during transport and storage.
3. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

C. Existing Items to Remain: Protect construction to remain against damage and soiling during selective demolition.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC SYSTEMS

A. Piping includes: Pipe, fittings, valves, accessories, hangers and insulation.

1. Where existing piping is to be removed:

a. Piping shall be drained, disconnected, removed and capped at an active main.
b. Piping not to remain in use shall be removed completely.

2. Where existing piping is to be relocated:

a. Piping shall be drained, disconnected and removed as shown.
b. Hangers may remain if they are to be reused for reinstallation.
c. Piping shall be stored for reinstallation.

B. Ductwork includes: Ductwork, fittings, dampers, registers, grilles, diffusers, accessories, hangers and insulation:

1. Where existing ductwork is to be removed:

a. Ductwork shall be disconnected, removed and capped at an active main.
b. Ductwork not to remain in use shall be removed completely.

2. Where existing ductwork is to be relocated:

a. Ductwork shall be disconnected and removed as shown.
b. Hangers may remain if they are to be reused for reinstallation.
c. Ductwork shall be stored for reinstallation.

C. Where piping or ductwork to be removed is concealed in construction it may be abandoned in place if capped at both ends and approved by the Owner and the Architect.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be reused, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage.
3. Comply with requirements specified in Section – 017419 Construction Waste Management and Disposal.

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.7 CUTTING AND PATCHING

A. All necessary cutting and patching shall be done by the General Contractor.

B. Removal and replacement of suspended ceilings necessary for selective demolition of mechanical systems shall be done under this section.

END OF SECTION 230080

SECTION 230500 - BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Basic requirements common to the work in general of Division 21/22/23 and other Divisions and Sections of the Specification where referenced.

B. Provide, unless specified otherwise, all labor, materials and equipment necessary for completely finished and operational mechanical systems described and specified under Division 21/22 and other Sections of this Division 23.

C. Provide all minor incidental items such as offsets, fittings, and accessories required as part of the work even though not specified or indicated.

D. Inspection: Inspect work preceding or interfacing with work of Division 21/22/23 and report any known or observed defects that affect the Work to the Construction Manager/General Contractor. Do not proceed with the work until defects are corrected.

E. Existing Utilities: Are indicated as accurately as possible on the Drawings. Close openings and repair damage in acceptable manner to utilities encountered. This Contractor shall be responsible for field surveying all aspects of existing conditions prior to bid date. Change orders will not be issued for a failure to review existing conditions which affect Division 21/22/23 work.

1.2 RELATED WORK

A. Requirements: Provide Basic Requirements in accordance with the Contract Documents.

1.3 UTILITIES, EXTENSIONS, CONNECTIONS AND FEES FOR WATER AND SEWER

A. Provide all building services extensions and connections to off-site and on-site utilities.

B. Sewer connection charges, typically based on fixture units, that in principle allow the right to obtain the sewer services from the utility will be arranged and paid for by the Division 23 Contractor.

C. Water system development fees, typically based on meter size, that in principle allow the right to obtain the water services from the utility will be arranged and paid for by the Division 23 Contractor**.**

D. Sewer tap fees as they are known to the trade and are the charges for actual materials and labor for tapping, inspection and recording of the tap shall be arranged and paid for by the Site Utilities Contractor**.**

E. Water tap fees as they are known to the trade and are the charges for actual materials and labor for tapping, inspection and recording of the tap shall be arranged and paid for by the Site Utilities Contractor**.**

F. In the event that the serving utility company installs their own taps, service, meters, etc., all costs imposed by this action shall be paid for by the Division 23 Contractor. Extensions from termination points to connection with building services and systems will be the responsibility of the Division 23 Contractor.

G. Be responsible for all pads, vaults, manholes, manhole covers, meter enclosures, valves, services boxes, and the like, all in conformance with requirements of the serving utility company.

H. In the event that the water service to the building is a combination domestic and fire protection service, the responsibility of said "combination service" to the point of domestic connection shall be that of a licensed Fire Protection Contractor, including tap, valves, excavation, backfill, compaction and meters, if any. After point of domestic connection, responsibility for separate fire and domestic services is with appropriate trades including all labor and materials as herein before mentioned.

1. Contractor shall coordinate with other trades all interface piping and types of connections to be provided for interface.
2. Provide fire hydrant, auxiliary gate valve, tapping sleeve and valve or tee, service boxes, and anchor or swivel couplings, thrust blocks, deadmen, rods, and the like, all in conformance with the requirements of serving utility company.

1.4 REFERENCES

A. General:

1. For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
2. The date of the standard is that in effect at the date of the Contract Documents, except when a specific date is specified.
3. When required by individual Specification sections, obtain copy of standard. Maintain copy at job site during work until substantial completion.

B. Schedule of Referenced Organizations: The following is a list of the acronyms of organizations referenced in these Specifications:

ADC	Air Diffusion Council 1000 E. Woodfield Rd. Schaumburg, IL 60173 www.flexibleduct.org
AGA	American Gas Association 400 No. Capitol St. N.W. Washington, DC 20001 www.aga.org
AMCA	Air Movement and Control Association 30 West University Drive Arlington Heights, IL 60004 www.amca.org
ANSI	American National Standards Institute 1819 L Street N.W. Washington, DC 20036 www.ansi.org
ARI	Air Conditioning and Refrigeration Institute 4301 No. Fairfax Drive. Arlington, VA 22203 www.ari.org
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers 1791 Tullie Circle, N.E. Atlanta, GA 30329 www.ashrae.org
ASME	American Society of Mechanical Engineers Three Park Avenue New York, NY 10016 www.asme.org
ASPE	American Society of Plumbing Engineers 8614 W. Catalpa Ave. Chicago, IL 60656 www.aspe.org
ASSE	American Society of Sanitary Engineering 901 Canterbury Westlake, OH 44145 www.asse-plumbing.org

ASTM	American Society for Testing and Materials 100 Barr Harbor Dr. West Conshohoeken, PA 19428 www.astm.org
AWS	American Welding Society 550 N.W. LeJeune Rd. Miami, FL 33126 www.aws.org
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235 www.awwa.org
CDA	Copper Development Association 260 Madison Avenue New York, NY 10016 www.copper.org
CISPI	Cast Iron Soil Pipe Institute 5959 Shallow Ford Rd., Suite 419 Chattanooga, TN 37421 www.cispi.org
CS	Commercial Standard of NBS (U.S. Dept. of Commerce, National Institute of Standards and Technology) Government Printing Office Washington, D.C. 20402
CTI	Cooling Technology Institute 530 Wells Fargo Drive Houston, TX 77090 www.cti.org
ICC	International Code Council 5203 Leesburg Pike, Suite 600 Falls Church, VA 22041 www.intlcode.org
IAPMO	International Association of Plumbing and Mechanical Officials 20001 E. Walnut Drive South Walnut, CA 91789 www.iapmo.org
NEBB	National Environmental Balancing Bureau 8575 Grovemont Circle Gaithersburg, MD 20877 www.nebb.org
NEC	National Electric Code (of NFPA)

NEMA	National Electric Manufacturer's Association 1300 N. 17th Street Rosslyn, VA 22209 www.nema.org
NFPA	National Fire Protection Association One Batterymarch Park P.O. Box 9101 Quincey, MA 02269 www.nfpa.org
NSF	NSF International 789 No. Dixboro Rd. Ann Arbor, MI 48113 www.nsf.gov
OSHA	Occupational Safety Health Administration (U.S. Dept. of Labor) Government Printing Office Washington, D.C. 20402 www.osha.gov
PDI	Plumbing and Drainage Institute 45 Brystal Drive South Easton, MA 02375 www.pdionline.org
SMACNA	Sheet Metal and Air Conditioning Contractor's National Association 4201 Lafayette Center Drive Chantilly, VA 20151 www.smacna.org
UL	Underwriters Laboratories, Inc. 333 Pfingston Rd. Northbrook, IL 60062 www.ul.com

1.5 DEFINITIONS

A. Specification Language Explanation: These Specifications are of abbreviated, simplified or streamlined type and include incomplete sentences. Omissions of words of phrases such as "the Contractor shall", "in conformity therewith", "shall be", "as noted on the drawings", "a", "the", are intentional. Supply when "NOTE" occurs on Drawings. Supply words "shall be" or "shall" by inference when colon is used with sentences or phrases. Supply words "on the Drawings" by inference when "as indicated" is used with sentences or phrases. Singular words will be interpreted as plural and plural words will be interpreted as singular where applicable and where full context of the Contract Documents so indicates.

B. Furnish: Except as otherwise defined in greater detail, term "furnish" is used to mean supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.

C. Install: Except as otherwise defined in greater detail, term "install" is used to describe operations at Project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations, as applicable in each instance.

D. Provide: Except as otherwise defined in greater detail, term "provide" means furnish and install, complete and ready for intended use, as applicable in each instance.

E. Indicated: The term "Indicated" is a cross-reference to graphics, notes or schedules on Drawings, to other paragraphs or schedules in the Specifications, and to similar means of recording requirements in contract documents. Where terms such as "shown", "noted", "scheduled", and "specified" are used in lieu of "indicated", it is for purpose of helping reader locate cross-reference, and no limitation of location is intended except as specifically noted.

F. General Contractor: The term "General Contractor" used in Division 23 and elsewhere in the Contract Documents means the party with whom the Owner has executed the Owner-Contractor Agreement.

G. Approved Equal: Except as otherwise defined in greater detail, term "approved equal" means that any materials, equipment, work procedures and techniques shall be either addressed on the drawing, specifications or addendum by manufacturer or by detailed material description. When brand names are referenced it implies that only the manufacturers listed are approved. All approved material, equipment, work procedures, and techniques will be noted in the specifications, drawings, or by addendum prior to bid date. Items not approved in this manner will not be considered.

1.6 QUALITY ASSURANCE

A. Quality Control:

1. Materials and apparatus required for the work to be new and of first-class quality; to be furnished, delivered, erected, connected and finished in every detail; and to be so selected and arranged so as to fit properly into the building spaces. Where no specific kind or quality of material is given, a first-class standard article shall be furnished.
2. Furnish the services of an experienced superintendent, who will be constantly in charge of the installation of the work, together with all skilled workmen, fitters, metal workers, certified welders, plumbers, millwrights, sprinkler fitters, drain layers, helpers, and labor required to unload, transfer, erect, connect, adjust, start, operate and test for each system.
3. Unless otherwise specifically indicated, equipment and materials to be installed in accordance with the recommendations of the manufacturer. This includes the performance of tests as recommended by the manufacturer.

B. Proof of Performance:

1. Division 23 Contractor shall provide proof of performance certification of all Mechanical Equipment and Systems to demonstrate that all Mechanical Equipment and Systems are operating to the intent of the design. This proof of performance shall include, but shall not be limited to, actual demonstration of all temperature/pressure control loops, operation of all heating/cooling equipment and other required tests upon request by the Engineer or Owner. A signed certificate from the piping, sheet metal, control, and balancing subcontractors stating that they have personally checked the operation of all equipment and control loops and that everything under their subcontract is operating as specified. These certificates shall be furnished to the 230593 Contractor for inclusion in the Operation and Maintenance Manual.

1.7 REGULATORY REQUIREMENTS

A. Execute work per Underwriters, Public Utility, Local and State Codes, Ordinances and applicable regulations. Obtain and pay for required permits, inspections, and certificates. Notify Architect of items not meeting said requirements.

B. Comply with editions of all applicable codes, ordinances and regulations in effect at the time of bid opening including but not necessarily limited to the following:

International Mechanical Code
International Plumbing Code
International Fuel Gas Code
International Energy Conservation Code
State Department of Health Requirements
State Energy Code
National Fire Protection Association Standards
International Fire Code
International Building Code
National Electrical Code NFPA-70
State Boiler Code
Jurisdictional County Health Department
Jurisdictional City Wastewater Management Division or District
Jurisdictional City Water Department
Jurisdictional Water Conservation Standards

C. If discrepancies occur between the Contract Documents and any applicable codes, ordinances, acts, or standards, the most stringent requirements shall apply.

D. Where hourly fire ratings are indicated or required, provide components and assemblies meeting requirements of the IBC, and listed by Underwriters Laboratories, Inc.

1.8 SUBMITTALS

A. Submit items to Commissioning Agent for review.

B. Submit Samples, Shop Drawings and Product Data as required by various Sections of Division 23 in accordance with The General Conditions of the Contract. The Contractor agrees that these Submittals processed by the Engineer are not Change Orders; that the purpose of these Submittals by the Contractor is to demonstrate to the Engineer that the Contractor understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install and by detailing the fabrication and installation methods he intends to use. Contractor further agrees that if deviations, discrepancies, or conflicts between these Submittals and the Contract Documents in the form of design drawings and specifications are discovered either prior to or after these Submittals are processed by the Engineer, the Design Drawings and Specifications shall control and shall be followed.

C. The submittals shall be submitted in a single package with all mechanical equipment for the project enclosed. The submittals shall be enclosed in a stiff back, 3-ring binder. All mechanical equipment shall be separated with tabbed index cards with an indexed legend provided in the front of the binder. In the event submittals are submitted in electronic format, the submittal shall be in the form of a single PDF file in which all equipment has been electronically bookmarked and all bookmarks have been identified using the equipment tags used on the drawings. Individual PDF files for separate pieces of equipment or specification sections will not be accepted.

D. Test Reports: Submit certified test reports as required by various Sections of Division 23 showing compliance in accordance with General Conditions of the Contract. Signed copies shall be included in the Operation and Maintenance Manual.

E. Operating Instructions and Maintenance Data: Prepare and submit printed operating instructions and maintenance data in accordance with Operating and Maintenance Data paragraph in this Section.

F. Submittals will be reviewed and marked as follows:

1. No Exceptions Taken: No action required.
2. Make Corrections Noted: Correct the submittals per notes by engineer and submit new copies of submittal to contractor for project records. Do not resubmit to engineer.
3. Rejected: Equipment as submitted does not meet requirements of contract documents. Revise and/or clarify per comments and resubmit to engineer.
4. Submittal Not Requested: Submittal not required per specification. Submittal returned with no review.

G. Note that the submittal review process does not relieve Contractor from being ultimately responsible for ensuring that submitted items satisfy all requirements of the Contract Documents.

H. Site Condition and Coordination:

1. Before any ductwork is fabricated or equipment installed and before running and/or fabricating any lines of piping or ductwork, the Contractor shall provide Architect and Engineer ¼" scale drawings of all mechanical rooms and main access walkways, coordinated with all trades with submitted equipment and verify all other areas to assure himself that they can be run and installed as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of the Structural and Architectural Work and maintain access walkways are clear for maintenance.

1.9 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Substitutions and Prior Approvals: Substitutions and prior approvals will be acceptable only when the proposed substitute has been submitted to the Engineer and approved through an addendum or change order. Request for prior approval shall be submitted a minimum of 10 calendar days prior to bid.

B. Some materials and equipment are specified by manufacturer and catalog numbers. The manufacturer and catalog numbers are used to establish a degree of quality and style for such equipment and material.

C. NOTE: When alternate or substitute materials and equipment are used Division 23 Contractor shall be responsible for engineering/redesign costs, space requirements, configurations, performance, changes in bases, supports, structural members and openings in structure, electrical changes and other apparatus and trades that may be affected by their use. Notification of General Contractor and other affected subcontractors shall be the responsibility of the Division 23 Contractor.

1.10 PROJECT RECORD DOCUMENTS

A. General: Comply with Division 1.

B. Job Site Documents: Maintain at the job site, one record copy of the following:

1. Drawings
2. Specifications
3. Addenda
4. Reviewed Product Submittals and Shop Drawings
5. Field Test Records

Do not use record documents for construction purposes. Maintain documents in clean, dry legible condition, apart from documents used for construction.

C. Record Information: Label each document "Record Document". Mark information with red ink. Keep each record current. Do not permanently conceal any work until required information is recorded.

D. Record following information on Drawings:

1. Horizontal and vertical location of underground utilities to be dimensioned from column lines.
2. Dimensioned location of internal utilities and appurtenances concealed in construction.
3. Field changes of dimension and detail.
4. Changes by change order or field order.
5. Details not on original contract drawings.
6. Manufacturer, trade name, catalog number and supplier of each product and item of equipment actually installed shall be indicated on equipment schedules.

E. Record the following information on Specifications:

1. Changes by change order or field order.
2. Other matters not originally specified.

F. Shop Drawings: Maintain shop drawings as record documents recording changes made after review as specified for drawings above.

G. Submittal: At completion of project, deliver record documents to Owner's representative and transmit a copy of signed receipt from Owner to the Engineer.

1.11 OPERATING AND MAINTENANCE DATA

A. The "Operating and Maintenance Manual" (O & M) is a bound compilation of descriptive drawings and data which identify equipment installed at the project site and detail the procedures and parts required to maintain and repair the equipment. Copies of final reviewed submittals shall be included for all equipment items.

B. Five sets of bound manuals will be required for this project. These are to be submitted for approval to the Project Manager. Five electronic versions of the manuals are also required, as described in paragraph I below.

C. Organization of the manuals shall follow the recommendations in ASHRAE Guideline current edition.

D. Enclose the material in rigid 3-ring or metal post binders and submit to the Project Manager at the completion of the project. Binders shall be Buckram or metal post binders or prior approved equal with block lettering. Simple binders with slide-in cover sheets are not acceptable. Sheet size shall be 8-1/2" x 11" with expandable metal capacity as required for the project. The number of binders forming one O & M Manual shall be based on a maximum limit of 4 inches. The following information shall appear on the front cover and backbone:

1. "Operation and Maintenance Manual"
2. Project Name (and volume number if more than one volume)
3. Project number
4. Building name, number, and street address
5. * Architect's name
6. * Engineer's name
7. * General Contractor's name
8. * Mechanical Contractor's name

* Items "6" through "8" need not be printed on the backbone.

E. Pages are to be standard 8-1/2" x 11" sheets, or 11" x 17" folded to fit the 8-1/2" x 11" sizes.

F. The manual shall include the following:

1. Alphabetical list of all system components including the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year's operation.
2. Operating instructions for complete system, including emergency procedures for fire or failure of major equipment and procedures for normal starting/operating/shutdown and long-term shutdown
3. Maintenance instructions, including valves, valve tag and other identified equipment lists, proper lubricants and lubricating instructions for each piece of equipment and necessary cleaning/replacing/adjusting schedules.
4. All test reports and proof of performance certificates.

5. Manufacturer's data and instruction sheets for each piece of equipment, marked to indicate the plan symbol, model, number, and options installed for each item of equipment furnished and installed on the project. These data sheet shall be accompanied by reviewed submittals that had no exceptions taken to them. Provide original printed material in each book, faxes are NOT acceptable. The serial numbers of each item of equipment installed are to be listed with the model numbers and plan symbols.

    a. Installation instructions.
    b. Drawings and specifications (final shop drawings).
    c. Complete parts lists, and a source of supply for each piece of equipment, marked with model, size, and plan symbol.
    d. A copy of the reviewed submittals for each piece of equipment, with any/all corrections identified during the submittal process made to the final submittal documents.
    e. Performance curves and capacity data, marked with model number, size, and plan code.
    f. Complete “as-builts” wiring and temperature control diagrams. (Shop drawings are not acceptable).
    g. Lubrication and other preventative maintenance data.
    h. Equipment warranties.
    i. The final balance report.

6. Design Intent Document furnished by Engineer.
7. Include a Table of Contents and tabbed index dividers.

G. In addition to the maintenance manual, and keyed to it, the equipment shall be identified and tagged as specified on drawings. Insert a copy of the Equipment List or Equipment Schedules in manual.

1. Identify all starters, disconnect switches, and manually operated controls, except integral equipment switches. Label with permanently applied, legible markers corresponding to operating instructions in the "Maintenance Manual".
2. Tag all valves per requirements in Section 230529.
3. Provide a typed tag list or schedule laminated or mounted under plexiglass in the equipment room stating valve ID number, location, service or function of each tagged item, and normal valve position. Insert a copy of tag list in each "Maintenance Manual". Also provide one copy of the list in a plastic closure as manufactured by Seton Name Plant Company, New Haven, Conn; or approved equal. The plastic closure shall include two holes punched at the top, with a brass or nickel grommet in each hole, and an 8” long length of nickel plated bead chain run through the holes, allowing the list to be hung from a wall peg.
4. Provide a reduced scale drawing of each floor indicating the location of each manual and automatic valve in every HVAC and plumbing piping system and include valve position number and normal valve position (normally open/normally closed) as per Specification Section 230529. Mount all drawings under plexiglass or laminate and mount on equipment room wall.

H. Division 230593 Contractor shall be responsible for scheduling instructional meetings for maintenance personnel on the proper operation and maintenance of all mechanical systems, using the maintenance manual as a guide. These meetings must be scheduled through the Architect, Construction Manager/General Contractor and far enough in advance so that all necessary personnel can be adequately notified.

1. Submit training certificate to Owner's Representatives at end of training and have certificate signed to indicate adequate training has been received.

I. Operating and Maintenance Data documents must be provided in digital format as follows:

1. Provide O&Ms in an intuitive format on a CD-ROM or DVD. Electronic manual preparation shall be under the direction of an individual or organization that has demonstrated expertise in the preparation of a comprehensive and complete electronic operation and maintenance manual. Qualifications shall be submitted for approval. One source of procurement used on past projects is Emanuals by Scanitall in Sandy, UT (tel. 801-619-2082). This is the responsibility of the Division 21/22/23 contractor.
2. A single CD or DVD to be authored with the latest edition of Adobe Acrobat, and be in a "non-protected" network accessible format.
3. All information on the CD-ROM or DVD shall be printable on 8.5"x11" or 11"x17"plain paper.
4. Capture images using OCR technology such that the user can key word search for information.
5. Provide a hypertext alphabetical index of all equipment and building products. All hypertext shall be blue in color.
6. Provide 3 copies of the O&M CD-ROM or DVD.

1.12 DELIVERY, STORAGE AND HANDLING

A. General: Deliver and store materials and equipment in manufacturer's unopened containers fully identified with manufacturer's name, trade name, type, class, grade, size and color.

B. Protection: Store materials and equipment off the ground and under cover, protected from damage. Maintain caution labels on hazardous materials.

C. Large Items: Make arrangements with other contractors on the job for introduction into the building of equipment too large to pass through finished openings.

D. Handling of Materials: Materials shall be handled, sorted and distributed using appropriate handling methods to protect all materials from damage. Dented, rusted, corroded or otherwise damaged materials shall be removed from the project site. Lined ductwork on which the liner becomes wet shall be removed from the project site. Determination of materials deemed unusable or inappropriate for installation shall be made by the Architect/Engineer.

1.13 PROJECT CONDITIONS

A. Accessibility:

1. Division 23 Contractor shall be responsible for the sufficiency of the size of shafts and chases and the adequate clearance in double partitions and hung ceilings for proper installation of his work. He shall cooperate with Contractors of other Divisions of the Work whose work is in the same space and shall advise the Construction Manager/General Contractor of his requirements. Such spaces and clearances shall, however, be kept to the minimum size required.
2. Division 23 Contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include (but not be limited to) valves, shock absorbers, traps, cleanouts, motors, controllers, switchgear, filters, VAV boxes, control valves, balancing valves, and drain points. If required for better

accessibility, furnish access doors for this purpose. Minor deviations from Drawings may be allowed to provide for better accessibility. Any changes shall be approved by the Architect/Construction Manager/General Contractor prior to making the change.

3. Division 23 Contractor shall provide the Construction Manager/General Contractor with the exact locations of access doors for each concealed valve, damper, or other device requiring service. Locations of these doors shall be submitted in sufficient time to be installed in the normal course of work.

B. Fabrication:

1. Before any ductwork is fabricated and before running and/or fabricating any lines of piping or ductwork, the Contractor shall assure himself that they can be run as contemplated in cooperation with Contractors of other Divisions of the Work and the physical constraints of the Structural and Architectural Work.

C. Freeze Protection:

1. Do not run lines in outside walls, or locations where freezing may occur. Piping next to outside walls shall be in furred spaces with insulation between the piping and the outside wall. Insulation of piping shall not be considered freeze protection. Buried pipe shall be installed minimum 6" below frost depth, unless noted otherwise in the documents.

D. Scaffolding, Rigging and Hoisting:

1. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment and apparatus furnished; remove same from premises when no longer required.

1.14 COORDINATION

A. General: Coordinate and order the progress of mechanical work to conform to the progress of the work of the other trades. Complete the entire installation as soon as the condition of the building will permit.

B. Coordination with Electrical Work: Section 230529.

C. Utility Interruptions: Coordinate mechanical utility interruptions with the Owner and the Utility Company. Plan work so that duration of the interruption is kept to a minimum.

D. Cutting and Patching: Section 230529.

E. Drawings and Specifications: The Mechanical Drawings indicate the general design and arrangement of lines, equipment, systems, etc. Information shown is diagrammatic in character and does not necessarily indicate every required offset, fitting, etc. Do not scale the Drawings for dimensions. Take dimensions, measurements, locations, levels, etc., from the Architectural Drawings and equipment to be furnished.

F. Each Division 23 subcontractor shall coordinate with other contractors to make certain that any of his equipment, piping or ductwork which is mounted on isolators or flexibly connected does not become "grounded" by another contractors work (e.g. walls, ceiling, etc.).

G. Discrepancies: Examine Drawings and Specifications for other parts of the work, and if any discrepancies occur between the plans for the work of this Division and the plans for the work of others, report such discrepancies to the Construction Manager/General Contractor and obtain written instructions for any changes necessary.

H. Order of Precedence: The precedence of mechanical construction documents are as follows:

1. Addenda and modifications to the Drawings and Specifications take precedence over the original Drawings and Specifications.

2. Should there be a conflict within the Specifications or within Drawings of the same scale, or between the Specifications and the Drawings, the more stringent or higher quality requirements shall apply.
3. In the Drawings, the precedence shall be Drawings of larger scale over those of smaller scale, figured dimensions over scaled dimensions and noted materials over graphic indications.
4. Should there be a conflict in dimensions or locations between Mechanical Drawings and Architectural Drawings, the Architectural Drawings shall have precedence.

1.15 START-UP PROCEDURES

A. Before start-up, each piece of equipment comprising a part of the system shall be checked for proper lubrication, drive rotation, belt tension, proper control sequence, and any other condition which may cause damage to equipment or endanger personnel.

B. Insure that all control systems are fully operational in automatic mode. Individually test each control loop to make certain it is operating as intended and is communicating properly with other devices.

C. If systems are not to continue in use following the start-up procedures, steps should be taken to insure against accidental operation or operation by unauthorized personnel. Provide padlocks on disconnect switches where applicable.

D. Factory personnel shall be notified as appropriate to start systems requiring their services.

E. Notify engineer at least 2 weeks prior to the scheduled start-up date of all major mechanical equipment and systems.

1.16 SCHEDULE OF TESTING

A. Provide testing in accordance with the General Conditions of the Contract.

B. A schedule of testing shall be drawn up by the Division 23 Contractor in such a manner that it will show areas tested, test pressure, length of test, date, time and signature of testing personnel.

C. All testing must be performed in the presence of the Architect's/Construction Manager's/General Contractor's representative; his signature for verification of the test must appear on the schedule.

D. All testing must be performed in accord with the procedures set forth in Division 23 and other Sections of the Specifications where referenced. At completion of testing, the completed schedule shall then be submitted in triplicate to the Architect and a copy shall be forwarded to the 230593 Contractor for inclusion in Operation and Maintenance Manual.

E. Make all specified tests on piping, ductwork and related systems as specified in this specification.

F. Make sure operational and performance tests are made on seasonal equipment.

G. Complete all tests required by Code Authorities, such as smoke detection, life safety, fire protection and health codes.

H. After test runs have been completed and systems have been demonstrated to be satisfactory and ready for permanent operation, all permanent pipeline strainers and filters shall be cleaned, air

filters cleaned or replaced, settings on pressure relief valves properly adjusted, valve and pump packings properly adjusted, belt tensions adjusted, drive guards secured in place, lubrication checked and replenished if required.

1.17 CLEANING AND FINISHING

A. Provide cleaning in accordance with the General Conditions of the Contract and Division 1.

B. Cleaning shall include but not be limited to removing grease, dirt, dust, stains, labels, fingerprints and other foreign materials from sight-exposed piping, ductwork, equipment, fixtures and other such items installed under Division 23 of the work. If finishes have been damaged, refinish to original condition and leave everything in proper working order and of intended appearance.

C. Section 232113 Contractor shall be responsible to certify that all HVAC Piping Systems have been cleaned in accordance with Section 232500 - HVAC Water Treatment whether actually done by the Section 232113 Contractor or by the 232500 Contractor.

1.18 WARRANTIES

A. Warranty: Provide a written warranty to the Owner covering the entire mechanical work to be free from defective materials, equipment and workmanship for a period of one year after Date of Acceptance. During this period provide labor and materials as required to repair or replace defects. Provide certificates for such items of equipment which have warranties in excess of one year. Submit to the Construction Manager/General Contractor for delivery to the Architect. Include a copy of all warranties in the Operation and Maintenance Manual.

B. This warranty will be superseded by the terms of any specific equipment warranties or warranty modifications resulting from use of equipment for construction heat or ventilation.

C. All refrigeration compressors shall have a (4) four year extended warranty from the manufacturer of the equipment in addition to the standard one-year warranty.

1.19 PROJECT CLOSEOUT

A. Project Observation Reports:

At or near the completion of the construction phase of this project, the Engineer will generate one or more Project Observation Reports for the owner. These reports will list the items of construction observed by the Engineer which are not in compliance with the Contract Documents.

The Mechanical Contractor and/or subcontractors shall certify completion of each listed item in writing and forward copies to the Architect, Engineer and General Contractor. The Engineer will not recommend the payment of retainage until this compliance certification has been received.

Each item on the Project Observation Report shall have a signature/date in the margin of the report indicating completion of that item.

1.20 CERTIFICATES AND KEYS

A. Certificates: Upon completion of the work, deliver to the Construction Manager/General Contractor one copy of Certificate of Final Inspection.

B. Keys: Upon completion of work, submit keys for mechanical equipment, panels, etc. to the Construction Manager/General Contractor.

END OF SECTION 230500

SECTION 230529 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED WORK

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.

B. Work furnished but not installed by this Contractor:

1. Access doors in accordance with paragraph 2.3 in this Section 230529.

1.2 SYSTEM DESCRIPTION

A. The work includes, but is not limited to the following:

Materials and methods common to the work in general of Division 23 and other Divisions and Sections of the Specifications where referenced.

1.3 QUALITY ASSURANCE

A. Welder Qualifications: Welding shall be performed by an ASME Certified welder with current certificate in accordance with ANSI B31.1 for shop and project site welding of piping work. Welder Qualifications:

1. Each welder shall have passed a qualification test within the past 6 months.
2. The test shall be in accordance with the ASME Boiler and Pressure Vessel Code, Section IX, "Welding Qualifications", ASME Section VIII, and ANSI 313.
3. The test report shall certify that the welder is qualified to weld the material to be used at the job site.
4. The Contractor shall submit three copies of each welder's qualification test report to the Project Manager for approval prior to commencing the work. No welder shall be used on the project until so certified.

1.4 REFERENCES

A. Reference Standards: Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the following:

1. For electrical equipment and products, comply with applicable National Electrical Manufacturers Association (NEMA) Standards, and refer to NEMA Standards for definitions of terminology herein.
2. Comply with National Electrical Code (NEC) NFPA-70 for electrical installation requirements.
3. Certified Pipe Welding Bureau (NCPWB) and American National Standards Institute (ANSI) Code Numbers B31.2, & B31.9 as applicable for welding requirements.
4. Comply with American National Standards Institute (ANSI A13) for identification of piping systems.
5. Comply with American National Standards Institute (ANSIB31.1) Code for Pressure Piping.
6. State of Utah, Division of Facilities Construction and Management Design Criteria.

1.5 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings and Product Data for the following items in accordance with the General Conditions of the Contract:

1. Legend and color of piping and equipment identification
2. Proposed access door sizes and locations

B. Operating Instructions and Maintenance Data: Submit printed Operating Instructions and Maintenance Data for the following items in accordance with Operating and Maintenance Data Paragraph in Section 230500.

1. Motors.
2. Starters.

C. Certificates: Before proceeding with the Work, submit to the Architect/Construction Manager/General Contractor, two copies of Certification that the welding work will be done according to ANSI B31.1 by welders who have been tested and whose qualification test sheets are available, attesting to their ability to weld in accordance with the Standard Procedure Specifications as established by the National Certified Pipe Welding Bureau.

PART 2 - PRODUCTS

2.1 MOTORS

A. General: Furnish motors necessary to operate mechanical equipment.

B. Motor Characteristics: Comply with the following requirements:

1. Variable Speed Drive Compatibility: All motors which are powered through a variable frequency drive shall conform to NEMA MG-1, Part 31 for inverter duty and shall be capable of continuous operation at 20% of nominal speed and shall meet the requirements of the Variable Frequency Drive specification in Section 230810 or Division 26 as applicable.
2. Altitude Deration: Motors to be furnished to maintain specified rated service factor at altitude of project.
3. NEMA Temperature Rating: Rated for 40 deg.C environment for continuous duty at full load, Class B motor temperature rise. Motors for use with variable frequency drives shall be Class F insulated. All motors shall be Class H insulated.
4. Starting Capability: Provide each motor capable of making starts as frequently as indicated by the automatic control system.
5. Phases and Current Characteristics: Provide squirrel-cage induction polyphase motors for 3/4 horsepower and larger, and provide capacitor-start single-phase motors for 1/2 horsepower and smaller. One-sixth horsepower and smaller may, at equipment manufacturer's option, be split-phase type. Coordinate current characteristics with power specified in Division 26 and with individual equipment requirements specified in other Sections of Division 23. Provide two separate windings on polyphase two speed motors. Do not purchase motors until power characteristics available at locations of motors have been confirmed, and until rotation directions have been confirmed.
6. Power Factor: All motors rated greater than 1000 watts shall have a Power Factor of not less than 95% under rated load conditions. The 95% PF may be obtained by design of the motor or by providing a capacitor. Capacitors, if provided to obtain the 95% PF, must be switched with the motor. If the motor draws less than 1000 watts at full load, it is excluded from the 95% power factor requirement.
7. Service Factor: 1.15 for polyphase motors and 1.35 for single-phase motors. Motors shall be selected such that the brake horsepower requirement is not within the service factor at design load.
8. Efficiency: All motors shall be premium efficiency type in accordance with the current State Energy Code, except where a higher efficiency is noted on drawings.

9. Motor Construction: Provide Design "B" motors for general purpose continuous duty and Design "C" motors where required for high starting torque such as the low speed motor on fans with a two-motor drive arrangement. Small motors that are part of packaged equipment may be manufacturer's standard motors meeting Energy Code requirements for efficiency.

    a. Bearings: Ball or roller bearings with inner and outer shaft seals: regreasable; except permanently sealed where motor is normally inaccessible for regular maintenance. Where belt drives and other drives produce lateral or axial thrust in the motor, provide bearings designed to resist the thrust loading. Refer to individual sections of Division 23 for fractional horsepower light-duty motorized equipment where sleeve-type bearings are permitted.
    b. Enclosure Type: Except as otherwise indicated, provide open drip-proof motors for indoor use where satisfactorily housed during operation, and provide guarded drip-proof motors where exposed to contact by employees or building occupants. Provide weather-protected Type I for outdoor use, Type II where not housed. Refer to individual Sections of Division 23 for other enclosure requirements.
    c. Overload Protection: Provide built-in thermal overload protection for each leg of each phase and, where indicated, provide internal sensing device suitable for signaling and stopping the motor at the starter. Thermal overload protectors shall be sized to accommodate the altitude of installation.
    d. Name Plate: Provide metal nameplate on each motor, indicating full identification of manufacturer, ratings, characteristics, construction, NEMA efficiency, power factor, special features and similar information.
    e. Motor Connections: Provide conduit connection boxes.
    f. Motors shall not exceed 80dbA rating when running their full speed and power range.

2.2 STARTERS

A. Note that some starters are furnished and installed under Division 26. Review electrical plans before bidding.

B. General: Furnish starters and contactors necessary to operate mechanical equipment motors. **Starter manufacturer shall be the same brand for ALL motors furnished under Division 23.** Approved manufacturers shall be those listed in Division 26 or this specification.

C. Motor Starter Characteristics: Comply with NEMA standards and NEC. Furnish Type I general purpose enclosures with padlock ears, and with frames and supports for mounting on wall, floor or panel as required. Furnish the type and size of starter recommended by the motor manufacturer and equipment manufacturer for the applicable protection and start-up condition; refer to individual equipment sections for basic load requirements. All starters shall be by the same manufacturer. Only manufacturers approved by Division 26 will be accepted. All starters shall comply with Division 26 requirements.

D. Manual Control:

1. Furnish maintained-contact push buttons and pilot lights, properly arranged for single-speed or multi-speed operation as indicated.
2. Furnish manual switch and pilot light for motors 1/3 horsepower and smaller, except where interlock or automatic operation is indicated.

E. Automatic Control:

1. Furnish magnetic starters for motors 1/2 horsepower and larger and for smaller motors where interlock or automatic operation is indicated. Include the following:

    a. Maximum number of auxiliary contacts available: three or more.
    b. "Hand-Off-Automatic" switches in starter cover.
    c. Interlocks, pneumatic switches and similar devices as required for coordination with the control requirement specified in Section 230900-Electronic Controls.
    d. Built-in 120 volt control circuit transformer, fused from line side, where service exceeds 240 volts.

        1) Control circuit conductors to be protected in accord with the National Electrical Code.

    e. Trip-free thermal overload relays, each phase.
    f. Externally operated manual reset except on refrigeration compressors which shall have automatic reset. Automatic reset shall be limited to three attempts. If motor fails to start after three attempts, manual reset shall be required.
    g. Undervoltage release or protection.
    h. Phase failure/phase reversal protection on all legs.

F. Weather Protection: Provide weather-proof mounting of magnetic starters for equipment outside of the building.

2.3 ACCESS DOORS

A. Furnish steel access doors, minimum size required for normal service use or as sized on drawings as manufactured by Inryco/Milcor, Walsh, where shown on mechanical or architectural drawings, and where required for access to valves, shock absorbers, dampers, mechanical equipment or appurtenances.

B. Standard Doors:

1. Frames: 16 ga. steel.
2. Panels: 14 ga. steel.
3. Finish: Chemically bonded prime coat of baked enamel.
4. Hinge: Concealed spring hinges openable to 175 degree; removable pins. Provide number of hinges as recommended by manufacturer for size of door.
5. Locking Devices: Flush steel, screwdriver operated, cam type locks. All access doors below 8'-0" in public areas shall be key-operated cylinder lock with two keys. Same key shall open all access doors.
6. Style of doors shall be appropriate for architectural finish at door location. Furnish masonry anchors where required.

B. Fire Rated Doors:

1. Frames: 16 ga. steel.
2. Panels: Sandwich type, 20 ga. steel sheets, manufacturer's standard insulated core.
3. Finish: Chemically bonded prime coat of baked enamel.
4. Hinge: Continuous type, steel with stainless steel pin.
5. Closer: Automatic closing mechanism.
6. Locking Devices: Self-latching, key-operated cylinder lock with two keys; interior, latch release mechanism.
7. Style of doors shall be appropriate for architectural finish at door location.
8. Fire rated doors shall have components and assemblies meeting requirements of the American Insurance Association, Factory Mutual Insurance Association and listed by Underwriters Laboratories, Inc.

C. Exact location of access doors shall be as directed by Mechanical Contractor and approved by the Architect. Coordinate with General Contractor and Architect.

2.4 VALVES

A. General:

1. Provide valves as specified herein and as indicated on the Drawings complete with accessories and attachments as required and appropriate for the pressure/temperature of system.
2. Supply valves for proper pressure ratings determined by the system working pressures at point of use and of proper types for systems and functions indicated.
3. Steam and Condensate System Isolation Valves: Use steam rated ball valves on pipe sizes 2” and smaller. Use gate valves on pipes larger than 2”. Use globe valves on manual bypass lines.
4. Provide like type valves of one manufacturer only unless specified otherwise.

5. Plainly and permanently mark valves with manufacturer's name or trademark, pressure rating, both Cold Working Pressure (CWP) and Steam Working Pressure (SWP), as applicable and flow direction when required to prevent improper installation.
6. Mark valves requiring approval by Underwriter's Laboratories (UL) or Factory Mutual Engineering Division (FM) with appropriate markings cast into the valve body.
7. Provide extended necks as appropriate for insulation.

B. Manufacturers:

1. The following manufacturers are acceptable providing the product to be considered is equivalent in every respect to the nomenclature provided by the specified make and model.

   a. Bronze Valves: Powell, Milwaukee, Crane, Hammond, Nibco.
   b. Iron Body Valves: Powell, Milwaukee, Traverse City, Kennedy, Iowa, American, Nibco.
   c. U.L., F.M. Approved or Listed Valves: Nibco, Demco, Pratt, Kennedy, Mission, Milwaukee, Hammond.
   d. Ball Valves: Hammond, Watts, Jamesbury, Worcester, Milwaukee, Apollo, Powell, Dynaquip, Nibco, Spirax Sarco, FNW.
   e. Butterfly Valves: Milwaukee, Hammond, Centerline, DeZurik, Fisher, Victaulic, Keystone, Posi-Seal, TEC, Flowseal, Nibco, IFC, FNW, Bray, EBRO.
   f. Lubricated Plug Valves: Homestead, Nordstrom, Powell.
   g. Non-Lubricated Eccentric Plug Valves: DeZurik.
   h. Stop and Drain and Drain Valves: Milwaukee, Hammond, Prier, Nibco or United Brass.
   i. Gas Cock: Peter Healy or Crane.
   j. Check Valves: Nibco, IFC, DFT.

C. Valve Schedule:

1. Standard Bronze Valves - 150 SWP/300 CWP, per ASTM B61/B62. No brass materials will be accepted.

   a. Check, Gate, and globe with union bonnet and rising stem.
   b. Sizes 1/8 through 2 inches.
   c. Schedule:

Plan Code:	G.V.	GL.V.	C.V.	L.C.V.
Valve Type:	Gate	Globe	Swing	Lift
Make:	Nibco	Nibco	Nibco	Crane
Straight Threaded:	T-134	T-235Y	T-433Y	365.5
Straight Soldered:	S-134	S-235Y	S-433Y	--
Angle Threaded:	--	T-335Y	--	--
Angle Soldered:	--	--	--	--

2. Standard Bronze Valves - 300 SWP/600 CWP, per ASTM B61/B62, no brass materials will be accepted.

   a. Gate, globe and check.
   b. Sizes 1/8 through 2 inches.

c. Schedule:

Plan Code	G.V.	GL.V.	C.V.	L.C.V.
Valve Type:	Gate	Globe	Swing	Lift
Make:	Nibco	Nibco	Nibco	Crane
Straight Threaded:	T-134	T-235Y	T-433Y	365.5
Straight Soldered:	S-134	S-235Y	S-433Y	--
Angle Threaded:	--	T-335Y	--	--
Angle Soldered:	--	--	--	--

3. Standard Iron Body Valves - 125 SWP/200 CWP.

a. Gate, globe and check.
b. Sizes 2-1/2 through 12 inches.

c. Schedule:

Plan Code:	G.V.	OS&Y	GL.V.	C.V.	W.C.V.	N.S.C.V.
Valve Type:	Gate	Gate	Globe	Swing	Weighted	Non Slam
Make:	Nibco	Nibco	Nibco	Nibco	Nibco	Crane
Straight Threaded:	T-619	T-617-0	T-718B	T-918Y	T-918YBLW	--
Straight Flanged:	F-619	F-617-0	F-718B	F-918Y	F-918YBLW	23
Angle Threaded:	----	----	T-818B		----	----
Angle Threaded:	----	----	F-818B	----	----	----

4. Standard Iron Body Valves - 150 SWP/300 CWP.

a. Gate, globe and check.
b. Sizes 2 through 12 inches.
c. Schedule:

Plan Code:	G.V.	OS&Y	GL.V.	C.V.	N.S.C.V.
Valve Type:	Gate	Gate	Globe	Swing	Non Slam
Make:	Nibco	Nibco	Nibco	Nibco	Crane (Chapman)
Straight Threaded:	T-669	T-667-0	--	--	--
Straight Flanged:	F-669	F-667-0	F-768B	F-968B	223
Angle Threaded:	--	--	--	--	--
Angle Flanged:	--	--	F-868B	--	

5. Standard Iron Body Valves - 250 SWP/500 CWP.

a. Gate, globe and check.
b. Sizes 2 through 12 inches.
c. Schedule:

Plan Code:	G.V.	OS&Y	GL.V.	C.V.	N.S.C.V.
Valve Type:	Gate	Gate	Globe	Swing	Non Slam
Make:	Nibco	Nibco	Nibco	Nibco	Crane
Straight Threaded:	T-669	T-667-0	--	--	--
Straight Flanged:	F-669	F-667-0	F-768B	F-968B	223
Angle Threaded:	--	--	--	--	--
Angle Flanged:	--	--	F-868B	--	--

6. UL and FM Approved Valves.

a. Gate, check and butterfly.
b. Sizes all.

c. Schedule:

Plan Code:	OS&Y	C.V.	W.V.C.	BF.V	D.V.
Valve Type:	Gate	Swing	Wafer	BTFY	Drain
Make:	Nibco	Nibco	Nibco	Demco	Nibco
Straight Threaded:	T-104-0	T-413W	--	--	T-211Y
Straight Flanged:	F-607-0	F-908-W	--	--	--
Wafer:	--	--	W-900-W	NE-H	--

7. UL and FM Approved Valves - 175 Pound Water.

a. Post indicator with indicator post.
b. Sizes 4 through 12 inches.
c. Schedule:

Plan Code:	P.I.V.	P.I.V.B.F.
Valve Type:	Gate	BTFY
Make:	Nibco	Demco
Straight Flanged:	F-609	NE-H (Wafer)
Mechanical Joint:	M-609	--
Indicator Post Vertical:	NIP-1	Stem extension and gear operator with post indicator U.L. Listed only.
Indicator Post through Wall:	NIP-2	--

8. Underground Valves - 175 Pound Water, American Water Works Association (AWWA).

a. Gate valves with service boxes.
b. Sizes (see schedule).
c. Schedule:

Plan Code:	GV & SB	GV & SB
Size/Inches:	3/4 thru 2	2 thru 16
Valve Type:	Oriseal	Gate
Make:	Mueller	Mueller
Model:	H-15201	A-2380-22 or 2380-18
Service Box:	H-10396-86	H-10357
Base:	H-10396-7-8-9 or H-10400	No. 6 Oval
Key:	Stationary rod attached.	A-24610 Furnish one each box.

9. Ball Valve:

a. Blowout proof stem.
b. Full port type with appropriate seals and seat, as specified.
c. Bronze bodies per ASTM B61/B62 or ASTM B-584. No brass material will be accepted.
d. Stainless steel bodies per ASTM A-351, Grade CF3M.
e. Schedule:

Plan Code:	B.V.	B.V.	H.V.	S.B.V.
Service:	Balancing	In line control and isolation	Refrigeration	Steam and Steam Condensate
Pressure:	150 SWP/300 CWP	150 SWP/300 CWP	500 CWP	150 SWP
Sizes/Inches:	1/4 thru 2-1/2	1/4 thru 3"	3/8" thru 2 1/8"	½” thru 2”
Make:	Nibco	Nibco	Nibco	Nibco
Straight Threaded:	T-580-70-66	T-585-70-66	--	T-595-Y-S6R-66
Straight Solder End:	S580-70	S585-70	S595-Y-66	--
Actuator:	Lever with memory stop	Lever	Lever	Lever
Port:	Standard	Full	Full	full

* Steam ball valve includes a three-piece body, seals rated for steam operating temperatures up to 400°F.

10. Butterfly Valves:

a. Schedule; standard 150 psi with 150 psi ANSI companion flanges for use where system pressures cannot exceed 200 psig shut off (static) pressure.

Plan Code:	BFV	
Style:	Lugged	
Pressure Rating ANSI Class:	150 minimum	
Body:	ASTM A126 Cast Iron or ASTM A395 Ductile Iron	
Disc:	Aluminum Bronze	
Stem:	316 Stainless	17-4 PH Stainless or 18-8 Stainless
Seat:	EPDM (-40 deg.F to 250 deg.F)	
Actuator:	2" thru 5" Infinite position lever with memory stop. 6" thru 24" Self-locking worm gear with adjustable limit stops, and position indicator. Provide chain wheel and chain where indicated by contract documents.	
Make:	Keystone	
Size:	2"-12"”	14”-36
Model:	222	AR2

b. Schedule: High performance 300 psi with 300 psi ANSI companion flanges for use where system pressures are more than 200 psig but cannot exceed 700 psig shut-off (static) pressure.

Plan Code:	BFV	
Style:	Lug	
Pressure Rating ANSI Class:	300 minimum	
Body:	Carbon steel ASTM A-216	
Disc:	316 stainless steel ASTM A-216	
Stem:	Stainless steel ASTM A564 Type 630 (17-4PH)	
Seat:	Virgin TFE	
Actuator:	3" and 4": Rachet handle with lock. 6 and over: Worm gear with lock.	
Make:	Flowseal (Mark Controls Corp.)	
Size:	3" and 4"	6" and over
Model:	XX-3L-121TTH-L	XX-3L-121TTH-2

11. Stop Check Valve:

a. Schedule:

Plan Code:	S.C.V.
Pressure:	250 SWP/500 CWP
Size/Inches:	2-1/2 thru 10"
Make:	Crane
Straight Flanged:	28E
Angle Flanged:	30E

12. Eccentric Plug Valve:

    a. Schedule:

Plan Code:	E.P.V.	E.P.V.
Pressure:	175 lb. CWP	175 lb. CWP
Size/Inches:	1/2 thru 3	4 thru 8
Make:	DeZurik	DeZurik
Model:	400	100
Actuator:	483-487	159 w/Memory Stop
Ends:	Threaded	Flanged

13. Gas Valves:

    a. Gas cock and lubricated plug.
    b. Schedule:

Plan Code:	G.C.K.	L.P.V.	L.P.V.	G.B.V.
Pressure:	100 PSI Air	200 lb. CWP	200 lb. CWP	250 PSI LP-Gas
Size/Inches:	1/2 thru 1	1/2 thru 3	4 thru 12	1/4" thru 3"
Make:	Peter Healy	Walworth	Walworth	Apollo
Model:	1500-F	1700	1707-F	80-100
Actuator:	None	E-2	Wrench as required	1/4 turn
Ends:	Threaded	Threaded	Flanged	Threaded

14. Specialty Valves:

    a. Petcock, stop and drain, drain, needle.

b. Schedule:

Plan Code:	PTK	S&D.V.	D.V.	N.V.
Type:	Petcock	Gate	Ball	Needle
Pressure:	250 LB.	125 LB.	125 LB.	200 LB.
Size/Inches:	1/8	1/2 and ¾	3/4	1/8 thru 3/4
Make:	Powell	Nibco	Apollo	Jenkins
Model:	922	76 or 726	78-104	743G
Ends:	Threaded	Threaded or Soldered	Threaded and Hose End Adaptor	Threaded

2.5 PIPE HANGERS, SUPPORTS, AND ACCESSORIES PROTECTION

A. General:

1. Provide hangers, rods, clamps, brackets, attachments, inserts, bracing, nuts, coach screws, eye bolts, clips, plates, and washers as required for appropriate installation for building structure provided.
2. All hangers and accessories shall be manufactured by one manufacturer for compatibility of all components.
3. All hangers, attachments, and accessories shall be provided with a certified manufacturers safety factor of five (5).
4. All hangers, attachments and accessories shall comply with the following:

   a. Safety factor of 5 (actual load vs. ultimate load).
   b. National Fire Protection Association (NFPA) (except as amended by provisions of this Specification for minimums) and as applicable.
   c. Factory Mutual Engineering Division (FM) as applicable.
   d. Manufacturers Standardization Society (MSS).

5. Support and positioning of piping shall be by means of engineered methods that comply with IAPMO PS 42-96.

B. Material:

1. Hangers in contact with steel, iron, cast or ductile iron shall be hot dipped galvanized or cold galvanized with "Galvilite by ZRC" cold galvanized compound only to a thickness of not less than 3.0 mil (.003 inches). "Galvilite by ZRC Worldwide, Marshfield, MA. Tel: (800) 831-3275, www.zrcworldwide.com" or equal.

2. Hangers in contact with copper piping shall be copper clad or provided with heavy density felt (20 oz.) pad permanently attached to the hanger and placed so as to prevent direct contact between pipe and hanger. Felt shall be mildew and moisture rot-proof. Heavy polyvinyl chloride coating on hanger, 5 mil thickness minimum will be acceptable in lieu of felt.
3. Hangers in contact with "plastic" or "glass" piping shall be galvanized in accordance with Sub-paragraph B-1, above and padded in accordance with Sub-paragraph B-2, above.
4. Hangers for insulated piping shall be sized to accommodate the insulation. Provide with insulation shields or insulation saddles* as applicable and appropriate and in accordance with the following schedule:

Nominal Pipe or Tubing Size	Shield Length	Shield Gauge Thickness	Material
½" thru 3"	12"	18	Galvanized
4"	12"	16	Galvanized
5"	15"	16	Galvanized
6"	18"	16	Galvanized
8"	24"	--	B-line (B3160-3165)
over 8"	36"	--	B-line (B3160-3165)

* Insulation inserts between piping and shield shall be furnished by 230700 Contractor for appropriate pipe size and insulation thickness for all insulated piping requiring a vapor barrier.

5. Provide swivel ring hangers similar and equivalent to B-Line B-3170, 3170CT, and 3170C for pipe sizes 1/2" thru 8".
6. Clevis type hangers may, at the Contractors option, be provided when similar and equivalent to B-Line B-3100, and 3100C.
7. Roller type hangers shall be used on all steam piping 4" and larger and when appropriate shall be equivalent to B-Line B-3110 black steel with cast iron roller. Provide insulation saddles for all roll-type hangers, B-Line B3160-3165. Calcium silicate inserts, in conjunction with insulation saddles shall be provided on all steam piping.
8. Beam and bar joist clamps shall be appropriate for attachment locations, top beam, bottom beam, etc., and provided with retainer rods, clips or straps as required.
9. Hanger spacing and minimum rod sizes shall be based on the applicable Mechanical and Plumbing Codes for the type of piping installed.
10. Riser clamps shall be provided on all vertical risers at each floor and shall conform to materials and protective coatings or pads as specified in Paragraph B of this Article 2.05. Clamps shall be similar and equivalent to B-Line B-3131 and B-3148.
11. Provide concrete inserts where required in flat slab construction similar and equivalent to B-Line B-22-1 Series 2000 lbs. per foot load capacity and spaced per hanger spacing schedule (sub-paragraph B-9 above) provide all accessories and nuts required.
12. Trapeze hangers shall be constructed of channel similar and equivalent to B-Line Series B-11 thru B-72 as appropriate complete with pipe clamps, nuts, rollers etc., as required. Channel to bear 5 times actual weight of all piping on trapeze system with minimum deflection. (.01 inch maximum). At a minimum, install pipe clamps on every other trapeze hanger, and where required to comply with seismic restraint design.
13. Wall brackets shall be fabricated "knee" brackets conforming to requirements of sub-paragraph B-12 above and made up with B-Line Series B-11 thru B-72 channel.

Angle clips may be used in wood joist construction when similar and equivalent to B-Line B-3060 or 3061.

14. Hangers attached to wood construction shall be attached by use of eye bolts, coach screws or lag bolts when load bearing ratings maintain a safety factory of 5.
15. All other means of support i.e., special construction, pipe stands, earthquake bracing, sway bracing, etc., shall be provided as required and in conformance with jurisdictional authority and these Contract Documents, submit all special or required support and bracing systems for review by the Architect/Engineer prior to installing any item.
16. All vertical refrigeration suction and hot gas, and all steam piping shall be provided with insulation shields and calcium silicate inserts at each support location.
17. All piping systems exposed to motorized traffic shall be fully protected by installation of concrete-filled pipe bollards. Bollards shall be cleaned and painted as directed by the Architect.
18. For plenum applications use pipe supports that meet ASMT E-84 25/50 standards.

C. Acceptable Manufacturers:

1. Manufacturers acceptable to this Specification are as follows, all other manufacturers must submit for acceptance.

    a. B-Line
    b. Fee & Mason
    c. Grinnell
    d. Hubbard Enterprises/HOLDRITE
    e. P.H.D.
    f. Michigan
    g. Tolco
    h. MAPA
    i. Hilti

2.6 IDENTIFICATION MATERIALS FOR PIPING AND EQUIPMENT

A. Materials for identification shall be as follows:

1. Metal Tags: Round brass discs, minimum 1-1/2" diameter with edges ground smooth. Each tag shall be punched and provided with brass chains for installation.
2. Engraved Nameplates: Fabricate from plastic sheet stock of sufficient thickness to allow engraved lettering in contrasting color. Attach nameplates to equipment with screws.
3. Painted Stencils: Of size and color per ANSI A13.1 using clean cut letters and oil base paint. Paint material shall comply with Architectural Painting Specifications. See Part 3 for legend and size for Stencils.

2.7 DIELECTRIC PIPE FITTINGS AND ISOLATORS

A. Manufacturer: Epco Sales Inc., Victaulic.

B. Schedule: (complete unions)

Model:	FX	GX
Sizes:	½" thru 2"	2" thru 12"
Maximum Pressure:	250 psi	175 psi
Maximum Temp.:	210 deg. F	210 deg. F
Epconite Gasket:	#2	#2
Ends:	FPT x Solder	FPT x Solder
Type:	Union	Flanged Union

C. Schedule: (companion flanges)

Model:	X	W	H
Sizes:	1-1/2" - 10"	1-1/2" - 12"	1-1/2" - 12"
Maximum Pressure:	175 psi	175 psi	175 psi
Maximum Temp.:	210 deg. F	210 deg. F	210 deg. F
Epconite Isolators:	#2	#2	#2
End Style:	Solder (Brass)	Weld neck	Iron Pipe Thread
Type:	Companion	Companion	Companion
Face Gasket:	Same as Isolators		

D. Dielectric fittings shall conform to ASA B16.8, and shall be plated as applicable a minimum of .0005" and have no flow restriction when assembled.

2.8 SOLVENTS FOR PLASTIC PIPING

A. Solvents for plastic piping joints shall be certified to meet SCAQMD Rule 1168/316A. This includes but is not limited to PVC, CPVC, and ABS piping, all grades and sizes.

2.9 EQUIPMENT DRAINS AND OVERFLOWS

A. Steel Pipe: ASTM A53, Schedule 40 galvanized.

1. Fittings: Galvanized cast iron, or ANSI/ASTM B16.3 malleable iron.
Joints: Screwed, or grooved mechanical couplings.

B. Copper Tubing: ASTM B88, Type M, hard drawn.

1. Fittings: ANSI/ASME B16.23 cast brass, or ANSI/ASME B16.29 solder wrought copper.
2. Joints: ASTM B32, solder, Grade 95TA.

C. PVC Pipe: ASTM D1785, Schedule 40.

1. Fittings: ASTM D2466 or D2467, PVC.
2. Joints: ASTM D2855, solvent weld.

D. ABS Pipe: ASTM D2680 or D2751.

1. Fittings: ASTM D2751.
2. Joints: ASTM D2235, solvent weld.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. General: Unless otherwise specifically indicated on Drawings or in Specifications, install equipment and materials in accordance with recommendations of manufacturer, including performance of tests as manufacturer recommends.

B. Protection:

1. Close ends of pipe and ductwork during construction and cover equipment to prevent entry of foreign material. Protect insulation against dirt, water, chemical or mechanical damage before, during and after installation. Cover floor drains and protect fixtures and equipment against damage during concrete pours and mechanical work.

C. Quiet Operation and Vibration:

1. All work shall operate in accordance with Section 230540 - Mechanical Sound and Vibration Control under all conditions of load.

2. Sound or vibration conditions not in accordance with Section 230540 and considered objectionable shall be corrected in a manner approved by the Architect under the Work of Division 23.

3.2 WELDING

A. Joints between sections of pipe, between pipe and fittings, shall be fusion welded. Use only certified welders. Strength of finished welded joints to be equal to strength of pipe. Width of finished weld to be at least 2-1/2 times the thickness of the part joined. Thickness of weld to be at least 25% greater than the thickness of pipe or fittings. Finished welded joints to present neat and workmanlike appearance.

B. Make no direct welded connections to valves, strainers, apparatus, and related equipment. Make connections to flanged valves, and flanged equipment with welded pipe connection flanges.

C. Radii of weld ells to be 1-1/2 times nominal diameter of fittings. Fittings used for all branch connections, whether full-size or reducing, to have interior surfaces smoothly contoured. Wall thickness of welded fittings equal to adjacent piping.

3.3 ELECTRIC WIRING

A. Furnish equipment requiring electrical connections to operate properly and to deliver full capacity at electrical service available.

B. All control wiring to be in accordance with manufacturer's recommendations; all wiring shall be color coded to facilitate checking.

C. Unless otherwise indicated, all mechanical equipment motors, starters, and controls shall be furnished, set in place, and wired in accordance with the Electrical Equipment/Wiring Responsibility Matrix on the drawings. Contractor should note that the intent of this electric wiring matrix is to have the Division 23 Contractor responsible for coordinating all control wiring as outlined, whether or not specifically called for by the mechanical or electrical drawings and specifications. Mechanical Contractor shall comply with the applicable requirements of Division 26 for electrical work of this Division 23 which is not otherwise specified. No extras will be allowed for Contractor's failure to provide for these required items. The Division 23 Contractor shall also refer to the Division 26 specifications and plans for all power and control wiring and shall advise the Architect/Engineer of any discrepancies prior to bidding.

ELECTRICAL EQUIPMENT/WIRING RESPONSIBILITY MATRIX

Item	Furnished By*	Set By*	Power Wiring*	Control Wiring*
Equipment Motors	MC	MC	EC	MC
Motor Starters & Overload Heaters	MC – Except when shown on MCC	EC	EC	MC
Variable Frequency Drives (VFDs)	MC	EC	EC	MC
Fused & Unfused Disconnect Switches, Thermal Overload & Heaters	EC	EC	EC	--
Manual Switches & Speed Control Switches carrying full load currents.	MC	EC	EC	EC
Fire/Smoke and Smoke Dampers	MC	MC	EC – Requires emergency power circuit if air system served is on emergency power.	EC
Control Relays & Transformer (See Note 2)	MC	MC	EC	MC
Thermostats (Line Voltage)	MC	EC	EC	EC
Temperature Control Panels	MC	MC	EC	MC
DDC Interface to Fire Alarm System	MC	MC	EC	MC
Exhaust fans for kitchen hoods or fume hoods where interlocked with make-up air fans.	MC	MC	EC	EC
Exhaust fans when switched with room lights.	MC	MC	EC	EC
Fire sprinkler system alarms, tamper switches, flow switches and fire alarm systems tie-ins to provide a complete fire protection system.	FPC	FPC	FPC	FPC
Water Softener Timeclocks, Timers, Lock-out Devices, Wheatstone Bridges and Meters	MC	MC	EC	MC
Temporary Heating Connections	MC	MC	EC	MC

* MC = Mechanical Contractor under Division 23 of the work.
* FM = Mechanical Contractor under Section 212200 - FM-200 Fire Suppression System.
* FPC = Fire Protection Contractor.
* EC = Electrical Contractor under Division 26 of the work.
* MGES = Medical Gas Equipment Supplier (Section 226313).

D. All temperature control conduit and wiring shall be furnished and installed under Section 230900. All motorized damper and motorized valve wiring shall be furnished and installed under Section 230900.

3.4 SLEEVES, PLATES AND CLOSURES

A. Division 23 Contractor shall provide and locate pipe sleeves, and inserts required before new floors and walls are built or shall be responsible for the cost of cutting and patching required where sleeves and inserts were not installed or where incorrectly located.

B. Provide sleeves for mechanical piping passing through concrete floor slabs and through concrete, masonry, tile, and gypsum wall construction. Provide metal collars to close and protect openings.

C. Where sleeves are placed in exterior walls below grade, pack spaces between the pipe or conduit and the sleeves with Hornflex Thiokol L-32 Sealant or Link Seal and make water-tight. Provide metal rodent collars securely fastened to structure.

D. Where pipe motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of pipe. Where sleeves pass insulated pipes, the sleeves shall be large enough to pass the pipe only and the insulation shall be made to butt against the construction, except for pipes requiring insulation having a vapor barrier, in which case, the sleeves shall be large enough to pass the pipe and insulation. Check floor and wall construction finishes to determine proper length of sleeves for various locations, make actual lengths to suit the following:

1. Terminate sleeves flush with floors, walls, partitions, and ceilings.
2. Seal annular space around pipes watertight at floor penetrations.
3. In areas where pipes are concealed, as in chases, terminate sleeves flush with floor.
4. In all areas where pipes are exposed, extend sleeves 1/4" above finished floor, except in rooms having floor drains, where sleeves shall be extended 2" above floor and in Kitchens and Mechanical Equipment Rooms, where sleeves shall be extended 4" above floor.

E. Sleeves shall be constructed of 24 gauge galvanized sheet steel with lock seam joints for all sleeves set in concrete floor slabs terminating flush with the floor. All other sleeves shall be constructed of galvanized steel pipe unless otherwise indicated on the drawings. "Crete Sleeve" (plastic type) sleeves are acceptable for concrete construction as manufactured by Sperzel Division, Shamrock Industries or Willoughby Industries.

F. Fasten sleeves securely in floors and walls so that they will not become displaced when concrete is placed or when other construction is built around them.

G. Provide tight fitting floor and ceiling plates on pipes passing thru walls, ceilings, and floors. Nickel or chrome plated in finished areas, galvanized cast iron in unfinished areas. Provide wall and ceiling flanges for ducts in finished areas.

H. Provide all cutting, patching of holes, openings, notches. Obtain written approval for notching, boring, chipping, burning, drilling, welding to structural members in accordance with the General Conditions of the Contract and paragraph 3.7 of this Section.

I. Where pipe sleeves penetrate fire rated walls and floors, this contractor shall use fire safing to seal openings.

3.5 FOUNDATIONS, PADS AND CURBS

A. Concrete foundations, pads and curbs for work under Division 23 shall be provided by the General Contractor. This requires the Division 23 Contractor to coordinate all necessary pads and curbs

with the General Contractor before bid date. Failure to do so results in these items becoming the responsibility of the Division 23 Contractor.

B. All dimensions and exact locations for anchor bolts, foundations, pads and concrete curbs for mechanical equipment in Division 23 shall be determined and located by the Division 23 Contractor.

C. When water heaters and similar equipment are installed in a suspended application, an engineered and manufactured platform shall be used. Weight loading capability shall include a minimum safety factor of 2.

3.6 EXCAVATING AND BACKFILLING

A. Excavate for all mechanical equipment such as fuel tanks, ductwork, sump pumps, manholes and trenches for underground pipelines to required depths. Compact bottoms of excavations. Slope to obtain required grade. Remove rocks, trash and debris before installation of equipment and backfilling. Backfill by hand tamping earth under the haunch of the pipe to specified compaction. Backfill and compact in thin layers until top of pipe is covered. Complete backfill by methods required or directed for soil characteristics to comply with the Architectural section of these specifications.

B. Excavations near footings shall be such that, when nearing building footings, or bearing foundation walls, the excavation bottom shall not be nearer the footing than a normal 45 degree bearing line from edge of footing bottom to bottom of excavation. When it is necessary to perpendicularly cross under a continuous foundation wall, care shall be taken to insure that crossing is clear of the structural foundation and of minimal width.

C. Do not place backfill over pipe lines until lines are properly tested.

D. When trenching through specially tested areas, such as paving, asphalt, etc., Contractor shall be responsible for restoring the surface to its original condition, and in a manner approved by the Architect. Repair trenches where settlement occurs, and restore the surface for the period of one year after final acceptance of the project. All cutting of paving, asphalt, etc. shall be by saw cutting.

3.7 CUTTING AND PATCHING

A. Openings in New Construction:

1. Provisions for New Openings: The Division 23 Contractor shall verify all openings required in the new construction in connection with the work under Division 23 with the Architectural and Structural Drawings and shall then meet with and verify same with the General Contractor/Construction Manager who will assign the work to the appropriate contractor to provide all openings in the new construction of the correct size and location in walls, floors or through roofs required for the installation of the mechanical work.

B. Cutting in New Construction:

1. Failure on the part of the Division 23 Contractor to make the above arrangements for required openings shall cause the cost of cutting and patching for the necessary openings for the installation of his work to be borne by him, either by being assigned to the General Contractor/Construction Manager or in the form of performing the required cutting himself. In either case, all patching shall be done by the appropriate finishing contractor as determined by the General Contractor/Construction Manager. No cutting or drilling of holes shall be done without approval of the Architect/Engineer.

C. Patching in New Construction:

1. The appropriate finishing contractor as determined by the General Contractor/Construction Manager shall patch all openings in the new structure. All openings made in fire rated walls, floors, or ceilings, shall be patched and made tight to conform to the fire rating for the enclosure. All materials used in patching shall match the materials specified in the Architectural Specifications and all patched areas shall be restored to the specified finish surface to the satisfaction of the Architect.
2. The Division 23 Contractor shall pay the appropriate Finishing Contractor as determined by the General Contractor/Construction Manager for all patching resulting from cutting to accommodate mechanical work.

3.8 PIPE HANGERS/SUPPORTS

A. Use inserts, anchors, expansion bolts or other approved and acceptable means of attachment to concrete construction. Set inserts in advance of concrete installation, provide required reinforcement rod for all inserts carrying loading equivalent of one 4" pipe or more. All inserts shall be flush with face of slab or wall containing insert.

B. Provide flat square washers for rods thru metal decking with nut above washer, when acceptable and approved.

C. Cinch hangers to carry appropriate share of loading and slope piping without sags or "pocketing" as appropriate and required.

D. Rod offsets, or angle installation, plumber tape or wire will not be accepted. Hanger rods shall be true and plumb.

E. Piping shall not be hung from other piping or equipment items. Provide attachments to building structure only. Use trapeze, wall brackets, knee brackets, etc., where hanger rods cannot be attached within spacing plumb to structures.

F. Provide sway and earthquake bracing where required in accordance with Section 230548 - Mechanical Seismic Control.

3.9 INSTALLATION OF VALVES

A. General:

1. Provide valves as shown on Contract Documents and as required for pressure relief, balancing and/or control of flow.
2. Provide isolation valves for maintenance and service on each piece of equipment regardless of whether or not shown on Contract Drawings.
3. Provide isolation valves for all branch line take-offs that serve more than two items of fixtures or equipment.
4. Provide balancing valves for each branch of domestic hot water circulating system, all heating/cooling water returns or supplies to equipment, and as shown on Contract Documents.
5. Provide access means for each valve or group of valves either by access panels or utilization of inherent access provided by building methods i.e., lift out ceiling construction or exposed valve installations in non critical areas such as janitor's closets, storage rooms, etc.
6. Install all valves with valve bonnets or operating stems in vertical (upright) position when possible, valves may be installed with bonnets or stems not less than 35 degrees downward from vertical plane except valves on vertical piping may be 90 degrees from vertical plane. Swing type check valves shall be installed on horizontal piping no more than 45 degrees upward slope from horizontal plane, using lift checks on vertical piping. Lift check valves shall not be used on sewage or sump pump discharge piping.
7. Inspect and tighten all bonnet nuts, bolts, packing glands, lubricate all valves requiring lubrication, secure all hand wheels and identification plates, be responsible for all valves having manufacturers name, trade name, working pressure and size stamped or cast into the body of the valve. Perform all maintenance, repacking and inspection prior to installation of valve.

B. Proper Installation of Valves:

1. Provide valves in accordance with the following schedule unless specified otherwise in Contract Documents.

a. Dead-end shut off: Gate, ball, butterfly, plug, stop and drain.
b. Throttling: Ball, plug, globe, diaphragm, needle, butterfly (when using butterfly valves for throttling, additional valves must be provided for service shutoff.)
c. Backflow prevention: Check.
d. Water hammer prevention: Silent or pilot operated non slam check.
e. Gas piping: Lubricated plug (or ground joint cock up to 1" only), or UL-Listed ball valve.

C. Removal and Repair Provisions:

1. Provide all valves which are not accessible for repair without removal from piping with union connection immediately adjacent to valve outlet.

3.10 PAINTING

A. Surfaces of exposed equipment and materials to be thoroughly cleaned and left ready for painting in accordance with Architectural Painting Specifications.

B. Duct interiors visible through registers, grilles and diffusers shall be painted flat black.

C. Exposed gas piping to be cleaned, primed and painted 2 coats (grey).

D. All other painting of mechanical equipment and piping, unless otherwise noted, shall be performed under other divisions of the work with the exception of identification of piping and equipment which will be the responsibility of the Division 23 Contractor.

3.11 IDENTIFICATION OF PIPING AND EQUIPMENT

A. General: Provide pipe identification, valve tags, stencils, or engraved nameplates to clearly identify the mechanical equipment, piping and controls of the various mechanical systems and direction of flow in piping.

B. Methods for identification shall be as follows:

1. Metal Tags: Stamp tags with letter prefixes to indicate service, followed by a number for location in system.
2. Engraved Nameplates: Attach nameplates with brass screws. Pressure-sensitive embossed labels are not acceptable. Nameplates shall bear the same identifying legend used on the Contract Documents.
3. Painted Stencils: Stenciled markings shall be neatly performed with no overspray, drips, or other imperfections. Pipes and equipment to be stenciled shall first be wiped clean of dirt, dust, rust, grease and moisture. Pipes and smooth, hard surface in the area the stencil is to be applied. Paint application shall comply with Architectural Painting Specifications.
Size of Legend and Letters for Stencils:

Insulation or Pipe Diameter	Length of Color Field	Size of Letters
¾" to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
over 10"	32"	3-1/2"
Ductwork and Equipment	NA	2-1/2"

4. Piping Legend and Color (Contractor shall obtain written approval of colors from Owner's representative prior to starting work.)

Legend	Background Color	Direction Arrow	Pressure
Feed Water	Yellow		
Chilled Water	Light Green	Arrow	
Compressed Air	Light Blue		PSI
Domestic Cold Water	Light Green		
Domestic Hot Water	Yellow		
Sprinkler-Fire	Red		
Fuel Oil	Light Brown	Arrow	
Natural Gas	Orange		
Heating Water	Yellow	Arrow	
Refrigerant Liquid	Yellow	Arrow	
Refrigerant Suction	Yellow	Arrow	
Refrigerant Hot Gas	Yellow	Arrow	

5. Pressure Sensitive Markers: Apply pressure sensitive markers in accordance with manufacturer's recommendations with complete wrap around may be used at Contractor's option. Marker adhesion will be tested for permanence. Any markers showing dog ears, bubbles, or other failings shall be replaced.
6. Semi-Rigid Plastic Identification Markers: Seton Setmark premolded (not pressure sensitive) identification markers may be used at Contractor's option on service piping which is accessible for maintenance operations (but not on piping in finished spaces). This type marker shall not be installed on bare pipe when surface temperature exceeds 180 deg.F unless a 1" thick insulation band is first provided under marker for protection from the hot pipe.

C. Identification of Piping: Identify all piping accessible for maintenance, in crawl spaces, above ceilings, and access spaces as well as exposed to view utilizing either pressure sensitive markers, semi-rigid plastic markers, or stenciled markings according to the following procedures:

1. Use an arrow marker for each pipe-content legend. The arrow shall always point away from the pipe legend and in the direction of flow: color and height of arrow to be same as content legend lettering.
2. If flow can be in both directions, use a double-headed arrow indication.
3. Apply pipe legend and arrow indication at every point of pipe entry or exit where line goes thru wall or ceiling cut.
4. Apply pipe legend and arrow indication within 3" of each valve to show proper identification of pipe contents and direction of flow.
5. The legend shall be applied to the pipe so that lettering is in the most legible position. For overhead piping, apply legend on the lower half of the pipe where view is unobstructed, so that legend can be read at a glance from floor level.
6. For pipes under 3/4" O.D., fasten brass tags securely at specified legend locations.
7. Legend on steam piping, condensate return, compressed air, medical air, gas, and vacuum systems shall include working pressure or vacuum.
8. Insulated piping equipped with electric heat trace shall additionally be labeled “Electric Traced” with label of same size and color as the pipe legend.

D. Valves: All valves, including but not limited to domestic hot and cold water, hot water recirculation, heating water, chilled water, condenser water, steam, steam condensate return, fire protection, gas, medical gas, vacuum and special service valves located inside the building, shall be tagged and identified as to type of service, location number, and normal valve position (normally open or normally closed).

E. Controls: All magnetic starters and relays, shall have nameplates or be stenciled to identify connecting or controlled equipment. All manual operating switches, fused disconnect switches and thermal over-load switches which have not been specified as furnished with indexed faceplates shall also have nameplates or be stenciled as to "connected" or "controlled" equipment. All automatic controls, control panels, zone valves, pressure electric, electric pressure switches, relays, and starters shall be clearly identified.

F. Pumps: All pumps shall be identified as to service and zones served. Base mounted pumps shall be stenciled or have system served nameplates. Brass tags secured by brass chains may be used on small in-line pumps.

G. Storage Tanks, Water Treatment Equipment and Heaters: All tanks and heaters shall be stenciled as to service. The connecting pipes to each shall be identified and the service temperature entering and leaving the tank or heater shall be indicated.

H. Fans: All supply and exhaust fans and air handling units and connecting ductwork supplying one or more areas from an equipment room or isolated crawl or furred space shall have nameplate or be stenciled as to plan code number, service and areas of zones served.

I. Air Conditioning Equipment: Air conditioning and evaporative cooling equipment such as chillers, pumps, condensers, or roof-top equipment shall be identified by stencils, or system nameplates.

J. Access Doors: Provide engraved nameplates or painted stencils to identify concealed valves, controls, dampers or other similar concealed mechanical equipment. Obtain Architect approval before installation on all access doors in finished areas.

K. Lift Out Ceilings: Provide engraved nameplates or black lettering on transparent adhesive labels on ceiling tee stem to identify concealed valves, controls dampers or similar concealed mechanical equipment which is directly above nameplate in ceiling space. Obtain Architect approval before installation.

L. Expansion tanks shall be labeled to indicate system served and precharge pressure.

M. Access Flooring: Provide thin engraved nameplate on access panel to indicate location of underfloor fan coils and smoke/fire dampers.

3.12 DRIP PANS

A. Provide drip pans under all fluid conducting piping which runs over servers, telecom equipment, electric switchgear, busway, or electric motor starters, and under all point-of-use water heaters.

B. Pans: 18 gauge galvanized iron. Pans shall be two inch deep, with rolled top edges, and shall extend six inches each side of the pipe or group of pipes and six inches beyond the equipment below. Keep pans as close to the underside of the pipes as practicable. All seams shall be soldered, and pans shall be crossbraced as required to prevent sagging and warping.

C. Pitch each pan to a drain connection, and pipe a 1-1/2 inch or larger copper tube drain to discharge over nearest available open drain.

D. Provide a drip pan under all coils that may have condensate during operation like heat recovery coils, etc. Pipe drain to nearest drain.

3.13 FIRE SAFING

A. Mechanical Contractor shall provide fire safing for his work as follows: Where fire rated separations are penetrated by pipes, conduit or ductwork, the annular space around the pipe, conduit or ductwork shall be filled with a U.L. Rated fire safing material. Refer to Division 7 for materials and application specifications.

3.14 DIELECTRIC PIPE FITTINGS AND ISOLATORS

A. Provide dielectric pipe fittings and isolators at all connections between dissimilar metals in the domestic water, hydronic water and fire protection systems to control corrosion potential caused by galvanic or electrolytic action.

B. Typical locations for dielectric isolation are; water heaters, storage and pressure tanks, water conditioning equipment, pumps, changes in service piping materials, make-up connections to boilers and chilled water systems, valves, deaerators, flexible connectors and the like where materials of different electrode potential are joined.

C. Hangers for piping shall be isolated per Section 230529 when hanger and piping materials are dissimilar and subject to production of electrolysis or galvanic action.

3.15 DRAIN LINES

A. Provide condensate drain lines from each cooling coil and evaporative media sump drain pan to nearest drain or to termination indicated.

B. Do not route condensate lines above electrical panels, switch gear, transformers, motor starters, elevator equipment, servers, or telecom equipment. Should there be a conflict with the plans and this paragraph, notify the Engineer immediately for corrective instruction prior to starting work.

3.16 HEATING SYSTEM USED FOR TEMPORARY HEAT DURING CONSTRUCTION

A. Permanent heating system shall not be used until building is totally and permanently enclosed (no temporary barriers for weather protection), and source of heat supply is permanently installed.

B. Once the heating system has been placed into operation, it shall not be shut down except for moderate weather, and all heated areas shall be maintained at a minimum temperature of 50 deg. F 24 hours a day.

C. When any air-handling equipment is used for temporary heat, the filters (MERV 13) shall be installed and maintained. Before building acceptance by Owner, these units shall be thoroughly cleaned and new filters shall be installed. This is over and above the extra set of filters to be provided the Owner as called for in the specifications. Coils shall be cleaned if necessary, as determined by the Engineer. Provide additional MERV 8 filter over all return air grilles to prevent debris from entering. Tape around perimeter edge to seal to grille.

D. Any and all systems being used for temporary heat shall become the Contractor's responsibility to maintain, and be put into first class working order before acceptance by the Owner.

E. Any manufacturer's guarantees that start with the use of equipment for temporary heat shall be extended by the contracting firm holding the prime contract for construction, so that the Owner will have his one-year guarantee from date of acceptance.

END OF SECTION 230529

SECTION 230540 - MECHANICAL SOUND AND VIBRATION CONTROL

PART 1 - GENERAL

1.1 RELATED WORK

A. Requirements: Provide Mechanical Sound and Vibration Control in accordance with the Contract Documents.

B. Related work specified in other Sections:

Section 230500 - Basic Mechanical Requirements
Section 230529 - Basic Mechanical Materials and Methods
Section 232113 - HVAC Piping & Specialties
Section 233300 - Ductwork and Accessories - Flexible Ductwork Connections

1.2 SYSTEM DESCRIPTION

A. The work includes, but is not limited to the following:

1. Support isolation for motor/driven mechanical equipment.
2. Rails or beams for distribution of equipment loading to isolation units.
3. Fabricated bases for distribution of equipment loading to isolation units.
4. Inertia base frames in conjunction with equipment isolation.
5. Isolation of pipes and ductwork.
6. Sound-linings.
7. Sound proofing of construction.
8. External sound proofing.

1.3 QUALITY ASSURANCE

A. The Division 23 Contractor shall be responsible for assuring that all the following sound pressure level criteria are met. Sound pressure level tests shall be carried out by the Section 230593 Contractor in compliance with the Section 230593 specifications.

B. Acoustical Criteria:

1. Noise levels due to equipment and ductwork to permit attaining sound pressure levels in all 8 octave bands in occupied spaces conforming to RC curves:

All occupied spaces ---------- RC-35

except

Occupied spaces within 15 foot radius from mechanical rooms, main supply and return duct shafts ---------- RC-40

Lobbies, Toilets, Commons Area ---------- RC-40

Kitchen ---------- RC-45-50

Teaching Laboratories ---------- RC-35-45

Research Labs with extensive telephone/speech use--- RC-40-50

Research Labs (minimum speech communication) ------ RC-45-55

Garage ---------- RC-50-60

Mechanical Rooms ---------- RC-60-80

C. Mechanical Acoustical Performance:

1. Air Distribution system equipment terminal device noise:

a. Maximum permissible discharge sound-power levels in octave bands of airborne transmission through the terminal units or related pressure reducing devices, when operated in installed condition per Drawings and Specifications shall be as per Table 1, following:

TABLE 1 - Maximum PWL (dB re 10E-12 Watt)

Octave Band	RC-30	RC-35	RC-40	RC-45
1	54	59	64	69
2	68	73	78	83
3	61	66	71	76
4	59	64	69	74
5	51	56	61	66
6	48	53	58	63
7	39	44	49	54

2. Pressure reducing variable air volume boxes radiated noise:

   a. Maximum permissible radiated sound-power levels in octave bands when operated in an installed condition over occupied spaces, shall be as per Table 2 following:

TABLE 2 - Maximum PWL (dB re 10E-12 Watt)				
Octave Band	RC-30	RC-35	RC-40	RC-45
1	54	59	64	69
2	62	67	72	77
3	58	63	68	73
4	55	60	65	70
5	53	58	63	68
6	50	55	60	65
7	46	51	56	61

3. Motor Acoustical Performance:

   a. Motor drives for pumps when installed per Drawings and Specifications shall operate with noise levels not exceeding 90dbA.
   b. Noise levels shall be determined in accordance with IEEE Standard #85 Test "Procedure for Air-Borne Noise Measurements on Rotating Electric Equipment.

4. Refrigeration Machine Cooler, Condenser, Compressor and Compressor Piping Acoustical Performance:

   a. The maximum permissible noise levels under design operating conditions, when measured in accordance with the methods and qualifications specified herein shall not exceed 90 dbA.

1.4 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings and Product Data for the following items in accordance with the General Conditions of the Contract.

1. Each type of isolator including spring diameters, deflections, compressed spring height and solid spring height.
2. Sound Lining.
3. Inertia Bases.

B. Test Reports: Submit certified test reports showing compliance in accordance with General Conditions of the Contract of the following items:

1. Certification that sound lining meets erosion test method described in UL Publication No. 181.

PART 2 - PRODUCTS

2.1 PIPING AND EQUIPMENT ISOLATION

A. Manufacturer: Mason Industries, Inc., Vibro-Acoustics.

B. Other acceptable manufacturers offering equivalent products: Korfund, Amber/Booth Co., Vibration Mountings and Control Co., Kinetics.

C. Neoprene Mounting Pads (Specification Schedule Type 1)

1. Kinetics Noise Control Type NPD.
2. Minimum static deflection 0.04" for 0.22" thick pad.
3. Cross, double ribbed elastomer in-shear pads, capable of 60 or 120 PSI loading, depending on load density of equipment being isolated.
4. Material thickness as required to provide minimum deflections listed in table at end of the specification section.

D. Double Deflection Neoprene Mountings (Specification Schedule Type 2)

1. Mason Industries Type ND Mounting, Type DNR Rails.
2. Minimum static deflection 0.35 inch.
3. Bolt holes where required.
4. Steel rails above mountings to compensate for overhang where required.

E. Spring Isolator Mountings (Specification Schedule Type 3)

1. Mason Industries Type SLF.
2. Free-standing, laterally stable without housing, complete with 1/4 inch neoprene acoustical friction pads between base plate and support and with leveling bolts that must be rigidly bolted to equipment.
3. Spring diameters no less than 0.8 of the compressed height of the spring at rated load.
4. Springs with minimum additional travel to solid equal to 50 percent rated deflection.

F. Restrained Spring Isolator Mountings (Specification Schedule Type 4)

1. Mason Industries Type SLR.
2. Spring isolator mounting equal to Type SLF but with housing that includes vertical resilient limit stops to prevent spring extension when weight is removed from equipment.
3. Provide hot dipped galvanized mountings exposed to weather.

G. Vibration Hangers (Specification Schedule Type 6)

1. Mason Industries Type DNH.
2. Spring and double deflection neoprene element in series.

3. Neoprene element minimum deflection 0.35 inch.
4. Spring diameters no less than 0.8 of compressed height of spring at rated load.
5. Springs with minimum additional travel to solid equal to 50 percent rated deflection.

H. Integral Structural Steel Base (Specification Schedule Type B)

1. Mason Industries Type WF.
2. Rectangular for equipment other than "T" or "L" shaped pump bases.
3. Pump bases for split case pumps to include supports for suction and discharge base ells.
4. Beams for perimeter members minimum depth equal to one tenth of the longest dimension of the base. Depth need not exceed 14 inches if deflection and misalignment is kept within acceptable limits by manufacturer.
5. Provide height saving brackets to provide a clearance of one inch.

I. Steel Rail Base (Specification Schedule Type B)

1. Mason Industries Type ICS.
2. Steel members welded to height saving brackets to cradle machines having legs or bases that do not require a complete supplementary base.
3. Provide members sufficiently rigid to prevent strains in the equipment.

J. Concrete Inertia Bases (Specification Schedule C)

1. Mason Industries Type K.
2. Rectangular structural beam or channel concrete forms for floating foundations.
3. Provide bases for split case pumps large enough for suction and discharge base ells supports.
4. In general, unless shown otherwise on the Drawings, provide bases with a minimum depth of one twelfth of the longest dimension of the base, but not less than 6 inches.
5. Forms to include minimum concrete reinforcement consisting of 1/2 inch bars or angles welded in place on 6 inch centers running both ways in a layer 1-1/2 inches above the bottom, or additional steel as is required by the structural conditions.
6. Forms furnished with drilled steel members with sleeves welded below the holes to receive equipment anchor bolts.
7. Provide height saving brackets to maintain a 1 inch clearance below base.

K. Flexible Butyl Hose Pipe Connectors (Up to 2")

1. Mason Industries Type RMM.
2. Flexible Butyl 150 lb. hose with brass screw type ends attached by expansion or swedging methods. Clamps are unacceptable.
3. Duty up to: 100 psi and 220 deg. F.
4. Hoses up to 1-1/4 inches shall be 12 inches in length and 1-1/2 inches to 2 inches shall be 18 inches in length.

L. Flexible Neoprene Sphere Pipe Connectors (2" to 12")

1. Mason Industries Type MFNC and Type MFTNC.
2. Neoprene single-sphere type with 150 lb. ASA steel floating flanges.
3. Duty up to: 150 psi and 230 deg. F.
4. Movement limits: minimal 3/8 inch axial compression, 1/4 inch axial elongation, 3/8 inch lateral movement and 15 deg. angular movement.

M. Braided Flexible Connectors (Drawing Code "FC")

1. Manufacturer: Thermo Tech, Inc., Metraflex, Flex-Hose Co., Flexicraft Industries, Flex-Precision ltd., Twin City Hose.
2. Flexible connectors manufactured of 300 series stainless steel convoluted metal bellows and braid, 150 psig ASA drilled flanges. Maximum permanent offset from centerline = ¾". Maximum intermittent offset from centerline = 3/8".
3. Pressure test to be certified for 300 psi at 250 deg. F.
4. Schedule:

Make: Metraflex									
Model: SLP									
Size:	1-1/2"	2"	2-1/2"	3"	4"	6"	8"	10"	12"
Connector Length:	6"	6"	10-1/4"	10-5/8"	11-3/4"	14-1/8"	15-3/8"	12-3/4"	18-3/8"
Max Pressure: 300 psig									
Max Temperature: 250 deg. F									

N. Acoustical Pipe Riser Anchors:

1. Mason Industries Type ADA.
2. All directional acoustical pipe anchor.
3. Minimum 1/2 inch thickness of heavy duty neoprene isolation material.
4. Vertical restraints in either direction.

2.2 SOUND LININGS

A. Acceptable Manufacturer: Johns Manville Permacote, Linacoustic and Spiracoustic.

B. Other acceptable manufacturers offering equivalent products: Knauf, CertainTeed ToughGuard R.

C. Product: Fibrous glass, acrylic surface coating, stenciled NFPA, conforming to ASTM C1071 (air velocity), ASTM G21 (fungi resistance) and ASTM G22 (bacteria resistance). Product shall not allow growth of mold or bacteria. This anti-microbial compound shall be tested for efficacy by a nationally recognized testing laboratory (NRTL) and be registered by the EPA for use in HVAC systems.

D. Minimum thickness: As indicated in Part 3 of this specification.

E. Sound Absorption Coefficient for 1.5" thickness per the following:

Frequency (cps) =	125	250	500	1000	2000	4000	NRC
Coefficient =	0.10	0.47	0.85	1.01	1.02	0.99	0.85

F. Flamespread Index: Maximum 25.
Smoke Developed Index: Maximum 50.
Tested in accordance with ASTM E84 and UL723. Provide UL labels on product packaging.

G. Suitable for duct velocity of 5000 fpm. Lining shall meet erosion test method described in UL Publication No. 181.

H. Dynamic loss coefficient: Maximum 1.2.

I. Thermal conductivity 0.24 Btu inch/h Ft^2 °F @ 75°F mean temperature.

J. Provide additional facing for protection of acoustical liner at plenum fan discharge plenum in field-built, single wall fan plenums. Liner shall be 26 gauge steel with perforated 28% minimum open area.

2.3 ADHESIVE AND SEALER

A. Acceptable Products: Adhesive, Benjamin Foster "81-99", or accepted equal, Sealer, Benjamin Foster "82-07" or accepted equal.

B. In conformance with NFPA 90A.

C. Flamespread: Maximum 25.

D. Fuel contributed and smoke developed: Maximum 50.

2.4 NON-HARDENING CAULKING

A. Acceptable Products: Tremco "Polybutene", Schuller or accepted equal.

B. Guaranteed to be permanently elastic.

2.5 VIBRATION DAMPING COMPOUND

A. Acceptable Manufacturers: Soundcoat GP-1 Vibration Damping Compound, Korfund Dynamics Corporation Vibro-damp 80A, Kinetics, Vibro-Acoustics.

B. Non-burning.

C. Compound shall effectively damp vibrations for a broad frequency range between 10 Hz to 20 kHz.

D. Decay rate Geiger plate 45 dB/sec. at 72 deg. F.

2.6 EXTERNAL SOUND BARRIER INSULATION

A. Acceptable Manufacturers: Kinetics Noise Control, Vibro-Acoustics.

B. Model: KNM 100 ALQ-1.

C. Sound barrier shall be a barrier/decoupling layer composite consisting of 1.0 lb. per ft^2 mass barrier bonded to 1" fiberglass batting, non-woven porous scrim-coated glass cloth, quilted together to encapsulate the glass fibers. Provide with barrier tape for sealing joints.

D. Sound Transmission Loss:

1. Transmission loss when attached to outside of piping shall be as per the following table:

Band No.	Band Center Freq. (Hz)	Transmission Loss (dB)
1	125	13
2	250	16
3	500	24
4	1000	33
5	2000	43
6	4000	49
-	STC	28

E. Flamespread: Maximum 25.

F. Fuel contributed and smoke developed: Maximum 50.

2.7 EXTERNAL SOUND BARRIER INSULATION (PIPING)

A. Acceptable Manufacturers: Kinetics Noise Control, Vibro-Acoustics.

B. Model: KNM 100 ALQ-1.

C. Sound barrier shall be a barrier/decoupling layer composite consisting of 1.0 lb. per ft^2 mass barrier bonded to 1" fiberglass batting, non-woven porous scrim-coated glass cloth, quilted together to encapsulate the glass fibers. Provide with barrier tape for sealing joints.

D. Sound Transmission Loss:

1. Transmission loss when attached to outside of piping shall be as per the following table:

Band No.	Band Center Freq. (Hz)	Transmission Loss (dB)
1	125	13
2	250	16
3	500	24
4	1000	33
5	2000	43
6	4000	49
-	STC	28

E. Flamespread: Maximum 25.

F. Fuel contributed and smoke developed: Maximum 50.

2.8 EXTERNAL SOUND BARRIER INSULATION (SHEET METAL)

A. Acceptable Manufacturers: Kinetics Noise Control, Vibro-Acoustics.

B. Model: KNM 100 ALQ-1.

C. Sound barrier shall be a barrier/decoupling layer composite consisting of 1.0 lb. per ft^2 mass barrier bonded to 1" fiberglass batting, non-woven porous scrim-coated glass cloth, quilted together to encapsulate the glass fibers. Provide with barrier tape for sealing joints.

D. Sound Transmission Loss:

1. Transmission loss when attached to outside of piping shall be as per the following table:

Band No.	Band Center Freq. (Hz)	Transmission Loss (dB)
1	125	13
2	250	16
3	500	24
4	1000	33
5	2000	43
6	4000	49
-	STC	28

E. Flamespread: Maximum 25.

F. Fuel contributed and smoke developed: Maximum 50.

PART 3 - EXECUTION

3.1 GENERAL - PIPING AND EQUIPMENT ISOLATION

A. Unless otherwise noted on the Equipment Mounting Schedule, provide mechanical equipment mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators to be selected in accordance with the weight distribution so as to produce reasonable uniform deflection. Deflections to be as noted on the Equipment Mounting Schedule included at the end of this section.

B. Coordinate work with other trades to avoid rigid contact with the building. Inform other trades following the isolation work, to avoid any contact which would reduce the vibration isolation.

C. The installation or use of vibration isolators must not cause any change of position of equipment or piping which would result in stresses in piping connections or misalignment of shafts or bearings. In order to meet this objective, maintain equipment and piping in a rigid position during installation. Do not transfer the load to the isolator until the installation is complete and under full operational load.

D. Support the machine to be isolated with a structural steel frame.

E. Provide brackets to accommodate the isolator and provide a mechanical stop. The vertical position and size of the bracket to be recommended by the isolator manufacturer.

F. For restrained spring isolators, use housing as blocking during erection so that installed and operating heights can be the same. Maintain a minimum clearance of 1/2 inch around restraining bolts between housing and spring to avoid interference with spring action. Limit stops to be out of contact during normal operation.

3.2 HANGERS

A. Install type 2 or 3 vibration isolation piping hangers where indicated in Equipment Mounting Schedule at the end of this section and within 20 feet (measured along piping) upstream and downstream of all pumps 3 HP or larger.

B. Install the isolators with the isolator hanger box attached to or hung as close as possible to the structure.

C. Suspend the isolators from substantial structural members, not from slab diaphragm unless specifically accepted.

D. Align hanger rods to clear hanger box.

3.3 EQUIPMENT BASES

A. Provide minimum operating clearance between the equipment frame or rigid steel base frame and the housekeeping pad or floor of 1 inch. Provide minimum operating clearance between concrete inertia base and the housekeeping pad or floor of 1 inch.

3.4 COIL BASES

A. Mount floor supported coil section on a 1/4" thick layer of ribbed neoprene pad, with a 16 gauge galvanized steel plate between coil frame and pad. Coil shall be mounted on a concrete curb of sufficient height to allow coil drain pan to be sloped in two directions to drain pan bottom outlet with P-trap and/or refrigerant suction line traps to be installed without hitting floor.

3.5 FLEXIBLE PIPING CONNECTORS

A. Provide flexible connectors for equipment that is supported by or mounted on vibration isolators except when connected piping is made up with a Victaulic Flex coupling system. Connectors to be installed under Section 232113.

B. Hoses shall be installed on the equipment side of the shut-off valves and horizontally wherever possible.

C. Provide connectors at pump suction and discharge, and elsewhere as required to accommodate thermal expansion, vibration and misalignment.

D. Provide flexible connectors on all suction and discharge connections to all base mounted centrifugal pumps, vertical turbine pumps, air compressors, dryers, vacuum pumps or other equipment items producing vibration, shock, noise, or thermal motion of piping.

E. Provide 300 psi companion flanges for connector for threaded, welded, soldered, or brazed piping as appropriate.

F. Connectors to be aligned, centered, and shall not bear weight of pipe, fittings, or pipeline accessories such as valves. Piping shall be supported both sides of horizontal or vertical connectors.

3.6 PIPE FLOOR SUPPORTS

A. Provide type 3 mountings with a minimum static deflection of 1.5 inches on horizontal pipe floor supported at slab in equipment rooms above grade.

3.7 SOUND ATTENUATORS

A. Install in accordance with manufacturers' recommendations to obtain published performance.

B. After installation, measure total system pressure before and after attenuators.

C. If pressure loss exceeds maximum static pressure loss schedules on drawings: modify entrance or discharge aerodynamic flow to obtain specified performance.

D. For maximum structural integrity, sound attenuator baffles should be installed in a vertical position; where this is not possible, structural reinforcement is required for attenuators wider than 24 in.

E. When elbows precede attenuators, baffles shall be parallel to the plane of the elbow radius.

3.8 SOUND LININGS

A. Dimensions of lined ductwork are clear inside dimensions after lining has been installed.

B. Sound linings to be held in place with mechanical fasteners as per the latest SMACNA duct liner application standard, with joints and any tears to be coated with Benjamin Foster or accepted equal adhesive. The transverse joints to be coated prior to installation so that the ends of the liner are compressed together while the adhesive is still moist, forming a seal of the leading and trailing edge of each joint. Excess adhesive to be brushed to an even finish over the joint.

C. Provide continuous sheet metal edge protectors at entering and leaving edges of lined duct sections where adjacent to unlined duct sections.

D. Extent of 1” ductwork sound linings:

1. Upstream of toilet/general exhaust fans and relief air fans, a minimum distance of 20'-0".
2. Transfer air ducts and shaft return stub ducts.
3. Return air elbow boots over ceiling grilles.
4. In all return and all rectangular exhaust ducts.

E. Extent of 1.5” ductwork sound linings:

1. Rectangular And round ductwork downstream of VAV boxes. Round ductwork to use JM Spiracoustic Plus, or equal.
2. In all low pressure rectangular supply ducting.
3. In plenums above supply diffusers.
4. Elsewhere when specifically indicated on drawings.
5. Do not install liner in duct serving evaporative cooled systems 10’-0” downstream of media.

F. Extent of plenum sound linings:

1. Mixed and outside air plenum walls and ceilings.

2. Supply air discharge and filter plenum walls and ceiling.
3. Return/Exhaust air plenums.
4. Return air plenum from riser to mixed air plenum.
5. Return/Exhaust air plenums inside packaged rooftop units when not factory installed.

G. Extent of perforated metal facing on sound linings:

1. In supply air fan discharge plenums.
2. In high velocity supply air ducts where shown on drawings.

3.9 SOUND PROOFING OF CONSTRUCTION

A. Required for opening between ductwork and piping and following construction:

1. Equipment room walls.
2. Floors, except in shafts.
3. Roofs, specifically inside roof curbs for mechanical equipment and where ductwork penetrates roof deck.

B. Sound proofing:

1. Fill openings with tightly packed fibrous glass blanket or board for full depth of penetration.
2. Caulk each side of opening with non-hardening, non-aging caulking compound.

3.10 EXTERNAL VIBRATION DAMPENING

A. For typical floor supply duct take-offs from main supply riser when required to meet specified sound levels, provide 1/8 inch thick duct exterior coating of vibration dampening compound. These treatments to be provided over the rectangular portion (flat sides) of the floor take-off ducts.

3.11 EXTERNAL SOUND BARRIER INSULATION

A. Provide foam composite, applied over the vane axial fan casings (both supply and return) extending from the inlet side of the intake sound traps, to the leaving side of the discharge sound traps, inclusive of all flexible connectors.

B. Provide a duct enclosure of 2 layers of 5/8" gypsum board with staggered seams extending from the point that the ducts leave the rooftop unit or fan plenum to the leaving side of the discharge sound trap(s). A minimum clearance of 1" shall be maintained between the ductwork and the enclosure walls; all voids between the enclosure and the ductwork to be filled with loose batt fiberglass insulation. The points at which the ductwork penetrates the enclosure; the sheetrock is to be cut away from the ductwork by 1/4" to 1/2" and the void is to be filled with non-hardening caulk. Caulk shall be fire-rated if enclosure is required to be fire-rated.

3.12 EQUIPMENT MOUNTING SCHEDULE

A. Manufacturer: Mason Industries, Inc., Kinetics, Vibro-Acoustics.

B. Schedule: See the following pages.

EQUIPMENT VIBRATION ISOLATION SCHEDULE						
EQUIPMENT TYPE	SLAB ON GRADE			20 FT. FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN. DEFL. (IN.)	BASE TYPE	ISOL TYPE	MIN DEFL. (IN.)
REFRIGERATION EQUIPMENT						
A. Scroll Compressors	C	3	.75	C	3	.75
B. Scroll Condensing Units & Chillers	A	2	.25	A	4	.75
AIR COMPRESSORS						
A. Tank Mounted	A	3	.75	A	3	.75
B. Base Mounted	C	3	.75	C	3	.75
PUMPS						
A. Close Coupled						
1. Up to 7 1/2 HP	B/C	2	.25	C	3	.75
2. 10 HP & Over	C	3	.75	C	3	.75

EQUIPMENT VIBRATION ISOLATION SCHEDULE						
EQUIPMENT TYPE	SLAB ON GRADE			20 FT. FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN. DEFL. (IN.)	BASE TYPE	ISOL TYPE	MIN DEFL. (IN.)
PUMPS						
A. Flexible Coupled						
1. Up to 40 HP	C	3	.75	C	3	.75
2. 50 to 125 HP	C	3	.75	C	3	.75
3. 150 HP & Over	(See Note 1)			(See Note 1)		
EVAPORATIVE CONDENSORS						
A. Up to 300 RPM	(See Note 2)			(See Note 2)		
B. 301 to 500 RPM	A	1,2	.25	A	4	2.5
C. 501 RPM & Over	A	1,2	.25	A	4	.75
FANS						
AXIAL & TUBULAR FAN HEADS						
A. Up to 22 in. dia.	A/B	2	2.5	A/B	3	.75
B. 24 in. dia. & Over						
1. Up to 50 HP						
a. Up to 300 RPM	(See Note 2)			(See Note 2)		
b. 301 to 500 RPM	B/C	3	1.5	C	3	1.5
C. 501 RPM & Over	B/C	3	.75	C	3	1.5
2. 60 HP & Over	(See Note 1)			(See Note 1)		

EQUIPMENT VIBRATION ISOLATION SCHEDULE						
EQUIPMENT TYPE	SLAB ON GRADE			20 FT. FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN. DEFL. (IN.)	BASE TYPE	ISOL TYPE	MIN DEFL. (IN.)
CENTRIFUGAL FANS & VENTILATION SETS						
A. Up to 22 in. Wheel dia.	A/B	2	.25	A/B	3	.75
B. 24 in. Wheel dia. & Over						
1. Up to 50 hp						
a. Up to 300 RPM	(See Note 2)			(See Note 2)		
b. 301 to 500 RPM	B	3	1.5	B	3	1.5
c. 501 RPM & Over	B	3	.75	B	3	.75
2. 60 HP & Over						
a. Up to 300 RPM	(See Note 2)			(See Note 2)		
b. 301 to 500 RPM	B/C	3	.75	C	3	1.5
c. 501 RPM & Over	B/C	3	.75	C	3	1.5
PACKAGED AIR HANDLING EQUIPMENT						
A. Up to 10 HP	A	2	.25	A	3	.75
B. 15 HP & Over	A	2	.25	A	3	.75

EQUIPMENT VIBRATION ISOLATION SCHEDULE						
EQUIPMENT TYPE	SLAB ON GRADE			20 FT. FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN. DEFL. (IN.)	BASE TYPE	ISOL TYPE	MIN DEFL. (IN.)
PACKAGED ROOFTOP AIR CONDITIONING UNIT	--	--	--	D	3	.75

BASE TYPES:

A = NO BASE, ISOLATORS ATTACHED DIRECTLY TO EQUIPMENT
B = STRUCTURAL STEEL RAILS OR BASE
C = CONCRETE INERTIA BASE
D = CURB-MOUNTED BASE

ISOLATOR TYPES

1 = RUBBER OR GLASS FIBER PAD
2 = RUBBER FLOOR ISOLATOR OR HANGER
3 = SPRING FLOOR ISOLATOR OR HANGER
4 = RESTRAINED SPRING ISOLATOR
5 = SPRING AND RUBBER IN SERIES HANGER

NOTES:

1. CONTRACTOR SHALL PROVIDE VIBRATION ISOLATION AND CALCULATIONS STAMPED BY A LICENSED PROFESSIONAL ENGINEER.

2. TO AVOID ISOLATOR RESONANCE PROBLEMS, SELECT ISOLATOR DEFLECTION SO THAT NATURAL FREQUENCY IS 40% OR LESS THAN LOWEST OPERATING SPEED OF EQUIPMENT (SEE ASHRAE HVAC APPLICATIONS HANDBOOK, 2007 EDITION).

EQUIPMENT VIBRATION ISOLATION SCHEDULE						
EQUIPMENT TYPE	30 FT. FLOOR SPAN			40 FT. FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN. DEFL. (IN.)	BASE TYPE	ISOL TYPE	MIN DEFL. (IN.)
REFRIGERATION EQUIPMENT						
A. Scroll Compressors	C	3	1.5	C	3	1.5
B. Scroll Condensing Units & Chillers	A	4	1.5	A	4	2.5
AIR COMPRESSORS						
A. Tank Mounted	A	3	1.5	A	3	2.5
B. Base Mounted	C	3	1.5	C	3	1.5
PUMPS						
A. Close Coupled						
1. Up to 7 1/2 HP	C	3	.75	C	3	.75
2. 10 HP & Over	C	3	1.5	C	3	1.5

EQUIPMENT VIBRATION ISOLATION SCHEDULE						
EQUIPMENT TYPE	30 FT. FLOOR SPAN			40 FT. FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN. DEFL. (IN.)	BASE TYPE	ISOL TYPE	MIN DEFL. (IN.)
PUMPS						
A. Flexible Coupled						
1. Up to 40 HP	C	3	1.5	C	3	1.5
2. 50 to 125 HP	C	3	1.5	C	3	2.5
3. 150 HP & Over	(See Note 1)			(See Note 1)		
EVAPORATIVE CONDENSORS						
A. Up to 300 RPM	(See Note 2)			(See Note 2)		
B. 301 to 500 RPM	A	4	2.5	A	4	2.5
C. 501 RPM & Over	A	1,2	1.5	A	4	1.5
FANS						
AXIAL & TUBULAR FAN HEADS						
A. Up to 22 in. dia.						
1. Up to 50 HP						
a. Up to 300 RPM	(See Note 2)			(See Note 2)		
b. 301 to 500 RPM	C	3	2.5	C	3	2.5
C. 501 RPM & Over	B/C	3	1.5	C	3	2.5
2. 60 HP & Over	(See Note 1)			(See Note 1)		

EQUIPMENT VIBRATION ISOLATION SCHEDULE						
EQUIPMENT TYPE	30 FT. FLOOR SPAN			40 FT. FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN. DEFL. (IN.)	BASE TYPE	ISOL TYPE	MIN DEFL. (IN.)
CENTRIFUGAL FANS & VENTILATION SETS						
A. Up to 22 in. Wheel dia.	A/B	3	.75	A/C	3	.75
B. 24 in. Wheel dia. & Over						
1. Up to 50 hp						
a. Up to 300 RPM	(See Note 2)			(See Note 2)		
b. 301 to 500 RPM	B	3	1.5	B	3	2.5
c. 501 RPM & Over	B	3	.75	B	3	1.5
2. 60 HP & Over						
a. Up to 300 RPM	(See Note 2)			(See Note 2)		
b. 301 to 500 RPM	C	3	2.5	C	3	2.5
c. 501 RPM & Over	C	3	1.5	C	3	2.5
PACKAGED AIR HANDLING EQUIPMENT						
A. Up to 10 HP	A	3	.75	A	3	.75
B. 15 HP & Over	A	3	1.5	A	3	1.5

EQUIPMENT VIBRATION ISOLATION SCHEDULE						
EQUIPMENT TYPE	30 FT. FLOOR SPAN			40 FT. FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN. DEFL. (IN.)	BASE TYPE	ISOL TYPE	MIN DEFL. (IN.)
PACKAGED ROOFTOP AIR CONDITIONING UNIT	A/B	3	1.5	A/B	3	2.5

BASE TYPES:

A = NO BASE, ISOLATORS ATTACHED DIRECTLY TO EQUIPMENT
B = STRUCTURAL STEEL RAILS OR BASE
C = CONCRETE INERTIA BASE
D = CURB-MOUNTED BASE

ISOLATOR TYPES

1 = RUBBER OR GLASS FIBER PAD
2 = RUBBER FLOOR ISOLATOR OR HANGER
3 = SPRING FLOOR ISOLATOR OR HANGER
4 = RESTRAINED SPRING ISOLATOR
5 = SPRING AND RUBBER IN SERIES HANGER

NOTES:

1. CONTRACTOR SHALL PROVIDE VIBRATION ISOLATION AND CALCULATIONS STAMPED BY A LICENSED PROFESSIONAL ENGINEER.

2. TO AVOID ISOLATOR RESONANCE PROBLEMS, SELECT ISOLATOR DEFLECTION SO THAT NATURAL FREQUENCY IS 40% OR LESS THAN LOWEST OPERATING SPEED OF EQUIPMENT (SEE ASHRAE HVAC APPLICATIONS HANDBOOK, 2007 EDITION).

END OF SECTION 230540

SECTION 230548 - MECHANICAL SEISMIC CONTROL

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Anchorage and seismic restraint systems for all Division 23 isolated and non-isolated equipment, ductwork and piping systems.

B. All Division 22 and 23 equipment/piping/ductwork shall be isolated and/or seismically supported in accordance with all requirements of the IBC and ASCE 7. This includes, but not limited to, the following:

1. Piping
2. Ductwork
3. Supply Air Fans
4. Unit Heaters
11. Hanging Exhaust Fans
20. Air Handling Units
21. Welding Hoods

1.2 RELATED WORK

A. Requirements: Provide Mechanical Seismic Control in accordance with the Contract Documents.

B. Section 230500 - Basic Mechanical Requirements.

C. Section 230529 - Basic Mechanical Materials and Methods.

D. Section 230540 - Mechanical Sound and Vibration Control.

1.3 REFERENCES

A. International Building Code, Current Edition in use by Jurisdictional Authority.

B. NFPA Bulletin 90A, Current Edition.

C. UL Standard 181.

D. SMACNA Seismic Restraint Manual: Guidelines for mechanical systems.

1.4 SYSTEM DESCRIPTION

A. The Division 23 Contractor shall be responsible for supplying and installing equipment, vibration isolators, flexible connections, rigid steel frames, anchors, inserts, hangers and attachments, supports, seismic snubbers and bracing to comply with the following:

1. Short period design spectral response acceleration coefficient S_{DS}= 1.08.
2. One-second period design spectral response acceleration coefficient S_{D1}= 0.57.
3. Site Class D.
4. Seismic Design Category D.

B. The following components have a component importance factor I_P of 1.5:

1. Fire Sprinkler Protection System
2. Natural Gas Piping

All other components have an importance factor I_P of 1.0.

1.5 QUALITY ASSURANCE

A. All supports, hangers, bases, anchorage and bracing for all isolated equipment and non-isolated equipment shall be designed by a professional engineer licensed in the state where the project is located, employed by the restraint manufacturer, qualified with seismic experience in bracing for mechanical equipment. Shop drawings included with deferred submittal for earthquake bracing and anchors from the restraint manufacturer shall bear the Engineer's signed professional seal. All calculations/design work required for the seismic anchorage and restraint of all Division 23 equipment and systems shall be provided by a single firm.

B. The above qualified professional engineer shall determine specific requirements for equipment anchorage and restraints, locations and sizes based on shop drawings for the mechanical equipment which have been submitted, reviewed and accepted by the Architect/Engineer for this project.

C. Seismic Engineer or the Engineer’s Representative shall field inspect final installation and certify that bracing and anchorage are in conformance with the Seismic Engineer’s design, the requirements of this specification section, and all seismic restraint requirements of the building code. Provide a certificate of compliance stating all Division 22 and 23 utilities and equipment have been anchored and restrained in accordance with the requirements of the building code and ASCE 7. The certificate of compliance shall include the Seismic Engineer’s signed Professional Engineer’s seal. Include a copy of the certificate in each copy of the Operation and Maintenance Manual.

D. The Division 23 Contractor shall require all equipment suppliers to furnish equipment that meets the seismic code, with bases/skids/curbs designed to receive seismic bracing and/or anchorage. All isolated and non-isolated mechanical equipment bracing to be used in the project shall be designed from the equipment submittals and certified to be code-compliant by the equipment manufacturer for seismic description loads defined above, with direct anchorage capability.

1.6 SUBMITTALS

A. A single submittal shall be provided for all seismic anchorage and restraints for all Division 23 equipment and systems provided as part of this project. Individual submittals for specific systems will not be accepted.

B. Submit shop drawings, calculations, and printed data for the following items under provisions of the General Conditions of the Contract:

1. Complete engineering calculations and shop drawings for all seismic restraint requirements for all equipment as required by the IBC.
2. The professional seal of the engineer who is responsible for the design of the Seismic Restraint System.
3. Details for all seismic bracing.

4. Details for steel frames, concrete inertia bases, and housekeeping pads. Include dimensions, embed depths, dowelling details, and concrete reinforcing requirements.
5. Clearly outlined procedures for installing and adjusting the isolators, seismic bracing anchors, snubbers, cables, and bolt connections.
6. Floor plan noting the locations, size, and type of anchorage and restraint to be used.
7. Include confirmation that all calculations are based on the design criteria listed in Paragraph 1.4.A of this Section.
8. Certificate of Compliance.

PART 2 - PRODUCTS

2.1 RESTRAINT EQUIPMENT AND SYSTEMS

A. Acceptable Manufacturers and Suppliers for Non-Isolated Systems:

1. Mason Industries, Inc.
2. Korfund
3. Amber/Booth Company
4. Vibration Mountings and Control Company
5. Kinetics
6. International Seismic Application Technology
7. Tolco
8. Vibro Acoustics
9. Hilti

B. Manufacture of restraints and anchors for isolated equipment required by this specification section shall also furnish the vibration isolators required by Specification Section 230540.

2.2 SNUBBERS

A. Snubbers shall be all-directional and consist of interlocking steel members restrained by replaceable shock absorbent elastomeric materials a minimum of 3/4 inch thick.

B. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8 inch or more than 1/4 inch.

C. Snubbers shall be Mason Industries Z - 1011 or accepted equivalent.

PART 3 - EXECUTION

3.1 DESIGN AND INSTALLATION

A. General:

1. All mechanical equipment, piping and ductwork shall be braced, anchored, snubbed or supported to withstand seismic disturbances in accordance with the criteria of this specification. Provide all engineering, labor, materials and equipment for protection against seismic disturbances as specified herein. The following mechanical components are exempt from seismic restraint requirements:

a. Components in Seismic Design Categories A and B.
b. Components in Seismic Design Category C that have an importance factor I_P of 1.0.
c. Components that have an importance factor I_P of 1.0, that are mounted less than four feet above the floor, that weigh less than 400 pounds, and that have flexible ductwork, piping, and conduit connections.
d. Components that have an importance factor I_P of 1.0, that weigh 20 pounds or less, and that have flexible ductwork, piping, and conduit connections.

2. Powder-actuated fasteners (shot pins) shall not be used for component anchorage in tension applications in Seismic Design Category D, E, or F.

3. Attachments and supports for mechanical equipment shall meet the following provisions:

    a. Attachments and supports transferring seismic loads shall be constructed of materials suitable for the application and designed and constructed in accordance with a nationally recognized structural code such as, when constructed of steel, AISC, Manual of Steel Construction (Ref. 9.8-1 or 9.8-2).
    b. Friction clips shall not be used for anchorage attachment.
    c. Expansion anchors shall not be used for mechanical equipment rated over 10 hp (7.45 kW). Exception: Undercut expansion anchors.
    d. Drilled and grouted-in-place anchors for tensile load applications shall use either expansive cement or expansive epoxy grout.
    e. Supports shall be specifically evaluated if weak-axis bending of light-gauge support steel is relied on for the seismic load path.
    f. Components mounted on vibration isolation systems shall have a bumper restraint or snubber in each horizontal direction. The design force shall be taken as $2F_p$. The intent is to prevent excessive movement and to avoid fracture of support springs and any non-ductile components of the isolators.
    g. Seismic supports shall be constructed so that support engagement is maintained.

B. Install ceiling mounted items in accordance with ASTM C 636.

1. Ceiling mounted air terminals or services weighing less than 20 pounds shall be positively attached to the ceiling suspension main runners or to cross runners with the same carrying capacity as the main runners.
2. Terminals or services weighing 20 pounds but not more than 56 pounds, in addition to the above, shall have two No. 12 gauge hangers connected from the terminal or service to the ceiling system hangers or to the structure above. These wires may be slack.
3. Terminals or services weighing more than 56 pounds shall be supported directly from the structure above by approved hangers.

C. Spring Isolated Equipment:

1. All vibration isolated equipment shall be mounted on rigid steel frames or concrete bases as described in the vibration control specifications unless the equipment manufacturer certified direct attachment capability. Each spring mounted base shall have a minimum of four all-directional seismic snubbers that are double acting and located as close to the vibration isolators as possible to facilitate attachment both to the base and the structure. Snubbers shall be installed with factory set clearances.

D. Non-Isolated Equipment:

1. The Division 230548 Contractor shall be responsible for thoroughly reviewing all drawings and specifications to determine all equipment to be restrained. This Contractor shall be responsible for certifying that non-isolated equipment is mounted and braced such that it adheres to the system description criteria in this specification section.

E. Piping:

1. Seismic braces for piping may be omitted when the distance from the top of the pipe to the supporting structure is 12" or less. Where pipes are supported by a trapeze, seismic braces may be omitted when the trapeze shall be supported by hangers having a length of 12” or less.
2. A rigid piping system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. Examples: Wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.
3. Unbraced piping attached to in-line equipment shall be provided with adequate flexibility to accommodate differential displacements.
4. At the interface of adjacent structures or portions of the same structure that may move independently, utility lines shall be provided with adequate flexibility to accommodate the anticipated differential movement between the ground and the structure.
5. Provide large enough pipe sleeves through walls or floors to allow for anticipated differential movements.

F. Ductwork:

1. Seismic restraints are not required for HVAC ducts with importance factor I_P of 1.0, provided that either of the following conditions are met for the full length of each duct run:

    a. HVAC ducts are suspended from rod hangers and hangers are 12 inches or less in length from the point rod attaches to duct, to the point rod connects to the supporting structure. Rods must be secured to both top and bottom cross angles with locking nuts above and below angle iron.
    b. HVAC ducts have a cross-sectional area of less than 6 square feet.
    c. This exception is not valid if the top of ductwork is not secured to hanger rods to limit pendulum length to 12 inches.

2. Equipment items installed in-line with the duct systems with an operating weight greater than 75 pounds shall be supported and laterally braced independently of the duct system.

END OF SECTION 230548

SECTION 230593 - TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 RELATED WORK

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these Documents.

B. Related work specified in other Sections:

Section 230500 - Basic Mechanical Requirements
Section 233300 – Ductwork and Accessories

1.2 SYSTEM DESCRIPTION

A. The work includes, but is not limited to the following:

1. Upon completion of the installation of all the plumbing, air and heating or cooling water systems, all necessary adjustments shall be made to provide capacities listed on the Drawings to properly balance these systems.
2. Submittals and written reports as specified.
3. Testing requirements as described in Specification Section 230500, paragraph 1.16.
4. Witness duct leakage test required by Specification Section 233300 – Ductwork and Accessories.
5. Provide assistance, in cooperation with the various trades, in the final adjustments and test of the Life Safety Systems to comply with the requirements of the Building and Fire Departments.
6. Provide Owner training as described in Specification Section 230500.

1.3 QUALITY ASSURANCE

A. Work under this section shall be executed under the direct supervision of a Registered Professional Engineer having an established professional office in the State of Utah and having an experience record of not less than five (5) years in the mechanical contracting industry, engaged in testing, balancing and adjusting of air and hydronic mechanical systems for not less than two (2) years of that time, or, under the direct supervision of a qualified testing, adjusting and balancing supervisor, possessing certification from the National Environmental Balancing Bureau (NEBB) or from the Associated Air Balance Council (AABC).

B. Comply with the applicable procedures in the chapter on Testing, Adjusting and Balancing in the latest ASHRAE Edition of the NEBB, AABC, and SMACNA Test and Balance documents.

C. Calibration and maintenance of instruments shall be in accordance with manufacturer's standards and recommendations, and calibration histories for each instrument shall be available for examination.

D. Accuracy of measurements shall be in accordance with the applicable measurement means as listed in the latest edition of NEBB, AABC, and SMACNA Test and Balance documents.

E. Allowable Tolerances:

1. Tolerances of adjustment for air handling systems are plus or minus 10% for supply, return, and exhaust systems at air devices and plus 10%/minus 0% at all fans/source equipment from figures shown on drawings.
2. Tolerances of adjustment for hydronic systems, are plus or minus 10% of design conditions shown on drawings at terminal devices and equipment, and plus 10%/minus 0% at all pumps.

F. Final Testing, Adjusting and Balancing of all hydronic and air systems shall be performed by an approved separate professional Testing, Adjusting and Balancing subcontractor meeting the above Quality Assurance requirements. Acceptable separate professional subcontractors approved to work on this project are as follows:

1. BTC Services, Inc.
2. Certified Testing & Balancing, Inc.
3. RS Analysis, Inc.

G. Subcontractors not listed above will not be approved.

H. Within 30 days after execution of the Owner-Contractor Agreement, transmit to Architect/Engineer the name and qualifications of the organization proposed to perform the services.

1.4 SUBMITTALS

A. Procedure: Submit Qualifications, Documentation, Test Schedules and Reports in accordance with the General Conditions of the Contract.

B. Qualifications:

1. Submit three copies of documentation to confirm compliance with Quality Assurance provisions:

a. Organization supervisor and personnel training and qualifications.
b. Specimen copy of each of the report forms proposed for use.

C. Preliminary Report: At least fifteen days prior to starting field work, submit three copies of:

1. A set of report forms filled out as to the design flow values and the installed equipment pressure drops, and the required CFM for air terminals.

2. A complete list of instruments proposed to be used, organized in appropriate categories, with data-sheets for each. Show:

a. Manufacturer and model number.
b. Description and use when needed to further identify the instrument.
c. Size of capacity range.
d. Latest calibration date.

3. Architect/Engineer will review submittals for compliance with Contract Documents, and will return one set marked to indicate:

a. Discrepancies noted between measured data and Contract Documents.
b. Additional, or more accurate, instruments required.
c. Requests for re-calibration of specific instruments.

D. Schedules:

1. Schedule tests to comply with project completion schedules.
2. Schedule testing and balancing of parts of the systems which are delayed due to seasonal, climatic, occupancy, or other conditions beyond control of the Contractor, as early as the proper conditions will allow, after consultation with Architect/Engineer.
3. Submit reports of delayed testing promptly after execution of those services.

E. Final Report: At least fifteen days prior to Contractor's request for final inspection, submit three copies of final reports, on applicable reporting forms, for review. Submit a fourth copy directly to the Engineer. Each individual final reporting form must bear the signature of the person who recorded data and that of the NEBB or AABC certified supervisor of the reporting organization. Identify instruments of all types which were used and last date of calibration of each. Report shall include:

1. A detailed letter to Engineer outlining all abnormal or notable conditions not covered in above data specifically identifying all locations where specified flow tolerances could not be met.
2. A set of reduced black and white or blueline prints with all air openings clearly marked to correspond with data sheets and with thermometer locations clearly marked.
3. Data sheets showing amount of air handled at each opening, instrument used, velocity readings, and manufacturer free area factor.
4. Data sheets giving log of room temperatures in rooms exhibiting objectionable temperatures during the heating season. Logs shall be taken when outside temperature is 30 deg.F or colder.
5. Data sheets giving log of room temperatures in rooms exhibiting objectionable temperatures during the cooling season. Logs shall be taken with full occupant load, full lighting, and maximum solar conditions.
6. Equipment data sheets giving make, size and model, of fans, starters and motors with rated amps and service factors, and drives. Include pumps, supply fans, exhaust and recirculating fans.
7. Operating data including fan RPM, inlet and outlet pressures, pressure drop across filters, face and bypass dampers, and measured motor current and voltage, BHP and CFM (total).
8. Heating equipment operating data including air temperatures entering and leaving heating coils (maximum air temperature rise), together with corresponding air flow and air pressure drop, water temperature entering and leaving heating coil, water flow and pressure drop through heating coil.
9. Cooling equipment operating data including air temperatures entering and leaving cooling coils together with corresponding air flow and air pressure drop, water temperature entering and leaving cooling coil, and water flow and pressure drop through cooling coil.
10. Cooling tower operating data including measurements of hot water, cold water and wet-bulb temperatures, circulating water flow rate, fan RPM, fan power and wind velocity.
11. Equipment and operating data as required to show performance of pumps, heat exchangers, domestic hot water circulating systems, heating, ventilating, and air conditioning units, cabinet heaters, unit heaters, unit ventilators, fans and temperature control devices.
12. Sound pressure levels showing readings in all 8 octave bands and plotted on RC(II) charts shall be submitted for the following:

a. All sides of Mechanical Rooms.
b. Lobbies, Labs, and Commercial Area.
c. Conference Rooms.
d. Spaces within 20 ft. of parking garage ventilation fan inlets and outlets.
e. All spaces exhibiting abnormally high or annoying noise levels.

13. Domestic hot water recirculation data including flow at each branch shown requiring specific flow, and at the pump.

1.5 PROJECT CONDITIONS

A. The following job conditions must be verified before any testing, adjusting or balancing of the environmental systems begin:

1. Installation of the designated system is complete and in full operation.

2. On hydronic systems, strainers shall be cleaned, temperature control valve operation shall be checked, pump rotation shall be checked, pressure reducing valves shall be adjusted, and other such conditions requiring correction.
3. Air systems shall be checked for dirty filters, filter leakage, equipment vibrations, damper operation, fan rotation, and other such conditions requiring correction.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PROCEDURE

A. Confirm that project conditions have been verified and that necessary corrections have been made before proceeding with the Work.

B. The Test and Balance Contractor must proportion air/water flows in the system while introducing a minimum amount of resistance. All systems are to be proportionally balanced.

C. Hydronic Systems:

1. Using system flow meters and/or contact pyrometer, the balancing firm shall adjust the quantity of water or glycol solution handled by each pump and supplied to each coil, solar collector, heat exchanger, cooling tower, and such other primary source equipment to meet design requirements, and mark each balancing cock at final setting.

D. Air Systems:

1. The balancing firm shall adjust all dampers, diffusers, registers, belts and sheaves for the delivery and distribution of air quantities shown in the Contract Documents and shall mark each balancing device at final setting.
2. Adjust fan speeds and motor drives within drive limitations for required air volume, provide new sheaves as necessary, or adjustable bands on constant volume plenum fans, and notify Division 26 Contractor of any thermal overloads that need to be changed/replaced.
3. Measure static air pressure conditions on air supply units, including individual filter and coil pressure drops, and total pressure across the fan. Make allowances for 0.5” w.c., equivalent to 50% loading of filters.
4. Exhaust and recirculation air systems shall be adjusted for air quantities shown on Drawings.
5. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
6. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
7. Measure building static pressure in both economizer mode and minimum outside air mode, and adjust supply, return and exhaust air systems to provide the required relationship between each to maintain approximately 0.05 inches water column positive static pressure at the Building Entries.
8. Distribution system shall be adjusted to obtain uniform space temperatures free from objectionable drafts and noise.

9. Where multiple air diffusers are shown on one terminal box, adjust dampers for the delivery and distribution of air quantities shown in the Contract Documents.
10. Multi-zone units are to be checked for motorized damper leakage. Air quantities are to be adjusted with all mixing dampers set first for cooling, then heating, then modulating. If it is significantly higher for heating or cooling, measure motor current and adjust fan speed for heating.
11. Dust collection system shall be adjusted for air quantities shown on the Drawings with all blast gates open and all floor sweeps closed.
12. Variable Air Volume System Powered Terminal Units: Set each volume controller to CFM setting shown on drawings, confirm that each unit has all control air connections properly made and confirm proper operation for automatic variable air volume temperature control.
13. Set all VAV boxes at minimum/maximum air flow shown on drawings.
14. Adjust air flow switches for proper operation on all fan powered VAV boxes.
15. Test Run: In order to determine that the system installation is complete and will operate satisfactorily, make a test run with equipment operating per normal temperature control schedule and sequence for a period of seven days for each heating and cooling season. Contractor shall notify Architect in writing when he is ready to begin test. Provide personnel to run test and operate and adjust equipment as may be required during test run. Keep a log for each day indicating all malfunctions that occurred and corrections and adjustments made. Be responsible for operation of equipment during this test.
16. Report: After all adjustments are made, a detailed report shall be prepared by the balancing firm and submitted to the Architect for approval. Owner reserves the right to spot check the report prior to final acceptance.

E. Plumbing System

1. Hot Water Recirculation Systems: Set flow at each balancing valve shown. Record flow at each pump. Verify the proper installation of automatic flow control valves.

END OF SECTION 230593

SECTION 230700 - MECHANICAL INSULATION

PART 1 - GENERAL

RELATED WORK

A. Requirements: Provide insulation in accordance with the Contract Documents.

B. Related work specified in other Sections:

Section 224450 - Plumbing Equipment
Section 230500 - Basic Mechanical Requirements
Section 230529 - Basic Mechanical Materials and Methods
Section 230540 - Mechanical Sound and Vibration Control
Section 232113 - HVAC Piping & Specialties
Section 235200 - Boilers
Section 235700 - Heat Transfer
Section 236400 - Refrigeration

SYSTEM DESCRIPTION

A. The mechanical insulation work required by this Section shall include materials and methods as described herein and on the Drawings and as required by applicable energy codes.

B. The work includes, but is not limited to providing insulation on the following:

1. Plumbing Systems:

Domestic Hot Water-Supply, Recirculating
Tempered Domestic Water-Supply, Recirculating
Tempered Domestic Water Circulating
Domestic Cold Water
Primary Roof Drain System
Overflow Roof Drain Bowls
Chilled Drinking Water Piping

2. Heating Systems:

Heating Water Supply and Return
Heat Exchangers, Converters and Air Separators
Thermal Storage Tanks
Boiler Feed Water
Blowdown Separator Tank & Vent
Blowdown Discharge Piping
Flue Gas Breeching and Single Wall Stacks
Induced Draft Fan Scrolls

3. Refrigerant and Brine Systems:

Refrigerant Piping

4. Air Distribution Systems:

   Exterior surfaces of all plenums and ducts which are a part of the following systems where duct or plenum is not lined (see Section 230540):
   Outside Air
   Combustion Air
   Mixed Air
   Medium Pressure Supply Air
   Low Pressure Supply Air
   Return Air
   Rigid Round Runouts to Diffusers

5. Other Systems:

   Cold Condensate Drains
   Piping Exposed to Freezing with Heat Tracer

QUALITY ASSURANCE

C. Qualifications: The firm executing the work of this Section shall have at least 3 years successful installation experience on projects with mechanical insulations similar in scope and nature to that required for this Project.

D. Requirements of Regulatory Agencies: All insulation shall be in accordance with Jurisdicational Building Code and State and Federal Energy Conservation Standards.

SUBMITTALS

E. Product Data: Submit manufacturer's specifications and installation instructions for each type of mechanical insulation in accordance with the General Conditions of the Contract. Include schedule showing manufacturer's product number, thickness and furnished accessories for each mechanical system requiring insulation.

F. Provide schedule of pipe sizes with insulation thickness at corresponding fluid temperatures.

PRODUCT DELIVERY, STORAGE AND HANDLING

G. Delivery of Materials: Deliver insulation, coverings, adhesives, and coatings to site in containers with manufacturer's stamp or label affixed showing fire hazard ratings of products.

H. Storage of Materials: Protect insulation against dirt, water, chemical and mechanical damage. Do not install damaged insulation; remove from project site.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers of insulation materials shall be as follows:

3M/Thermal Ceramics (FireMaster)
Armstrong
Certain-teed
Dow Chemical
Gilsulate International, Inc. (Gilsulate 500XR Loose-Fill Insulation)
Johns Manville
Knauf
Manson Insulation Products
Owens-Corning
Renler (Pyroscat FastR Wrap)
SpecSeal (Claymac)
Unifrax (Fyrewrap)

2.2 MATERIALS

A. Conductivity:

TYPE OF INSULATION	MAXIMUM THERMAL CONDUCTIVITY/INCH
Calcium Silicate	0.47 at 600 degrees Fahrenheit
Glass Fiber Pipe Insulation	0.25 at 75 degrees Fahrenheit
Glass Fiber Rigid Equipment Insulation	0.25 at 75 degrees Fahrenheit
Glass Fiber Rigid Duct Insulation	0.24 at 75 degrees Fahrenheit
Glass Fiber Blanket Duct Insulation	0.29 at 75 degrees Fahrenheit
Expanded Polystyrene	0.24 at 75 degrees Fahrenheit
Ceramic Fiber Grease Duct Wrap	0.25 at 70 degrees Fahrenheit
Polyisocyanurate Foam	0.19 at 75 degrees Fahrenheit
Granular Loose Fill	See below

B. Duct Board: Rigid glass fiber board with a minimum density of 1-1/2 pounds per cubic foot, a maximum thermal conductivity of 0.24 at 75 deg.F and complying with National Fire Protection Association Pamphlet 90A.

C. Duct Wrap: Blanket-type fiberglass insulation 1-1/2" thick, 0.75 pounds per cubic foot density.

D. Vapor Barrier Coatings: To have a perm rating not more than 0.25 when tested in accordance with ASTM E96, procedure A.

E. Adhesives, Sealers, Facings and Vapor Barrier Coatings: To be compatible with materials to which applied, and shall not corrode, soften, or otherwise attack the pipe or insulation materials in either the wet or dry state. Use only adhesives, sealers, facings, and vapor barrier coatings as recommended by the manufacturer of insulation materials.

F. Chemicals for Treating Paper: Non-soluble.

G. Non-Collapsing Inserts: Calcium Silicate or Polyisocyanurate (Dow Trymer 2000). No Polystyrene inserts are allowed.

H. Granular, Loose-Fill Insulation: Inorganic, nontoxic, nonflammable, sodium potassium aluminum silicate with calcium carbonate filler. Include chemical treatment that renders insulation hydrophobic.

1. Thermal Conductivity (k-Value): 0.60 at 175 deg F and 0.65 at 300 deg F.
2. Application Temperature Range: 35 to 800 deg F.
3. Dry Density: 40 to 42 lb/cu. ft.
4. Strength: 12,000 lb/sq. ft.

2.3 PERFORMANCE CRITERIA

A. Insulation and accessory materials to meet the following criteria:

1. Insulation Materials: To be noncombustible as defined in National Fire Protection Association Pamphlet 220 and to be Underwriter's Laboratory listed.
2. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread rating of 25 or less, and smoke-developed rating of 50 or less, as tested by ANSI/ASTM E 84 (NFPA 255) method.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Testing of piping and ductwork to be completed prior to application of insulation.

B. Apply insulation tightly over clean, dry surfaces with sections or edges firmly butted together.

C. Make insulation continuous through sleeves or openings in walls and floors.

D. Run sealed vapor barriers continuous throughout all cold surface insulation systems.

E. Avoid the use of staples on vapor barrier jackets. Seal all vapor barrier penetrations with white vapor barrier sealant.

F. Apply adhesives so as not to exceed the coverages recommended by the manufacturers.

G. Leave surfaces clean and ready for painting.

H. Do not insulate cleanouts, access openings or identification plates. Neatly bevel insulation and finishes up to the edges of such openings and stop with sheet metal rings.

I. Provide non-collapsing inserts between pipe and all shields/saddles on all insulated piping 2" and larger.

3.2 SPECIFIC INSTALLATION REQUIREMENTS

A. Minimum Pipe Insulation Schedule:

2012 International Energy Conservation Code

PIPE INSULATION THICKNESS IN INCHES*			
	Nominal Pipe Diameter		
Fluid	< 1.5"	≥ 1.5"	≥ 8"
Domestic Cold Water	1.0	1.5	1.5
Domestic Hot Water	1.5	2.0	2.0
Chilled Water/Glycol, Chilled Brine, Refrigerant, Cooling Tower Water	1.0	1.0	1.5
Heating Water	1.5	2.0	2.0

*Based on insulation having a conductivity not exceeding 0.27 BTU per inch/h·ft^{2}·°F.

Exceptions:

1. Factory installed piping within HVAC equipment tested and rated in accordance with 2012 IECC referenced procedures.
2. Strainers, control valves, and balancing valves associated with piping 1-inch or less in diameter on heating water systems.

DUCT AND PLENUM INSULATION	
Location	Min. Insulation Value
In unconditioned spaces (i.e. ceiling spaces or unheated spaces)	R-6
Outside building envelope	R-8

Exceptions:

a. When located within equipment.
b. When design temperature difference between the interior and exterior of the duct or plenum does not exceed 15°F (i.e. return air ducts in ceiling spaces).

B. Plumbing System:

1. Domestic Cold Water:

Horizontal piping and where freeze protection is required, one-half inch thick fiberglass pipe covering with all service jacket self-seal lap.

All domestic cold (PEX) piping to be insulated to maintain fire/plenum rating where used in air plenums.

2. Roof Drains:

Horizontal mains and vertical from horizontal to and including drain bowls, one-half inch thick fiberglass pipe covering with all service jacket self-seal lap.

Overflow roof drain bowls shall be insulated but not overflow drain piping. Vertical mains shall be insulated.

3. Domestic Hot and Tempered Supply and Circulating Water:

Insulate entire system.
Thicknesses per table of 230700-3.2, A.
Provide all exposed piping with PVC jacketing. See specification section 230700, 3.2, H4 for materials to be used.

4. Domestic Hot Water Heaters, Storage Tanks, and Accumulators (not factory insulated):

Two inch thick fiberglass board, foil faced or faced with Du-All tank wrap or equal. Finish with six-ounce canvas or fiberglass reinforcing mesh and fire retardant lagging adhesive.

5. Chilled Drinking Water:

Thicknesses per Chilled Water Piping System, 40-55 deg. F., of 230700-3.2 A.

6. Fittings:

Premolded PVC fitting covers with Fiberglass insert. PVC covers shall be rated for return air plenum use.

7. Valves:

All systems: Oversized pipe covering of same material and thickness as adjacent pipe covering. Finish with six-ounce canvas and heavy coat of vapor barrier mastic coating.

C. Heating System:

1. Heating Water Supply and Return:

a. Fiberglass pipe covering with all-service jacket and self-seal lap. Provide PVC jacket on all piping exposed to view, and in mechanical rooms.

b. Thicknesses per Minimum Pipe Insulation Schedule in Section 230700-3.2, A.

c. Heat exchangers, convertors, air separators, storage tanks and receivers:

351 deg. and up ....…..... 4" thick
251 deg. - 350 deg..... 3" thick
up to 250 deg.....…..... 2" thick

Fiberglass pipe covering or Du-All pipe and tank wrap with all service jacket. Finish with six-ounce canvas or fiberglass reinforcing mesh applied with heavy coat of lagging adhesive where subject to abuse.

2. Fittings:

d. Premolded PVC fitting covers with Fiberglass insert.

3. Valves:

a. All systems: Oversized pipe covering of same material and thickness as adjacent pipe covering. Finish with six-ounce canvas or fiberglass reinforcing mesh and heavy coat of vapor barrier mastic coating.

4. Boiler Breechings, Drum Heads, Flue Boxes, Draft Fan Scrolls, Fly Ash Separators and Stacks to Roof:

a. Insulate with 3" thick fiber glass insulation with 650 deg. F. temperature limit, all-service jacket and lap seal.

D. Air Distribution System:

1. Exterior surfaces of outside air, combustion air, mixed air, and recovery coil discharge:

One and one-half inch thick fiberglass three pound board with all service jacket. Seal all joints and pins with tape material to match jacket. Apply material with weld pins or stick clips.

2. Exterior surfaces of supply and return air plenums where not indicated to be lined:

   One and one-half inch thick fiberglass three pound board with all service jacket. Seal all joints and pins with tape material to match jacket. Apply material with weld pins.

3. Exterior surfaces of exposed supply ductwork not lined:

   One and one-half inch thick fiberglass three pound board with all service jacket. Seal all joints and pins with tape material to match jacket. Apply material with weld pins or stick clips.

4. Concealed supply ductwork not lined:

   Two inch thick 0.75 pound fiberglass duct wrap with foil scrim facings. All joints sealed. Apply material with adhesive or wire 18 inches o.c.

5. Low pressure round runouts to diffusers:

   Two inch thick 0.75 pound fiberglass duct wrap with foil scrim facings. All joints sealed. Apply material with adhesive or wire 18 inches o.c.

6. See Specification Section 230540 – Mechanical Sound and Vibration Control for requirements for lined ductwork.

E. Other Systems:

1. Engine Exhaust and Muffler inside Building:

   Two and one-half inch calcium silicate block or pipe covering. Point all joints and seams. Finish with one-half inch thick insulating cement and six-ounce canvas applied with heavy coat of lagging adhesive. Add wire mesh reinforcing in cement where subject to abuse.

2. Piping Exposed to Freezing with Heat Tracer:

   One-inch thick fiberglass pipe covering with all service jacket-self seal lap. Finish with 0.016-inch thick corrugated aluminum jacket and fitting covers for protection.

   NOTE: Insulation shall be applied over heat tracer.

3. Piping Insulation Exposed to Rainfall:

   Provide 0.016-inch thick corrugated aluminum jacket and fitting covers on all insulation exposed to rainfall. Install seam on bottom of horizontal and angled piping. Seal all joints weather-tight. Seal jacket seams with silicone sealant.

4. Protective Insulation Jacketing:

   Provide high impact polyvinyl chloride pipe covering on insulated piping. Thickness to be 30 mil. Install per manufacturer's recommendations for hot and chilled piping systems.

Seal using solvent welding adhesive, providing slip joints as required for expansion and contraction. Ceel-Co Ceel-Tite 300 series, Schuller Zeston 300 series, or approved equal.

5. Condensate Drains Inside Buildings:

1/2" thickness fiberglass pipe covering with all service jacket self-seal lap.

END OF SECTION 230700

SECTION

AUTOMATIC TEMPERATURE CONTROLS

PART 1 - GENERAL

1.1 GENERAL CONDITIONS

A. The General Conditions, Supplementary General Conditions, alternates and addenda, applicable drawings and the technical specifications, shall all apply to all work under this division.

1.2 SYSTEM DESCRIPTION

A. A system of DDC automatic temperature controls shall be furnished and installed as a part of this contract to give the owner a completely operable system. Acceptable manufacturers and installers shall be Schneider Electric by Utah Controls Inc. of Draper, Utah as an extension of the existing District DDC system.

B. The DDC system shall incorporate a Netplus router or AS for networking system to tie this facility directly into the District's Ethernet campus wide system. All networking software and DDC interface software shall be provided under this section to seamlessly connect this facility to the network. This contractor shall coordinate with the District's IT department to obtain all IP addresses and network clearances to connect the DDC system to the Ethernet network.

C. The Host computer software located at the District maintenance office shall be upgraded to the most current revision of INET Revision 2.42.

D. The system shall be as indicated on the drawings and specified herein. Building HVAC systems and unitary heating devices shall be entirely controlled by the DDC system. System shall include local DDC controllers mounted at each fan system, VAV box, fan-coil unit and cabinet unit heater. These local DDC controllers shall be interconnected by a 2-wire LAN (local area network) with a master/central DDC controller located in the Maintenance office. The master/central DDC controller, in turn, shall communicate with the existing school district host computer located in the district offices. The graphics on the computer shall display on separate, bit-mapped color screens each fan system, VAV box, cabinet unit heater, central heating system and central cooling system. Each screen shall have available for display in the appropriate location each input and output point monitored or generated by the DDC system. All digital output points shall have override capability. All screens shall be password protected so that sensitive data cannot be easily corrupted by inexperienced operators while allowing complete access to trained maintenance personnel. All of the above screens, data and features shall also be available for monitoring and modification from the Host computer located in the District offices via a Netplus router.

E. All system and unitary controls shall be of the direct digital type (DDC). Self-tuning PID (Proportional, Integral, and Derivative) control algorithms shall be applied where applicable on all applications. The control system shall be a networked, distributed intelligence system, with the control loops for each system being capable of stand-alone operation.

F. The system shall include all control devices, valves and damper parts as called for hereinafter.

G. Manufacturers and installers other than listed in 1.2 A must demonstrate to the owner the ability to communicate to the existing district wide DDC system and obtain written prior approval.

1.3 SCOPE

A. Will be to remove all of the pneumatic controls and replace them with a new control system which shall consist of electronic type DDC, direct digital controllers, input/output modules, ATC interface panels, and accessory equipment for a completely installed system of automatic temperature controls.

1.4 WORK TO BE PERFORMED BY OTHERS

A. Division 16 shall furnish and install all single phase and multiple phase electrical power wiring to magnetic starters, disconnect switches, VFD's and motors. He shall also provide 120 VAC, 20 Ampere power sources to each group of ATC panels and VAV boxes as shown on the electrical plans. The ATC contractor shall be responsible for all 24 VAC wiring to ATC equipment.

B. The sheet metal contractor shall install all dampers supplied by the ATC contractor. Each damper shall be installed so that it will operate freely and without binding. To insure that the damper both opens and closes completely with less than 7#/sq. ft. torque applied at the operating shaft, each damper shall be checked after its installation, but before the damper actuators are attached.

C. The mechanical contractor shall install all valves, immersion wells and pressure taps supplied him by the ATC contractor.

1.5 INSTALLATION BY AUTOMATIC TEMPERATURE CONTROL (ATC)CONTRACTOR

A. The ATC contractor shall furnish and install all necessary electrical control wiring for the complete temperature control system, heating and ventilating equipment motor starting circuit controls and all electrical control interlocks for same, and for control wiring for miscellaneous HVAC equipment furnished by the Owner.

B. The ATC contractor shall furnish & install all necessary electrical control wiring of all temperature controls, heating and ventilating equipment motor starting circuit controls, all electrical control interlocks for same and for miscellaneous packaged equipment.

C. All line and low voltage electrical and control wiring shall be installed in EMT conduit in exposed or inaccessible areas in accordance with the National Electrical Code and applicable local codes and in compliance with Division 16. Plenum cable may be installed in accessible areas.

1.6 QUALITY ASSURANCE

A. Provide an unconditional **TWO-YEAR** parts and service warranty. This warranty shall commence at the time of demonstration of system completion of all portions of the ATC system.

B. Emergency response by contractor shall be available 24 hrs/day 7 days/week 365 days/yr. Response time shall not be greater than 12 hours from time of call.

C. All parts and material and their installation methods shall be in accordance with the manufacturer's recommendations and specifications. All parts and material shall be new.

D. The Contracting firm executing the work of this section shall have at least 5 years' in business and experienced in completing work of similar scope and nature to that specified. The firm shall be a licensed electrical contractor in the state of Utah. The contractor shall be a local authorized agent of the DDC system manufacturer.

1.7 SUBMITTAL AND TECHNICAL INFORMATION

A. Submit shop drawings (6 sets) and manufacturer's data for the following items to the mechanical engineer:

1. Wiring and installation diagrams.
2. ATC device specification sheets
3. Point list
4. Control flow diagrams, complete with all control schematics and sequences of operation.
5. Documentation of all software and hardware. These manuals shall be complete with installation procedures as well as start up and programming instructions. They should also contain any testing or maintenance procedures required to operate system on a continuing basis.

1.8 PROJECT COMPLETION REQUIREMENTS

A. Upon completion of the project, the ATC contractor shall spend the necessary time with the building's operating personnel to adequately instruct them on the operation of the system. These training sessions shall be scheduled at times convenient to the School District and shall be conducted at the project.

B. Provide 5 copies of the project operating and maintenance instruction manuals for use during the training sessions. Each manual shall contain both a current hard copy and a CD Rom of all DDC system programming.

C. The ATC contractor shall provide as part of his contract the on-site services of a programmer familiar with the system for an additional 24 hours, which the Engineer and/or the School District may use as they see fit to fine-tune or add features to the system.

D. The ATC contractor shall provide as part of his contract the on-site services of a technician familiar with the system to assist the air & water balance contractor in completing his portion of the project. The technician shall be available for a minimum of an additional 32 hours for this assistance.

E. Operation & Maintenance Manuals: Provide 5 manuals in addition to those manuals specified above. These manuals shall provide descriptions of maintenance procedures for all system components, including sensors and controlled devices. They shall cover inspection, periodic preventative maintenance, fault diagnosis, and repair or replacement of defective components. They shall include complete as-built ATC installation drawings with sequences of operation for all mechanical systems controlled by the ATC contractor. They shall each include both a hard copy & diskettes of all as-built system programming.

PART 2 - EQUIPMENT

2.1 DDC INPUT DEVICES

A. All DDC input devices shall provide industry standard signals and shall be compatible with the DDC controllers used.

B. All temperature input devices shall have a rated accuracy of 1% or better.

C. All pressure input devices shall have a rated accuracy of 2% or better. Pressure transmitters shall be selected to match the application, and shall not be damaged by pressures at five times the maximum measurable pressure.

D. Miscellaneous input devices shall have accuracy's as individually specified.

2.2 DDC OUTPUTS

A. Modulating outputs shall be in accordance with industry standards and shall be compatible with the driven DDC devices.

B. DDC digital outputs shall be either relay contact closures or Triacs rated for the application.

2.3 DUCT SMOKE DETECTORS

A. Duct smoke detectors are to be furnished and wired by Division 16. Detectors shall be installed by the ATC contractor.

B. Division 16 shall furnish & install a fire alarm/fan shutdown relay at each fan system. The ATC contractor shall wire between the alarm relay contacts and the fan system starter to lock out the supply fans when the building is in fire alarm.

2.4 AUTOMATIC VALVES

A. ATC valve bodies 2" and smaller shall be screwed; larger valve bodies shall be flanged. Screwed valves shall be rated at 150 psi or greater and shall have cast iron or brass bodies. Flanged valves shall be rated at 250 psi or greater and have cast iron or steel bodies. All automatic valves shall be for DDC control application.

B. Shut-off pressure ratings of each valve shall be as required by the application.

C. The valves shall be manufactured by TAC or Honeywell.

2.5 MOTORIZED ATC DAMPERS

A. Motorized control dampers that are not supplied with the air handling units shall be furnished by the Automatic Temperature Control Contractor. Dampers shall be factory-built, low leakage units such as Ruskin CD-50 or approved equal. Blades shall be 6" maximum width, 6063-T5 extruded aluminum width, 1/2" axles, and Oilite or Cycoloy bearings.

B. Frames shall be 5" x 1", 6063-T5 extruded aluminum hat channel design, 0.125" minimum thickness with corner braces to assure squareness.

C. Dampers shall be low leakage type with compressible end seals and neoprene or extruded vinyl blade and jamb seals. Leakage shall not exceed 6.2 cfm/sq. ft. at 4" W.G. Dampers shall require less than 7#-in/sq. ft. torque at the operating shaft for proper operation.

D. Outdoor & return air dampers shall be parallel blade with blade direction oriented to assist mixing of air streams. Relief air and other volume control dampers shall be opposed blade.

2.6 DAMPER AND VALVE ACTUATORS

A. Damper and valve actuators shall be of the gear-train type. All moving parts shall be permanently lubricated and not require addition or replacement of oil. Actuators shall meet the NEMA 3R rainproof rating and shall have an ambient temperature operating rating of -40°F to 140°F, without the addition of extra equipment. Actuators shall also carry the UL 94-5V rating for installation in return air plenums.

B. Damper and valve actuators shall accept the appropriate Ma, VDC or digital output signals provided by the DDC controllers.

C. Damper actuators shall be mounted outside the air stream whenever possible and be of sufficient size to operate the connected damper. Mount damper actuator on firm baseplate.

D. Damper actuators linked to outdoor air and relief air dampers shall close their attached dampers upon power failure or fan shutdown.

2.7 ROOM TEMPERATURE SENSORS

A. Wall mounted space temperature thermostats shall be installed in wall boxes and shall include an adjustable setpoint in occupied areas.

B. Wall mounted space sensors for areas subject to abuse such as the Gymnasium shall have the sensor mounted on a wood mounting bracket and have a heavy duty, key locking, metal protective guard.

2.8 CO2 LEVEL TRANSMITTERS

A. CO2 level transmitters shall be suitable for duct mounting and shall have an averaging sensor whose length is the width of the return air duct. CO_2 sensors shall be self calibrating, if regular calibration of the sensor is required, a calibration kit shall be supplied to the owner. Output signal shall be 0-5 or 0-10 VDC as required by the DDC system.

B. CO2 sensors for the gym space and common space shall be room type mounted adjacent to the space thermostat with similar heavy duty steel protective guards.

2.9 OUTSIDE AIR SENSOR

A. The outside air temperature sensor shall be contained within a wooden instrument enclosure. The location and design of such shall provide a signal to the DDC system that is accurate to within +/- 2 degrees F, regardless of building mass, sun location or other environmental conditions.

2.10 HOST COMPUTERS

A. The School District facility management and control system includes an existing Centralized Host computer currently located at the District offices.

B. A Automation Server (AS) Router shall be provided and installed to allow connection to the existing school district HVAC monitoring network. The school district shall provide all necessary IP addresses and a connection port onto their existing Ethernet network.

C. Copies of all software disks, operation manuals, along with installation instruction shall be provided to owner.

D. The controlling software database shall be constructed by the ATC contractor to provide a fully operational DDC control system that may be monitored, controlled & modified from the District Centralized Host computer. All control schedules, algorithms, and control logic shall be in place within each DDC controller and stored as back-up copies on both Host computers hard disks which may be down-loaded to individual DDC controllers as necessary. Documentation provided shall include block software flowchart showing the interconnection between each of the control algorithms and sequences.

E. The building shall be represented by complete graphical floor plans, with accurate locations of each major piece of HVAC equipment. Each major piece of HVAC equipment shall be graphically represented at each Host computer with all appropriate DDC points dynamically represented.

F. All designated building alarms shall be automatically reported as they occur as determined by the Davis School District.

2.11 MASTER DDC CONTROL PANEL

A. The master DDC controller shall provide to the Host computer (s) diagnostic reports of the following types, for all DDC devices:
   1. When specified alarm conditions occur, provide a report internally listing the status of specific items associated with the equipment generating the alarm.
   2. Report shall be routed to the local Host computer, District Host computer or other combinations of computers via modem as designated by the owner. Depending on the time of day, the owner shall specify up to five sites to which exceptions shall be auto-dialed and reported. This shall allow the owner to assign off hours exception responses to various facility personnel as necessary. Selection of the sites to be dialed can be programmed by the owner, and set to change automatically per time of day and day of week. Information may be duplicated to multiple combinations of locations.
   3. Report shall record the time the status information was taken, and shall allow operational personnel to use this information to diagnose the alarm situation.
      a. Trend logs.
      b. Energy reports.
      c. Exception tables/by operator
      d. Override information table/by operator
      e. Run time information on equipment
      f. Review of specific facility information by operators.
      g. Building information for information display

B. All programming defining the functions to be performed by the master DDC control panel from loss due to power failure for a minimum of six months.

C. The master DDC control panel shall be multi-tasking and shall provide the capability to simultaneously perform at least, but not limited to, the following functions:
   1. Down loading of application program changes without affecting the simultaneous operation of existing operating application programming.
   2. Operator access to the entire network of local digital controllers.

2.12 LOCAL DDC CONTROL PANELS

A. Local DDC control panels shall be located near mechanical systems as necessary to provide both digital and analog input and output points as specified and/or required to achieve specified system performance.

B. Each local DDC control panel shall provide all control functions for the mechanical equipment specified to be controlled from that panel.

C. Every input and output point shall be well labeled and every digital output shall have a LED indication of the position of the output relay.

D. ATC contractor shall provide documentation of the software application program for each digital controller.

E. Documentation provided shall include block software flowchart showing the interconnection between each of the control algorithms and sequences.

F. System acceptance shall not be completed until this documentation is provided and located in each ATC interface panel.

G. Systems providing modulating outputs via pulse width modulation techniques shall provide within each ATC interface panel all the components required to implement the functions equivalent to an analog output.

2.13 ATC INTERFACE PANELS

A. ATC interface panels shall be mounted near each group of local DDC controllers other than VAV box controllers. Each panel shall be made of not less than 16 gauge steel. Panel shall have a full back plate and full hinged door such that when the door is closed, the assembly provides a completely enclosed, NEMA 1 enclosure. Panels shall be fully painted and fitted with key locks. Appropriately sized nameplates shall be used to identify all panel mounted devices. Major wiring within panels shall installed within distribution gutters (similar to Panduit). All wiring entering and leaving panels shall terminate on numbered terminal strips. All wiring within panels shall be color coded and the color shall not be changed between the terminal strip and the end destination of that wire. Panels shall contain wiring diagrams of the panel interior and associated devices. Diagrams shall identify all interior devices and shall include terminal numbers.

B. Panels shall contain the following devices as applicable:
1. Control transformers
2. NEC required fusing
3. Local DDC controllers (contractor option)
4. NEC required grounding
5. Logic relays
6. 120 VAC convenience outlet
7. Air pressure transmitters
8. Control switches
9. Pilot lights
10. Terminal strips

2.14 LABELING

A. All ATC supplied devices shall be permanently labeled with labels indicating device name, system identifier and function within the system. All labels external of the DDC controls cabinets shall be of the engraved type.

2.15 AIRFLOW MEASURING STATIONS (Alternate #2)

A. Airflow measuring stations for air handler outside air shall be Ebtron Gold series or Air Monitor ELECTRA-flo with number of sensors required by manufacturer for the specific application.

B. Large vav box airflow measuring stations shall be Ebtron Silver series or Air Monitor ELECTRA-flo.

C. It will be the responsibility of this section to provide the necessary power for the airflow measuring station.

D. Each airflow measuring station installation shall be field supervised and final installation certified by a qualified representative of the manufacturer. A manufacturers field certification report shall be submitted at project completion.

PART 3 - SEQUENCE OF OPERATION

3.1 VAV FAN SYSTEMS

A. The VAV fan systems each consist of a supply fan driven by a VFD or VFD's will be added if they are not present on the fan motors, filters & outdoor air, return air and relief air dampers.

B. The supply fan shall be started from a local DDC controller through an "OFF-AUTO" switch, located on the face of the VFD bypass panel. The initial occupied time schedule shall be 6:30 A.M. to 4:00 P.M. Monday through Friday.

C. In "OFF" position, fan shall be stopped, and in "AUTO" position, fan shall be on during OCCUPIED mode and cycled to maintain minimum space temperature when in the UNOCCUPIED mode.

D. Fan system operation in AUTO mode shall be subject to a new freezestat, building fire alarm, new supply duct high static pressure, building optimal start-stop programs, and other conditions or logic pre-programmed into the DDC controllers.

E. If the fan system is shut-down, or fails to start due to abnormal conditions, an alarm shall be sent to the DDC system. When the fan is stopped under any condition, the outside air damper and relief air dampers shall close.

F. Hawkeye style analog current transmitters shall be installed on each fan in the fan wall system and wired in series. If any fan in the fan wall system fails to start, this fan failure point shall indicate a fan alarm to the DDC system.

G. Fan status for proof of fan operation shall be by measuring the amps from each VFD to validate air flow.

H. A manual reset, high limit pressure switch within the fan room sensing supply duct static pressure shall shut down the fan and alarm the DDC system if its 3" wc setting is exceeded.

I. Whenever the outdoor air temperature exceeds 76° F, the outside air and relief air dampers shall close to the minimum position as determined by the return duct CO2 level transmitter and minimum air flow requirements.

J. The outside air and return air dampers shall sequence as follows:

   a. When no outside air is required, the outside air dampers shall be shut and the return air dampers shall be 100% open.
   b. As outside air is required by the air handler for minimum outside air or economizer purposes, the outside air dampers shall begin to modulate open. During this time the return air dampers shall remain 100% open.

c. At 50% outside air flow, both the outside air dampers and the return air dampers shall be 100% open.
d. As more than 50% outside air flow is required, the outside air dampers shall remain at 100% open and the return air dampers shall begin to modulate closed.
e. The reverse shall occur as less outside air is required.

K. A 0-5" w.c. supply duct static pressure transmitter with its static tip located 2/3 of the way down the supply duct and acting through a DDC controller shall modulate supply fan speed to maintain the supply duct static pressure set point as described below:

L. The supply duct static pressure set point shall be continually adjusted by the DDC controller through a PID control loop. The intent of this control loop is to ensure that the supply fan VFD operates at the lowest possible speed to maintain air flow requirements on all VAV boxes. The supply duct static pressure PID control loop shall adjust the discharge set point between 0.2" and 1.5" w.c. (adjustable) as required.

M. A CO2 level transmitter located in the return air duct, acting through a DDC controller, shall reset the outside air damper minimum position. The amount of reset action shall be adjustable and subject to a maximum of 25% minimum outdoor air.

N. An averaging style mixed air temperature sensor, acting through a DDC controller, shall provide 48°F mixed air temperature low limit control of the air handling system.

O. If mixed air temperature drops below 39°F as sensed by an electrically interlocked averaging style freeze stat, supply fan shall stop, outdoor and relief air dampers shall close and an alarm shall be sent to both the local and District Offices Host Computers.

P. A –0.25 to 0.25"w.c. static pressure transmitter with an outside probe, must be a Dwyer A306, and an interior probe strategically located in an interior hallway in area served by the correct fan system, acting through the DDC system shall modulate the relief dampers in sequence to maintain 0.04"w.c.building static pressure. Individual control of the supply fan speeds shall be achievable by the DDC system controller.

Q. A temperature sensors shall be located inside of the building under each relief damper and within 4 feet of its opening to the outside. This temperature sensor shall be included as a low building space temperature reading. During extreme weather conditions this sensor is intended to prevent pipes and other equipment in the building from freezing. If any of these sensors fall below 50 degrees in the unoccupied mode, the fan system shall start to supply warm air to the plenum. Also, if any of the sensors fall below 35 degrees the relief dampers shall be commanded closed.

R. The DDC system shall also provide negative building pressure control for the space that it serves. If the building static pressure begins to fall below the minimum building static pressure set point of 0.01"w.c., the controller shall send a signal to the outside air dampers to open to allow negative building pressure control.

S. UNOCCUPIED mode: The lowest space temperature sensor served by the air handler, acting through a DDC controller, shall cycle the supply fan with the heating valve open 100% to maintain desired minimum space temperature.

T. Outdoor air & relief dampers shall remain closed. When the supply fan is not running.

U. No override buttons are provided on site, if system needs to be overridden they will call it into the controls division.

V. Daily runtime of EACH fan system shall be logged and displayed on the air handler graphic page. The runtime value shall be reset at the end of each day and the runtime of the fan shall be logged.

W. Filter pressure sensor with gauge.

X. Outdoor air flow monitors to measure and report CFM to BAS system.

3.2 FIRE ALARM FAN SHUT-DOWN: (All Fan Systems)

A. All heating, ventilating and air conditioning system supply fans shall automatically shut off when the building fire alarm system is energized. All fans to automatically start up again when fire alarm system is reset. Fire alarm system fan relays shall be "normally energized" and shall be installed by Division 26 at each fan system.

3.3 FAN SYSTEM FILTER BANK ALARMS

A. A differential pressure indication control element with its static pressure tips located across each fan system filter bank & makeup air unit filter bank shall provide the DDC system with the differential pressure drop across each filter bank. An alarm shall be supplied to the DDC system whenever the filter differential pressure remains above 0.35" w.c. for more than 15 continuous minutes.

3.4 HOT WATER HEATING SYSTEM CONTROL

A. The building heating water heating system consists of two boilers and two boiler heating water pumps.

B. Boilers and associated pumps are enabled when OAT is less than 60 Deg F. (adjustable). HW variable frequency pumps (P-1 & P-2) shall be monitored and controlled by the DDC. HW supply and return temperature shall be monitored by a Stainless Steel temperature sensor mounted in a Stainless Steel thermal well.

C. There are two variable speed building heating water pumps. Pumps operate during the OCCUPIED and WARM-UP modes and are each rated at 100% of the building load. Pumps shall be operated via a system pressure differential switch. Location to be determined.

D. When the panel mounted toggle HAND-OFF-AUTO (H-O-A) switches are in the AUTO position, these pumps will be controlled by the building energy management system. During the OCCUPIED or WARM-UP modes, if the outside temperature is below 72 degrees F., pump will start. Pumps shall lead/lag based on schedule from the DDC system.

E. When the panel mounted toggle HAND-OFF-AUTO (H-O-A) switch is in the AUTO position, the boiler is enabled by the building management system. The boilers will be enabled whenever one or more of the heating pumps are running. Once enabled, the boilers operate from their operating and safety controls.

F. When air handling units are off, the DDC system shall command the hot water valves closed.

G. If any of the space temperatures falls below 50 Deg F. (adjustable), the building DDC shall generate an alarm.

H. Static water pressure transmitters with pressure sensing taps located in both the heating water supply & return lines at locations approved by the Mechanical Engineer and acting through a DDC controller shall modulate the speed of the hot water pump(s) to maintain desired hot water system differential pressure. (Initial differential pressure setting shall be 10 psig) The first heating water pump shall start & run continuously when the outdoor air temperature is 75° F or lower. The second pump shall start and run in parallel with the first pump when the outdoor air temperature is below 35° F.

I. If a hot water pump is not running when commanded to do so by the DDC system, the other hot water pump shall automatically start & an alarm shall be sent to the DDC system.

J. When water flow through a boiler is detected by a paddle-type water flow switch located in the return water line to the boiler, the boiler control system shall be enabled.

K. Once enabled by the school district controls the boilers shall be staged on a lead-lag basis through the boiler management controls system, the boiler valve will open and turn on the local boiler pump. The lead boiler shall automatically alternate every month. The lag boilers shall operate only when the lead boiler cannot maintain the desired hot water supply temperature per the outdoor air temperature reset schedule shown below. If for nay reason the lead boiler fails, the lag boiler shall energize to maintain building water temperature. Provide a hard wired start/stop on the boiler management system for the lead boiler. If a boiler goes into alarm send notification to Davis School District controls system and sequence on the next backup boiler. Davis School District controls system to send the boilers system a firing rate.

L. Interlock the boiler controls to allow operation only when automatic valve opens and water flow exists through the boiler as determined by a flow switch installed in the boiler's heating water piping.

M. Provide interlocks with each boiler alarm system to alarm the DDC system if boiler shuts down due to flame failure, etc. or if boiler does not fire when commanded to do so.

N. Provide remote reset of unit from controls at main Dist. Office.

O. Provide analog temperature sensors in immersion wells in the hot water supply piping of each boiler as well as the main supply and return water lines leaving the boiler room.

P. A local DDC controller with analog temperature sensors located in both the supply water and the outdoor air shall modulate hot water reset to maintain building supply water temperature (reset from outdoor temperature) as follows (ADJUSTABLE):

Outdoor Air Temperature	Supply Water Temperature
70°F	90°F
0°F	180°F

Q. This sequence shall incorporate proportional plus integral (PI) control algorithms to minimize offset from setpoint.

3.5 DOMESTIC HOT WATER

A. The DDC system shall enable and disable the domestic hot water heaters based on occupancy schedule.

B. The emergency shutdown switch(es) when activated must disconnect all power to the Domestic Water Heaters.

3.6 EMERGENCY SHUTDOWN SWITCHES (Boilers B-1,& B-2& Water Heaters)

A. A remote mushroom type, single acting, manually reset, shutdown switch shall be located just inside the boiler room door and marked for easy identification. A pilot light shall illuminate whenever the push button is pressed. If there is more than one door to the boiler room, there should be a switch located at each door.

B. The emergency shutdown switch(es) when activated must disconnect all power to the boiler burner controls. A visual alarm indicator of a different color than the building fire alarm indicators shall be activated when the boilers are shutdown.

3.7 EXISTING EXHAUST FANS

A. Exhaust fans shall be individually operated by pre-determined schedules from the building DDC system. There will be an enable and status point for each fan.

3.8 EXISTING LIGHTING CONTROL

B. Add to lighting control system a solar light sensor. District to program this sensor into the BMS.

3.9 EXISTING UNIT VENATALORS

A. Unit Vent Heaters shall be individually operated by pre-determined schedules from the building DDC system. There will be an enable and status point for each fan.

B. Replace the pneumatic control valves, pneumatic damper actuators, and thermostats with new electronic DDC style.

C. In the unoccupied mode the UVH will be enabled any time the space temperature drops below 60 degrees and then turns off when it reaches setpoint.

3.10 CEILING CLASSROOM FIN TUBE HEATERS

A. A FT Heaters shall be individually operated by pre-determined schedules from the building DDC system. Space temperature shall modulate the reheat coil valve in sequence to maintain the desired space temperature.

B. In the unoccupied mode the FT will be enabled any time the space temperature drops below 60 degrees and then turns off when it reaches setpoint.

3.11 BUILDING ENERGY METERS

A. The ATC contractor shall provide and install an electric KWH meter on the main building power entrance. The power data shall be displayed on the graphics pages which shall include: Current KW demand, Daily High KW demand, Monthly High KW demand, Daily Total KWH consumption, and Monthly Total KWH consumption. Daily power data from the power meters shall be logged into the database of the control system. The control system shall generate reports showing the history of the power usage in the building by month, by year, or month to month or year to year comparisons. The ATC contractor shall provide all necessary hardware and software.

3.12 ALTERNATE #1 VAV BOX CONTROL W/ REHEAT COILS (REPLACEMENT)

A. Room space temperature sensing shall be from wall-mounted temperature sensing elements with adjustable set points. A duct style temperature sensor shall be installed at each VAV box air discharge.

B. The ATC contractor will wire to the room occupancy sensor supplied and installed by divison 26 for lighting. The division 26 contractor will provide occupancy sensors with a dry contact for use by the ATC contractor to hard wire directly to the VAV box controllers. The VAV controller will be programmed to go to unoccupied set points when no occupancy is detected by the sensor. Upon occupancy detection, by the lighting sensor, the VAV box controller will automatically return to occupancy set points and operation provided the building occupancy schedule and/or the schedule for the VAV box zone is on by the master DDC control system schedule.

C. Each VAV box shall display current KBTU discharging into the space. The ATC contractor shall provide all hardware, software and configuration to provide KBTU per VAV box. Values shall be displayed on the graphic pages, trended and alarmed with user adjustable alarm limits. The DDC system shall accumulate KBTU going into the space to display daily total heating KBTU and daily total cooling BTU consumed. The KBTU totals shall be logged into the controls database and utilized for required energy alarming. BTU per square foot, as determined by the area served square footage shall be displayed per VAV box and configured for high per square foot alarming.

D. The occupancy schedule for the 3-position VAV controller shall be adjustable and configured in the DDC system. The DDC control system shall return the VAV box to an unoccupied state as determined by the building occupancy time schedule (adjustable). Unoccupied set up and set back settings shall be configured and completely adjustable.

E. Classroom VAV control shall interface with room occupancy sensors to shut box to 100% closed during unoccupied mode during school hours. Boxes shall re-set to minimum setting during night set-back.

F. A VAV box-mounted DDC controller shall be provided for control and operation of each VAV box and reheat coil. Sensor shall modulate the box primary air damper between minimum ventilation position and maximum designed airflow and position the reheat coil valve in sequence to maintain the desired space temperature. Heating and cooling set points shall be individually adjustable from the man-machine interface device (Host computer) or the District offices.

G. Each VAV box shall be configured for central plant heat mode which shall reverse the operation of the VAV damper to open for heating instead of cooling whenever the air handler is in the warm-up mode.

H. Each VAV box shall be configured and programmed for CFM set point modulation based on system variable such as CO2. The ATC contractor shall demonstrate the program and the freely programmable VAV DDC controller.

I. Each VAV box DDC controller shall have a 24-volt power connection with all 24-volt control wiring by the ATC contractor. 24 volt transformers shall be located in the DDC controller of the air handler serving the VAV box for ease of maintenance.

SECTION

AUTOMATIC TEMPERATURE CONTROLS

PART 1 - GENERAL

1.1 GENERAL CONDITIONS

A. The General Conditions, Supplementary General Conditions, alternates and addenda, applicable drawings and the technical specifications, shall all apply to all work under this division.

1.2 SYSTEM DESCRIPTION

A. A system of DDC automatic temperature controls shall be furnished and installed as a part of this contract to give the owner a completely operable system. Acceptable manufacturers and installers shall be Schneider Electric by Utah Controls Inc. of Draper, Utah as an extension of the existing District DDC system.

B. The DDC system shall incorporate a Netplus router or AS for networking system to tie this facility directly into the District's Ethernet campus wide system. All networking software and DDC interface software shall be provided under this section to seamlessly connect this facility to the network. This contractor shall coordinate with the District's IT department to obtain all IP addresses and network clearances to connect the DDC system to the Ethernet network.

C. The Host computer software located at the District maintenance office shall be upgraded to the most current revision of INET Revision 2.42.

D. The system shall be as indicated on the drawings and specified herein. Building HVAC systems and unitary heating devices shall be entirely controlled by the DDC system. System shall include local DDC controllers mounted at each fan system, VAV box, fan-coil unit and cabinet unit heater. These local DDC controllers shall be interconnected by a 2-wire LAN (local area network) with a master/central DDC controller located in the Maintenance office. The master/central DDC controller, in turn, shall communicate with the existing school district host computer located in the district offices. The graphics on the computer shall display on separate, bit-mapped color screens each fan system, VAV box, cabinet unit heater, central heating system and central cooling system. Each screen shall have available for display in the appropriate location each input and output point monitored or generated by the DDC system. All digital output points shall have override capability. All screens shall be password protected so that sensitive data cannot be easily corrupted by inexperienced operators while allowing complete access to trained maintenance personnel. All of the above screens, data and features shall also be available for monitoring and modification from the Host computer located in the District offices via a Netplus router.

E. All system and unitary controls shall be of the direct digital type (DDC). Self-tuning PID (Proportional, Integral, and Derivative) control algorithms shall be applied where applicable on all applications. The control system shall be a networked, distributed intelligence system, with the control loops for each system being capable of stand-alone operation.

F. The system shall include all control devices, valves and damper parts as called for hereinafter.

G. Manufacturers and installers other than listed in 1.2 A must demonstrate to the owner the ability to communicate to the existing district wide DDC system and obtain written prior approval.

1.3 SCOPE

A. Will be to remove all of the pneumatic controls and replace them with a new control system which shall consist of electronic type DDC, direct digital controllers, input/output modules, ATC interface panels, and accessory equipment for a completely installed system of automatic temperature controls.

1.4 WORK TO BE PERFORMED BY OTHERS

A. Division 16 shall furnish and install all single phase and multiple phase electrical power wiring to magnetic starters, disconnect switches, VFD's and motors. He shall also provide 120 VAC, 20 Ampere power sources to each group of ATC panels and VAV boxes as shown on the electrical plans. The ATC contractor shall be responsible for all 24 VAC wiring to ATC equipment.

B. The sheet metal contractor shall install all dampers supplied by the ATC contractor. Each damper shall be installed so that it will operate freely and without binding. To insure that the damper both opens and closes completely with less than 7#/sq. ft. torque applied at the operating shaft, each damper shall be checked after its installation, but before the damper actuators are attached.

C. The mechanical contractor shall install all valves, immersion wells and pressure taps supplied him by the ATC contractor.

1.5 INSTALLATION BY AUTOMATIC TEMPERATURE CONTROL (ATC)CONTRACTOR

A. The ATC contractor shall furnish and install all necessary electrical control wiring for the complete temperature control system, heating and ventilating equipment motor starting circuit controls and all electrical control interlocks for same, and for control wiring for miscellaneous HVAC equipment furnished by the Owner.

B. The ATC contractor shall furnish & install all necessary electrical control wiring of all temperature controls, heating and ventilating equipment motor starting circuit controls, all electrical control interlocks for same and for miscellaneous packaged equipment.

C. All line and low voltage electrical and control wiring shall be installed in EMT conduit in exposed or inaccessible areas in accordance with the National Electrical Code and applicable local codes and in compliance with Division 16. Plenum cable may be installed in accessible areas.

1.6 QUALITY ASSURANCE

A. Provide an unconditional **TWO-YEAR** parts and service warranty. This warranty shall commence at the time of demonstration of system completion of all portions of the ATC system.

B. Emergency response by contractor shall be available 24 hrs/day 7 days/week 365 days/yr. Response time shall not be greater than 12 hours from time of call.

C. All parts and material and their installation methods shall be in accordance with the manufacturer's recommendations and specifications. All parts and material shall be new.

D. The Contracting firm executing the work of this section shall have at least 5 years' in business and experienced in completing work of similar scope and nature to that specified. The firm shall be a licensed electrical contractor in the state of Utah. The contractor shall be a local authorized agent of the DDC system manufacturer.

1.7 SUBMITTAL AND TECHNICAL INFORMATION

A. Submit shop drawings (6 sets) and manufacturer's data for the following items to the mechanical engineer:

1. Wiring and installation diagrams.
2. ATC device specification sheets
3. Point list
4. Control flow diagrams, complete with all control schematics and sequences of operation.
5. Documentation of all software and hardware. These manuals shall be complete with installation procedures as well as start up and programming instructions. They should also contain any testing or maintenance procedures required to operate system on a continuing basis.

1.8 PROJECT COMPLETION REQUIREMENTS

A. Upon completion of the project, the ATC contractor shall spend the necessary time with the building's operating personnel to adequately instruct them on the operation of the system. These training sessions shall be scheduled at times convenient to the School District and shall be conducted at the project.

B. Provide 5 copies of the project operating and maintenance instruction manuals for use during the training sessions. Each manual shall contain both a current hard copy and a CD Rom of all DDC system programming.

C. The ATC contractor shall provide as part of his contract the on-site services of a programmer familiar with the system for an additional 24 hours, which the Engineer and/or the School District may use as they see fit to fine-tune or add features to the system.

D. The ATC contractor shall provide as part of his contract the on-site services of a technician familiar with the system to assist the air & water balance contractor in completing his portion of the project. The technician shall be available for a minimum of an additional 32 hours for this assistance.

E. Operation & Maintenance Manuals: Provide 5 manuals in addition to those manuals specified above. These manuals shall provide descriptions of maintenance procedures for all system components, including sensors and controlled devices. They shall cover inspection, periodic preventative maintenance, fault diagnosis, and repair or replacement of defective components. They shall include complete as-built ATC installation drawings with sequences of operation for all mechanical systems controlled by the ATC contractor. They shall each include both a hard copy & diskettes of all as-built system programming.

PART 2 - EQUIPMENT

2.1 DDC INPUT DEVICES

A. All DDC input devices shall provide industry standard signals and shall be compatible with the DDC controllers used.

B. All temperature input devices shall have a rated accuracy of 1% or better.

C. All pressure input devices shall have a rated accuracy of 2% or better. Pressure transmitters shall be selected to match the application, and shall not be damaged by pressures at five times the maximum measurable pressure.

D. Miscellaneous input devices shall have accuracy's as individually specified.

2.2 DDC OUTPUTS

A. Modulating outputs shall be in accordance with industry standards and shall be compatible with the driven DDC devices.

B. DDC digital outputs shall be either relay contact closures or Triacs rated for the application.

2.3 DUCT SMOKE DETECTORS

A. Duct smoke detectors are to be furnished and wired by Division 16. Detectors shall be installed by the ATC contractor.

B. Division 16 shall furnish & install a fire alarm/fan shutdown relay at each fan system. The ATC contractor shall wire between the alarm relay contacts and the fan system starter to lock out the supply fans when the building is in fire alarm.

2.4 AUTOMATIC VALVES

A. ATC valve bodies 2" and smaller shall be screwed; larger valve bodies shall be flanged. Screwed valves shall be rated at 150 psi or greater and shall have cast iron or brass bodies. Flanged valves shall be rated at 250 psi or greater and have cast iron or steel bodies. All automatic valves shall be for DDC control application.

B. Shut-off pressure ratings of each valve shall be as required by the application.

C. The valves shall be manufactured by TAC or Honeywell.

2.5 MOTORIZED ATC DAMPERS

A. Motorized control dampers that are not supplied with the air handling units shall be furnished by the Automatic Temperature Control Contractor. Dampers shall be factory-built, low leakage units such as Ruskin CD-50 or approved equal. Blades shall be 6" maximum width, 6063-T5 extruded aluminum width, 1/2" axles, and Oilite or Cycoloy bearings.

B. Frames shall be 5" x 1", 6063-T5 extruded aluminum hat channel design, 0.125" minimum thickness with corner braces to assure squareness.

C. Dampers shall be low leakage type with compressible end seals and neoprene or extruded vinyl blade and jamb seals. Leakage shall not exceed 6.2 cfm/sq. ft. at 4" W.G. Dampers shall require less than 7#-in/sq. ft. torque at the operating shaft for proper operation.

D. Outdoor & return air dampers shall be parallel blade with blade direction oriented to assist mixing of air streams. Relief air and other volume control dampers shall be opposed blade.

2.6 DAMPER AND VALVE ACTUATORS

A. Damper and valve actuators shall be of the gear-train type. All moving parts shall be permanently lubricated and not require addition or replacement of oil. Actuators shall meet the NEMA 3R rainproof rating and shall have an ambient temperature operating rating of -40°F to 140°F, without the addition of extra equipment. Actuators shall also carry the UL 94-5V rating for installation in return air plenums.

B. Damper and valve actuators shall accept the appropriate Ma, VDC or digital output signals provided by the DDC controllers.

C. Damper actuators shall be mounted outside the air stream whenever possible and be of sufficient size to operate the connected damper. Mount damper actuator on firm baseplate.

D. Damper actuators linked to outdoor air and relief air dampers shall close their attached dampers upon power failure or fan shutdown.

2.7 ROOM TEMPERATURE SENSORS

A. Wall mounted space temperature thermostats shall be installed in wall boxes and shall include an adjustable setpoint in occupied areas.

B. Wall mounted space sensors for areas subject to abuse such as the Gymnasium shall have the sensor mounted on a wood mounting bracket and have a heavy duty, key locking, metal protective guard.

2.8 CO2 LEVEL TRANSMITTERS

A. CO2 level transmitters shall be suitable for duct mounting and shall have an averaging sensor whose length is the width of the return air duct. CO_2 sensors shall be self calibrating, if regular calibration of the sensor is required, a calibration kit shall be supplied to the owner. Output signal shall be 0-5 or 0-10 VDC as required by the DDC system.

B. CO2 sensors for the gym space and common space shall be room type mounted adjacent to the space thermostat with similar heavy duty steel protective guards.

2.9 OUTSIDE AIR SENSOR

A. The outside air temperature sensor shall be contained within a wooden instrument enclosure. The location and design of such shall provide a signal to the DDC system that is accurate to within +/- 2 degrees F, regardless of building mass, sun location or other environmental conditions.

2.10 HOST COMPUTERS

A. The School District facility management and control system includes an existing Centralized Host computer currently located at the District offices.

B. A Automation Server (AS) Router shall be provided and installed to allow connection to the existing school district HVAC monitoring network. The school district shall provide all necessary IP addresses and a connection port onto their existing Ethernet network.

C. Copies of all software disks, operation manuals, along with installation instruction shall be provided to owner.

D. The controlling software database shall be constructed by the ATC contractor to provide a fully operational DDC control system that may be monitored, controlled & modified from the District Centralized Host computer. All control schedules, algorithms, and control logic shall be in place within each DDC controller and stored as back-up copies on both Host computers hard disks which may be down-loaded to individual DDC controllers as necessary. Documentation provided shall include block software flowchart showing the interconnection between each of the control algorithms and sequences.

E. The building shall be represented by complete graphical floor plans, with accurate locations of each major piece of HVAC equipment. Each major piece of HVAC equipment shall be graphically represented at each Host computer with all appropriate DDC points dynamically represented.

F. All designated building alarms shall be automatically reported as they occur as determined by the Davis School District.

2.11 MASTER DDC CONTROL PANEL (IF REQUIRED)

A. The master DDC controller shall provide to the Host computer (s) diagnostic reports of the following types, for all DDC devices:
   1. When specified alarm conditions occur, provide a report internally listing the status of specific items associated with the equipment generating the alarm.
   2. Report shall be routed to the local Host computer, District Host computer or other combinations of computers via modem as designated by the owner. Depending on the time of day, the owner shall specify up to five sites to which exceptions shall be auto-dialed and reported. This shall allow the owner to assign off hours exception responses to various facility personnel as necessary. Selection of the sites to be dialed can be programmed by the owner, and set to change automatically per time of day and day of week. Information may be duplicated to multiple combinations of locations.
   3. Report shall record the time the status information was taken, and shall allow operational personnel to use this information to diagnose the alarm situation.
      a. Trend logs.
      b. Energy reports.
      c. Exception tables/by operator
      d. Override information table/by operator
      e. Run time information on equipment
      f. Review of specific facility information by operators.
      g. Building information for information display

B. All programming defining the functions to be performed by the master DDC control panel from loss due to power failure for a minimum of six months.

C. The master DDC control panel shall be multi-tasking and shall provide the capability to simultaneously perform at least, but not limited to, the following functions:
   1. Down loading of application program changes without affecting the simultaneous operation of existing operating application programming.
   2. Operator access to the entire network of local digital controllers.

2.12 LOCAL DDC CONTROL PANELS (IF REQUIRED)

A. Local DDC control panels shall be located near mechanical systems as necessary to provide both digital and analog input and output points as specified and/or required to achieve specified system performance.

B. Each local DDC control panel shall provide all control functions for the mechanical equipment specified to be controlled from that panel.

C. Every input and output point shall be well labeled and every digital output shall have a LED indication of the position of the output relay.

D. ATC contractor shall provide documentation of the software application program for each digital controller.

E. Documentation provided shall include block software flowchart showing the interconnection between each of the control algorithms and sequences.

F. System acceptance shall not be completed until this documentation is provided and located in each ATC interface panel.

G. Systems providing modulating outputs via pulse width modulation techniques shall provide within each ATC interface panel all the components required to implement the functions equivalent to an analog output.

2.13 ATC INTERFACE PANELS (IF REQUIRED)

A. ATC interface panels shall be mounted near each group of local DDC controllers other than VAV box controllers. Each panel shall be made of not less than 16 gauge steel. Panel shall have a full back plate and full hinged door such that when the door is closed, the assembly provides a completely enclosed, NEMA 1 enclosure. Panels shall be fully painted and fitted with key locks. Appropriately sized nameplates shall be used to identify all panel mounted devices. Major wiring within panels shall installed within distribution gutters (similar to Panduit). All wiring entering and leaving panels shall terminate on numbered terminal strips. All wiring within panels shall be color coded and the color shall not be changed between the terminal strip and the end destination of that wire. Panels shall contain wiring diagrams of the panel interior and associated devices. Diagrams shall identify all interior devices and shall include terminal numbers.

B. Panels shall contain the following devices as applicable:
1. Control transformers
2. NEC required fusing
3. Local DDC controllers (contractor option)
4. NEC required grounding
5. Logic relays
6. 120 VAC convenience outlet
7. Air pressure transmitters
8. Control switches
9. Pilot lights
10. Terminal strips

2.14 LABELING

A. All ATC supplied devices shall be permanently labeled with labels indicating device name, system identifier and function within the system. All labels external of the DDC controls cabinets shall be of the engraved type.

PART 3 - SEQUENCE OF OPERATION

3.1 SEE PLANS AND DRAWINGS

3.2 FIRE ALARM FAN SHUT-DOWN: (All Fan Systems)

A. All heating, ventilating and air conditioning system supply fans shall automatically shut off when the building fire alarm system is energized. All fans to automatically start up again when fire alarm system is reset. Fire alarm system fan relays shall be "normally energized" and shall be installed by Division 26 at each fan system.

3.3 FAN SYSTEM FILTER BANK ALARMS

A. A differential pressure indication control element with its static pressure tips located across each fan system filter bank & makeup air unit filter bank shall provide the DDC system with the differential pressure drop across each filter bank. An alarm shall be supplied to the DDC system whenever the filter differential pressure remains above 0.35" w.c. for more than 15 continuous minutes.

3.9 EXISTING UNIT VENATALORS

A. Unit Vent Heaters shall be individually operated by pre-determined schedules from the building DDC system. There will be an enable and status point for each fan.

B. Replace the pneumatic control valves, pneumatic damper actuators, and thermostats with new electronic DDC style.

C. In the unoccupied mode the UVH will be enabled any time the space temperature drops below 60 degrees and then turns off when it reaches setpoint.

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pipe and Fittings.

B. Gas Meter.

C. Gas Pressure Regulator.

D. Flexible Connectors and Quick Couplers.

E. Earthquake Shut-off Valve.

1.2 RELATED REQUIREMENTS

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.

B. Section 230500 - Basic Mechanical Requirements.

1.3 RELATED SECTIONS

A. Section 230529- Basic Mechanical Materials and Methods: Valves, pipe hangers, supports and accessories.

B. Section 230548 - Mechanical Seismic Control.

C. Section 224450 - Plumbing Equipment: Gas supply and runout with gas cock or valve to water heater connection points.

D. Section 224460 - Special Plumbing Equipment Systems: Gas supply and runout with gas cock or valve to connection points on all kitchen and laboratory equipment, headers or modules.

E. Section 235200 - Boilers: Gas supply and runout with gas cock or valve to boiler connection points.

F. Section 235400 - Fuel Fired Heaters: Gas supply and runout with drip leg and gas cock or valve to heater connection points.

G. Section 237400 - Air Handling Systems on Roof: Gas supply and runout with gas cock or valve to rooftop packaged air handler connection points.

1.4 REFERENCES

A. NFPA 54 (ANSI Z223.1) - National Fuel Gas Code.

B. ANSI Z223.1a - Supplement to National Fuel Gas Code.

1.5 DEFINITIONS

A. The following are references with definition acronyms used in this section:

1. U.L. - Underwriters Laboratory Listed for Fire Protection Systems.
2. F.M. - Factory Mutual Engineering Division.
3. IRI - Industrial Risk Insurors AKA: F.I.A. Factory Insurance Association.
4. Jurisdictional Agencies:

a. Building Department.
b. Fire Department or Fire Prevention Bureau or Marshal.
c. Insurance Agency, Carrier, and/or Underwriter.
d. Engineer refers to the consulting Mechanical Engineer of record.

1.6 SYSTEM DESCRIPTION

A. Provide gas supply from street main to building meter (When gas supply company does not provide) and from gas meter outlet to all gas consuming equipment complete with piping, meters, valves, unions, dirt legs, hangers, supports, anchors, expansion compensators and regulators.

1.7 QUALITY ASSURANCE

A. Welding: Welders shall be certified in accordance with requirements in Section 230529.

1.8 REGULATORY REQUIREMENTS

A. Conform to Regulatory Requirements listed in Section 230500.

B. Provide special inspections required in IBC Chapter 17.

1.9 SUBMITTALS

A. Submit Product Data for the following items under provisions of the General Conditions of the Contract:

1. Pipe, fittings, valves, hangers and supports.
2. Gas solenoid valves, cabinets and controls.
3. Regulators.
4. Meters.
5. Earthquake Shut-off Valves.

B. Submit printed Operating Instructions and Maintenance Data for the following items under provisions of Operating and Maintenance Data paragraph in Section 230500:

1. Gas solenoid valves and controls.
2. Regulators.
3. Meters.
4. Valves.
5. Quick Couplers.

6. Earthquake Shut-off Valves.

C. Submit certified test reports, dated and signed by authorized person showing compliance of tests of the fuel gas systems, in accordance with the Contract Documents.

1.10 SEQUENCING/SCHEDULING

A. Coordinate all work with all other trades and utility companies for elimination of interference, utilization of combined hanger support systems, timely routing and installation of systems, verifications of existing connector utilities, locations, depths, connection regulation, proper valving and junction structures or fittings. Location of meters, and remote readers as applicable and appropriate.

1.11 WARRANTIES

A. Provide original copies of all warranties for specific equipment where specified and in accordance with Section 230500.

B. Provide 20 year full warranty on all cathodic protection and pipe wrapping against corrosion of piping due to electrolytic or active soil conditions.

1.12 GAS SERVICE

A. Arrange with Utility Company to provide gas service to indicated location with shut-off at terminus. Consult with Utility as to extent of its work, costs, fees and permits involved. 231123 Contractor shall pay such costs and fees; obtain permits.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Buried Exterior (meter and building service):

1. Pipe: Schedule 40 Black Steel ASTM A-53 pipe for butt welding or plastic piping as defined below when acceptable jurisdictional authorities.
2. Fittings: Butt weld steel, ASTM-234.
3. Wrapping: Scotchwrap 10 mil PVC tape or Standard of serving Utility Company.
4. Contractor's Options, when acceptable to jurisdictional authorities:

a. Natural Gas:

1) High Density Polyethylene pipe and fittings; ASTM D-3350:335434C, PPI:PE 3408/3406, Type III, Grade P34 Category 5 per ASTM D 1248, SDR 11 pipe.

2) Polyvinylchloride natural gas pipe and fittings:

Size 1/2" thru 1-1/2": Sch. 40 Type 1 PVC 1120, IAPMO: 15-10-71, ASTM D 1785.

Size 2" thru 6": Class 315 Type 1 PVC 1120, IAPMO: 15-10-71, ASTM D 2513.

B. Interior Exposed or Accessible:

1. Size 1/2" thru 1-1/2":

Pipe: Schedule 40, ASTM A 53
Fittings: Threaded malleable iron
Joint Seal: Teflon
Unions: Black malleable iron ground joint, bronze to iron seat, 150 lb. class, ANSI B2.1 and ASTM A 197.

2. Size 2" and over:

Pipe: Schedule 40, ASTM A53, Type S Grade B
Fittings: Butt weld ASTM A 234
Unions: 150 lb. forged steel weld neck flange, ANSI B16.5 and ASTM A105.

C. Interior, concealed, non-accessible spaces and return air plenums:

Use no unions, tubing fittings, right or left couplings, bushing, shut-off valves, compression coupling, or swing joints made by combinations of fittings.

2.2 GAS PRESSURE REGULATOR

A. General: Provide single stage, steel jacketed, corrosion-resistant gas pressure regulators with atmospheric vent, elevation compensator; with threaded ends for 2" and smaller, flanged ends for 2-1/2" and larger; for inlet and outlet gas pressures, specific gravity, and volume flow required.

B. Provide vent-limited or vented gas pressure regulators as required by appliance served. Vented regulators shall be piped to vent to outdoors per jurisdictional requirements.

2.3 FLEXIBLE HOSE GAS CONNECTORS AND QUICK COUPLERS

A. Manufacturers:

Flexible Connector: Thermo-Tech Products Co. or approved equal.
Quick Coupler: Hansen Manufacturing Co. "Gas Mate" or approved equal.

B. Description:

Flexible Connector: Corrugated type 304 stainless steel flexible pipe with stainless steel braid and heavy flexible armor shield.

Quick Coupler: One way quick coupler with gas rating in cubic feet per hour equal to equivalent gas appliance rating.

PART 3 - EXECUTION

3.1 GENERAL

A. Welding, wiring, sleeves, plates and closures, foundations and pads, excavation and backfill, cutting and patching and installation of piping, valves, pipe hangers, supports, expansion compensators and identification shall be in accordance with Section 230529 - Basic Mechanical Materials and Methods.

C. Provide all fuel gas piping from source to each connection point of all gas fired equipment items listed in "Related Work" paragraph in Part 1. Provide drip leg and gas cock or valve for each equipment item. Make final connections in compliance with equipment manufacturer's instructions. Flexible connections will not be allowed except where explicitly specified.

3.2 PIPING

A. General:

1. Install fuel gas distribution piping in accordance with jurisdiction codes and local Utility Company requirements and in conformity with standards listed in "References" paragraph in Part 1.
2. Install "Tee" fitting with bottom outlet fitted with full size 6" long nipple and capped, at bottom of pipe risers or drops.
3. Use dielectric unions where dissimilar metals are joined together.
4. Use Teflon joint seal on metal gas piping threads, make up with 3 threads showing.
5. Remove cutting and threading burrs before assembling piping.

6. Do not install defective piping or fittings. Do not use pipe with threads which are chipped, stripped or damaged.
7. Plug each gas outlet, including valves, with threaded plug or cap immediately after installation and retain until continuing piping, or equipment connections are completed.
8. Connections to all gas-fired equipment shall include a union downstream of the manual gas shut-off valve.
9. For piping buried in building substrate, or below floor slabs, install in welded conduit, ventilated to outdoors on both ends, and tested to same requirements as gas piping.
10. For buried piping outside of building walls, piping shall rise out of ground 12" before penetrating building wall.
11. Provide exterior gas piping and fittings with primed and painted surface. Coordinate color with Owner, Architect, and authority having jurisdiction.

B. Buried Piping: Welded and wrapped with joints left exposed until testing has been accepted. Bury 24" below grade minimum.

D. Wrapping:

1. Provide factory applied pipe wrap in accordance with standard of serving utility company. Hand wrap or machine wrap buried exterior gas piping with Scotchwrap 10 mil PVC tape using 50% overlap wrap minimum. Double wrap fittings and joints. Extend fitting wrapping not less than 6 inches past the end of the fitting onto the pipe section. Test pipe and fittings prior to wrapping fittings. Coat steel and iron pipe with Scotchwrap pipe primer before wrapping.

2. Pipe wrapping shall conform to the following schedule:

Pipe Size	Tape Width	Scotchwrap No.	
		Standard	Cold
¼ - ¾ inch	1 inch	50	40
1 - 1-1/2 inch	2 or 4 inch	50	40
2 inch and larger	4 inch	50	40
Color Backing		Black	Green

3. During application of wrap, if the ambient temperature is 40 deg.F or less, use only Scotchwrap No. 40 tape. If ambient temperature is 41 deg.F or more, use only Scotchwrap No. 50.

E. Buried Pipe Identification: Install bright colored continuously printed plastic ribbon tape of not less than 6 inches width and 4 mil thickness 6 to 8 inches below finished grade directly over buried pipe. Provide metalized tape over non-metallic pipe.

F. Interior Concealed Piping: All pipe and fittings shall be welded. Do not install valves of any type in air plenums or concealed spaces.

3.3 HANGERS AND SUPPORT SYSTEMS (Interior)

A. Provide pipe hangers, supports and accessories in accordance with Section 230529 - Basic Mechanical Materials and Methods.

3.4 ROOF SUPPORTS AND ANCHORS

A. Approved Manufacturers: Miro, Mapa.

B. Provide pipe supports spaced per Hanger Specifications in Section 230529 - Basic Mechanical Materials and Methods. Provide pipe straps to anchor pipe to supports.

C. Provide pipe expansion loops as shown and required to eliminate pipe stress due to thermal expansion imposed by solar influence.

D. See details on Drawings.

3.5 VALVES

A. Provide valves in accordance with Section 230529 - Basic Mechanical Materials and Methods.

3.6 GAS COCKS AND GAS VALVES

A. Provide at supply runout connection for each gas-fired equipment item; and on risers and branches where indicated.

B. Locate gas cocks and valves where easily accessible, and where they will be protected from possible damage.

3.7 GAS SERVICE

A. Complete arrangements with Utility Company to provide gas service to indicated location with shut-off at terminus.

B. Extend service pipe from Utility's terminus to inside building wall, under Utility's direction.

C. Provide shut-off outside building where indicated, in adjustable gas service valve box, with cover set flush to finished grade.

D. Provide shut-off in gas service pipe at entry in building, extend pipe to gas meter location indicated; provide parts and accessories required by Utility to connect meter.

3.8 GAS PRESSURE REGULATOR

A. Install as indicated; comply with Utility requirements. Pipe atmospheric vent to outdoors (unless a vent-limited regulator is used), full size of outlet. Install gas shut-off valve upstream of each pressure regulating valve.

3.9 FLEXIBLE HOSE GAS CONNECTORS AND QUICK COUPLERS

A. Provide flexible stainless steel connectors with full size quick coupler for all kitchen and heavy movable gas appliance equipment.

B. Connectors shall be of lengths required to displace equipment for complete cleaning under and around gas appliance.

C. Provide lubricated plug valve at service connection on equipment branch and quick coupler at service end of flexible hose connector.

D. Provide union connection on appliance or on manifold end of hose connection.

3.10 TESTS

A. General: Test fuel supply lines with air under pressure before being covered. Use a calibrated, certified static gauge graduated to one pound per square inch.

B. Testing shall be of the complete piping system, before covering, or of individually separable larger portions of the system. Only the last connection to the appliance may be tested under operating conditions. This connection will be tested with soap and brush under line pressures. This connection must remain exposed.

C. Test Procedures: Use either of the following methods at the Contractor's option:

1. 30 psig air pressure for a period of 24 hours with no drop in gauge pressure, indicating the line to be airtight.
2. 100 psig air pressure, with joints tested with standard soap and brush inspection and maintain for 3 hours without drop in pressure.

D. Retesting: Retest piping failing initial tests following correction of defective work. Requirements of initial tests shall apply.

E. Test Records: Record pressure and ambient temperature at start and end of test. Submit written results of test to the Architect/Engineer.

END OF SECTION 231123

SECTION 232120 - PROCESS PIPING SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Process Pipe Fittings Hangers and Supports

B. Valves and System Specialties

1.2 RELATED WORK

A. Requirements: Provide Process Piping Systems in accordance with the Contract Documents.

B. Section 230500 - Basic Mechanical Requirements

C. Section 230529 - Basic Mechanical Materials and Methods

D. Section 221410 - Plumbing Piping

E. Section 221411 - Disinfecting Water Supply System

F. Section 224450 - Plumbing Equipment

G. Section 221430 - Plumbing Specialties

1.3 SYSTEM DESCRIPTION

A. Provide process piping, equipment, accessories and specialties for special services required for manufacturing process.

1.4 QUALITY ASSURANCE

A. Comply with appropriate certifications, standards and code for all work.

B. Welding in accordance with Section 230529.

C. Copper pipe and fittings: ASTM B-88, B-260 and ANSI B16.22 cleaned per ASTM B 280 for semiconductor applications.

D. Piping shall be supported per manufacturers requirements and recommendations - continuous support will be required for elevated temperature (over 80 deg.F) and solvent classified conveyance piping, otherwise hangers and supports shall be per Section 230529.

E. Provide 2 coat epoxy coated galvanized 24 ga. steel troughing for all piping routed over personnel, machinery, assembly, and electronic areas and protected in accordance with OSHA requirements.

F. Comply with Insurance Co. or underwriters requirements.

1.5 REGULATORY REQUIREMENTS

A. Comply with Regulatory Agencies requirements per Section 230500.

1.6 SUBMITTALS

A. Submit shop drawings and product data for the following items:

1. Valves
2. Pipe and Fittings
3. Joining Methods and Devices
4. Hanging Systems, support accessories
5. Central Vacuum Cleaning Systems
6. Equipment and Accessories

B. Submit printed operating, cleaning and maintenance Data for the following items:

1. Valves
2. Pipe and Fittings
3. Equipment and Accessories

C. Submit certified test, cleaning, and disinfection reports dated and signed by authorized person, certifying accomplishment of required procedure and results in accordance with the contract documents.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Schedule: Pipe Specifications.

System	16 Guage Steel	Copper "K"	Copper "L"	Black Steel Schedule 40
AR		X		
CO^2		X		
Vacuum Cleaning	X			
Mixed Welding Gas				X
Acetylene				X

***Vacuum Cleaning (see following paragraph B)

B. Asterisks in Schedule:

* = Pipe to be cleaned in accordance with ASTM B-280.

** = Vacuum Cleaning System piping shall be 16 gauge steel galvanized tubing in accordance with Spencer Industravac specifications including fittings and joining methods.

C. Nomenclature in Schedule:

1. Copper K: Type K with BCup brazed joints, wrought copper fittings.
2. Copper L: Type L with 95-5 (SnSb) soldered joints, wrought copper fittings.
3. Black Steel Schedule 40 (HVAC Piping).
4. ASTM A53, Grade A, Schedule 40. Black butt weld or continuous welded steel.

D. Refer to Section 221410 - Plumbing Piping for specifications on copper.

2.2 VALVES

A. Schedule:

1. Process Vacuum:

a. Ball valve - Jamesbury Style AHV Series, for vacuum to 1 x 10 -6 mm Hg. TFE seats and seals.

2. Compressed Air (see #4 also):

a. Ball Valve - Jamesbury Style B 22 TT series, Viton seats and seals, cleaned, bagged and sealed in accordance with ASTM - B-280.
b. Air Check Valve - Powell #563Y cleaned, bagged and sealed in accordance with ASTM B-280.

3. Oxygen (See #4 also):

a. Same as compressed air ball valve specification.

4. Compressed Air, Oxygen and Nitrogen:

a. Diaphragm Valve - Carten Series G packless, extended socket, flared, brazed connections, and downstream purge connection. Cleaned, sealed and bagged per ASTM B-280.

2.3 WASTE AND VENT PIPING

A. Refer to Section 221410 for general and acid waste and vent piping.

B. Refer to Section 221430 for cleanout requirements.

PART 3 - EXECUTION

3.1 PIPING

A. Waste (including acid waste, hydrofluoric waste, deionized reclaim and solvent waste): Slope lines 1.04% per foot unless otherwise indicated.

B. Vents: Pitch to drain, collect risers where practical, offset toward center of building and extend through roof. Vent all traps and sumps.

C. Water: Refer to Section 221410.

D. Relief Valve Drain: Extend drain to floor drain or other approved receptacle.

E. Process Gases and Clean Dry Air: Connect branches to top of main. Provide stubs with removable plug or cap as required to facilitate testing and special cleaning of systems.

F. Stubs: Install capped or plugged stubs or plugged fittings where indicated on the drawings and elsewhere to facilitate pipe cleaning, flushing or testing.

G. Pipe Protection: Protect all piping from damage and contamination. Keep pipe ends of process gas piping sealed prior to and during erection at end of each working day. Use manufactured rubber or plastic caps or plugs on DI system and caps or plugs of variety as recommended by ASTM B-280 for process gases.

H. Cutting: Cut tubing and copper piping with wheel cutter. Cut all other piping with power saw. Ream and deburr all cut ends.

I. Where different pipe materials interconnect, provide appropriate, manufactured adaptors or flanged connections with appropriate gasket material.

J. Some equipment face piping may be delivered to job site in separate packages. Re-install these items in accordance with manufacturer's layout drawings or as instructed in field by Owner's representative.

K. Brace, support and secure all vertical pipes longer than 36" between changes of direction. Use channel strut type system anchored to floor and overhead structure. Fasten pipe to support a 6'-0" O.C. and a minimum of two (2) fasteners per vertical pipe.

L. Locate all hand operated valves which require daily or more frequent operation, at a height not more than 6'-0" above finished floor.

M. Install all plastic piping systems in strict accordance with pipe manufacturer's recommendations, including preparation of pipe and fittings for jointing, selection of solvent and primer, curing and installation. Prior to fabricating system, demonstrate in the presence of the representatives of Owner, Architect and Engineer the proposed field method of making joints.

N. Clean all water piping per section 221411.

3.2 EQUIPMENT

A. Install all equipment at location indicated on drawings and as directed by Architect/Engineer in field, and in strict accordance with equipment manufacturer's requirements.

B. Install all skid mounted equipment with 1/2" thick PVC strip under entire skid.

C. Use stainless steel fasteners only, to anchor D.I. and acid waste treatment equipment to floor.

D. Where anchoring devices are not a standard part of any equipment, submit shop drawing for proposed method of securing equipment.

E. Filters/deionizers, filtration or deionizer resin media shall not be installed except under direct supervision of Owners Project Representative and/or factory start-up representative.

3.3 PIPE TESTING

A. Test all piping as noted below, with no leaks or loss in pressure. Repair or replace defective piping until tests are accomplished successfully. The use of oil pumped air or nitrogen is expressly forbidden, all air and nitrogen used for testing and purging operations must be water pumped.

System	Test Pressure	Test Medium	Test Time

System	Test Pressure	Test Medium	Test Time
Vents	25 PSIG	Water	4 hours
Compressed Air	150 PSIG	Air	4 hours
House Vacuum	20 PSIG	Air	4 hours
Oxygen	150 PSIG	Nitrogen	24 hours
Process Vacuum	50 PSIG	Water	4 hours

3.4 PIPE CLEANING

A. Process Gas:

1. Cleaning: Before erection and again after cutting to length and deburring, all nitrogen, oxygen, hydrogen and compressed air pipe and fittings must be thoroughly cleaned of oil, grease or other combustible materials. Protect all cut and cleaned piping, fittings, and other pipe line accessories from contamination. Store indoors in protected area until system is installed. The following is an acceptable procedure for cleaning. Alternate methods that are generally acceptable within the industry may be used, after acceptance by the Owner.

   a. Sequential wiping with 100% lint-free cloth swabs each saturated with electronic grade trichlorethylene, or as necessary, until lint-free cloth is clean with no trace of dirt, oil, grease or discoloration. Line to be blown dry with process N2 between each swabbing and then lint-free cloth is to be blown through line with pressure process nitrogen.
   b. Sequential flushing at greater than 10 psi pressure differential with 100 line volumes each of electronic grade trichlorethylene, or isopropyl alcohol. Use a special pump designed for this purpose. Blow dry lines with process N2 between each flushing.
   c. Purge nitrogen and oxygen lines with 1000 volumes of process N2.
   d. Cycle purge the system by opening all valves to 5 psig pressure, introducing process N2 until line pressure builds to at least 25 psig. Close off N2 supply pressure and let line pressure fall to 5 psig, then repressure and repeat ten (10) times.
   e. Post cleaning of pipe after welding or assembling sections of pipe as described in items, a, b, c, and d above.

2. Analysis - Before connecting services to the service piping tanks, make arrangements with the supplier of the bulk gases to take samples of gases from the existing system and have them analyzed for purity. If the purity is not as described below, notify the engineer immediately.

   a. Compressed air piping shall have a purity of 99.999%. Allowable limits are:

      1) Less than 3 PPM 02.
      2) H2: non-detectable (less than 1 PPM)
      3) Less than 2 PPM CO and CO2.
      4) Less than 1 PPM Hydrocarbons.
      5) Less than 1 PPM H20.
      6) Dew point less than - 105 deg.F.
      7) Noble gases: non-detectable (less than 1 PPM).

   b. Oxygen piping shall have a purity of 99.6%. Allowable limits are:

1) Less than 100 PPM N2.
2) H non-detectable (less than 1 PPM).
3) Less than 2 PPM CO and CO2.
4) Less than 4000 PPM Noble gases.
5) Less than 25 PPM total hydrocarbons.
6) Less than 1 PPM H2O.
7) Dew point - 105 deg.F.

3. Testing: After the new system has been installed the owner will test the new system. They will conduct tests with their own gas chromatograph in conjunction with a mass spectrometer when required. Gases will be tested at the point of use and must have purities as described under "analysis."

END OF SECTION 232120

SECTION 233410 - SPECIAL EXHAUST SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General purpose fume scrubber.

B. Fume Exhaust Fan.

C. Interior Coated Aluminum Ductwork.

D. Dust Collector.

E. Dust Collection Ductwork.

F. Snorkel Exhauster.

1.2 RELATED REQUIREMENTS

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this section, and Contractor shall review and adhere to all requirements of these documents.

B. Section 230500- Basic Mechanical Requirements.

1.3 RELATED SECTIONS

A. Section 230529 - Basic Mechanical Materials and Methods.

B. Section 230540 - Mechanical Sound and Vibration Control

C. Section 230548 - Mechanical Seismic Control

D. Section 233400 - Air Handling Fans

E. Section 234100 - Air Cleaning

F. Section 233300 - Ductwork and Accessories

G. Section 230593 - Testing, Adjusting and Balancing

1.4 REFERENCES

A. "Industrial Ventilation, a manual of Recommended Practice" published by American Conference of Governmental Industrial Hygienists.

1.5 SUBMITTALS

A. Submit shop drawings and product data for the following items under provisions of the General Conditions of the Contract:

1. Fume Scrubber.
2. Fume Exhaust Fan.
3. Dust Collection Ductwork.
4. Dust Collector.
5. Snorkel Exhaust System.

B. Submit printed Operating Instructions and Maintenance Data for the following items under provisions of Operating and Maintenance Data paragraph in Section 230500:

1. Fume Scrubber.
2. Fume Exhaust.
3. Dust Collector.
4. Snorkel Exhaust System.

PART 2 - PRODUCTS

2.1 GENERAL PURPOSE FUME SCRUBBER

A. Acceptable Manufacturers: Harrington FRP, Beverly Pacific FRP, Tri-mer PVC.

B. Provide a horizontal fume scrubber complete with fan, pumps, packing, drainage and spray trees, and interconnected piping.

C. Scrubber shall be of the size and capacity scheduled on drawings.

D. All wetted parts and materials of the scrubber are to be of fiberglass reinforced plastic with improved self-extinguishing properties except for the miscellaneous hardware (i.e., pumps, spray nozzles, spray tree, view-port windows and other parts which are better made of other materials).

1. All wetted parts and materials are to be resistant to 1/2 to 1 percent of any or all of the following chemicals by weight.

a.	Acetic Acid	88%
b.	Acetone	88%
c.	Alcohol	92%
d.	Formic Acid	88%
e.	Hydrochloric Acid	88%
f.	Hydrofluoric Acid	92%
g.	Hydrogen Peroxide	78%
h.	Nitric Acid	78%
i.	Sodium Hydroxide	88%
j.	Sulfuric Acid	97%

2. In addition, wetted parts of the scrubber shall withstand a 5 percent NaOH solution made from commercial grade NaOH which contains a moderate amount of NaCL.

E. Efficiency: The air washer shall have a removal efficiency as installed for the removal of the chemicals listed above in the efficiencies listed above.

F. Scrubber Construction: Fabrication practice and materials shall conform to National Bureau of Standards Voluntary Product Standard PS 15-69 except as it may in part conflict with the following specifications. Resins utilized in the construction shall be Atlac 711 or Dow Chem 510.

1. Access to the packing and mist eliminators shall be provided in the form of a bolted FRP cover mounted on reversed flanges to eliminate the need for threaded inserts. This access opening shall extend over the entire horizontal area of the packing at the top of the washer casing. Bypassing of the packing through this space shall be prevented by the additional packing to fill this space. If packing is used, it must be irrigated at the same rate as the main packing. A plug type cover is also acceptable.
2. Access to the front and rear of each packed section shall be by means of personnel access ports of minimum dimensions of 16 inches wide by 30 inches high. The ports shall be closed by means of an external reversed flange and a plexiglas plate bolted in place with stainless bolts and nuts. Sealing shall be by means of closed cell vinyl form gasketing between the plexiglas and the flange inside the bolt line. Stress on the plexiglas due to the bolts shall be distributed by means of an externally mounted rectangular epoxy coated angle iron frame through which the bolts pass. FRP flanges shall be of such thickness that additional reinforcing is not needed to prevent distortion due to the stresses involved in compressing the foam gasket.
3. The bottom of the scrubber sump(s) shall be reinforced to support the normal operating weight of the complete air washer plus the normal liquid charge and the occasional high unit stresses caused by the weight of service personnel and a ladder which may be required to serve the interior components. Sole exterior vertical supports on which the air washer rests shall be steel shapes not to exceed 2 inches wide or less than 3 feet apart. Decking material installed to attain this strength shall be a part of the scrubber floor and not a separate item.

4. A pumping sump shall be provided for the pumps used to irrigate the packing. The sump shall be external to the body of the scrubber but shall be a molded part of the washer housing. Communication with the washer sump shall be via large opening in the bottom of the side of the housing which is flush with the inside bottom surface of the air washer sump. The pump sump bottom inside surface shall be at or below the bottom inside surface of the scrubber sump to facilitate drainage. All drain ports shall be set with inverts, at or below the part of the basin which they serve to facilitate drainage.
5. Inlet and outlet transitions. The transitions shall be complete with Koroseal plastic flexible connectors and stainless steel drawbands for securing to blower inlet and ductwork. Connections on transitions for connection to scrubber inlet and outlet shall be flanged and drilled for connection and are to include all necessary stainless steel bolts, nuts and washers and required vinyl gaskets.
6. Rigging Attachments. The separate components (fan, frame, and scrubber) shall be provided with lifting rings so located that the center of gravity of the component during lifting is within and below plane provided by the rings so that it may be rigged to hang level (in its operating position) during lifting. There shall be either three or four lifting rings on each component. Each ring shall withstand 100% of the weight of the unit being lifted within its allowable working stress applied from the direction that would occur if that ring were the sole support of the component. Design safety factor shall be at least four based on ultimate strength of each ring.
7. Provide common corrosion resistant base for scrubber and fan assembly constructed of continuous structural steel channels or beams.

G. Pumps:

1. The pumps shall be of the vertical cantilever design with no bearings or seals or metal parts in the wetted portion of the pump. The pumps shall be capable of running dry indefinitely. The pumps shall be driven by open drip-proof motors with weather covers, or TEFC motors, designed to operate on 460V 3 phase 60 cycle power. Pumps shall be designed to deliver sufficient capacity at the total dynamic head required to satisfy the connected spray piping. In washers with more than one set of packing, each set shall be served by a separate pump and piping system. Disassembly of the piping to permit removal shall be by means of fully threaded unions or flanges.
2. There shall be a strainer provided on the suction side of the pumps to protect the pumps from solid material which might damage them and to protect the spray nozzles from clogging with foreign matter. Strainers shall be serviceable from outside the washer without disassembly of any part not directly related to the strainers and without draining the washer sump. Pumps shall be separately removable from the pumping sump without interference with the operation of the remaining pump. Sufficient removal clearance shall be provided for removal of strainer screens without dislodging accumulated foreign matter.

H. Piping:

1. All recirculation piping shall be schedule 80 PVC with corrosion resistant flexible connectors, pump inlet strainer, stainless steel nuts, bolts and washers, suitable gasketing as required which is resistant to the chemicals being scrubbed.
2. Packing irrigation piping and pumps shall be capable of irrigating the packing at a minimum of 80% of the flood rate according to the packing manufacturer's published performance specifications. Pack irrigation piping shall be designed to be removed from the air washer through the man-access doors without cutting the pipes.

3. Disassembly of piping to permit removal shall be by means of "O" ring type unions. Pipe size reduction, if required, at spray nozzles shall be by means of fully threaded reducers or bushings. (Combination socket/threaded bushings shall not be used.)
4. Access for testing. The scrubber shall be fitted with static pressure sensing ports at the inlet, outlet, and between each active section of the internal elements that cause an air side pressure drop. In addition, the recirculating piping shall have, at each pump discharge, a pressure gauge fitted to an isolation valve. The pressure gauge shall be weather proof and be fitted with stainless steel wetted parts. It shall have a minimum of 2-1/2" dial diameter and its range shall be selected so that in normal operation it is indicating at approximately mid-range. In no case, however, is the maximum gauge reading to be less than the maximum head available from the pump under any condition of flow.

I. Delivered Configuration:

1. The scrubber and fan shall be delivered in the following configuration.
2. The scrubber shall be fully assembled with one set of packing and pumps.
3. The packing shall be designed to efficiently scrub contaminated air at no greater than 1.5" WC pressure drop through scrubber at a face velocity not to exceed that recommended by the packing manufacturer but in no case over 500 fpm.
4. The pumps shall deliver the appropriate volume and head of water to the fully insulated spray tree. Furnish 1" half coupling drain connections at the bottom of fan scroll and at 45 degrees toward the fan discharge. Scrubber shall have side access panels for complete side servicing.
5. Furnish to Engineer for review, prior to fabrication, dimensioned shop drawings of scrubber and fan.
6. Insofar as practicable, all pieces of equipment, including transitions and stacks, are to be factory fabricated and shipped to job site.

J. Installation and Operating Instructions:

1. The manufacturer shall provide to the Owner and also attached to the air washer or frame in a separate enclosure from the shipping documents, a set of installation and operating instructions, including rigging and lifting diagram as well as plumbing, electrical and maintenance information applicable to this assembly of equipment. Diagrams shall indicate the center of gravity of each component as lifted and the complete assembly in operating condition.

K. Guarantee:

1. Manufacturer shall guarantee the scrubber for a period of one year against all defects, including but not limited to lack of scrubbing efficiency and fan performance to submitted curves, and shall provide all materials, tools and labor to correct the defects at the convenience of the owner, during other than normal working hours. If an operational defect which may be corrected by an increase of utilities consumption is possible to correct by some other non-operating cost related change, then the owner shall have the right to require the lower operating cost change regardless of the cost to the air washer/fan manufacturer. Failure of the washer/fan system to move the specified volume of air at the specified internal pressure drop shall be considered an operational defect.

2.2 FUME EXHAUST FAN

A. Acceptable Manufacturers: (Fiberglass only will be accepted)

1. Harrington FRP
2. Beverly Pacific FRP
3. New York Blower FRP
4. Loren Cook

B. Fan shall be of size and capacity scheduled on drawings.

C. Fan Construction:

1. The fan housing shall be manufactured from Atlac 711 or Dow Chem 510 resin or equal by Koppers, and shall be resistant to the corrosive fumes, liquids and gases listed for fume scrubber. This resin shall be self extinguishing, nonburning type with a flame spread of 25 or less according to the ASTM E84 tunnel test.

2. Centrifugal exhaust fans shall have an outlet located in the bottom most section of the fan housing to facilitate removal of any condensate which may form in the fan housing. Outlet shall be threaded female NPT. If insert is used, it must be of the material which bonds readily to the FRP housing construction and has equal reactions to ambient conditions in order to prevent failure due to corrosion or swelling or shrinkage. Housing in area of this fitting shall be built up as required to accept increased stresses of pipe connection. Minimum size 3/4" NPT. An additional outlet shall be provided at 45 deg. from the bottom to permit rotation of discharge 45 deg. (angle up).
3. Fan shall have an inspection and access door of minimum size 12" x 16" at 60` on either side of vertical top centerline. Housing shall be flanged to permit gasketing inside the bolt line and to permit retention by nuts and bolts. Threads in the housing are not acceptable.
4. The interior surface of the fan housing shall be completely gel coated with the same resin used in the manufacture of the part, to afford a smooth cleanable surface and insure that no glass fibers are exposed to the gas stream.
5. The exterior surface of the fan housing shall be gel coated to assure a smooth exterior appearance, free from cracks and crazing and be free from pits or bubbles.
6. The fan housing to be manufactured using fiberglass material specifically designed for the method of application.
7. Gasket materials used in the housing shall be resistant to the same chemicals as the housing and fan. Neoprene is not acceptable.
8. The fan wheel shall be backward curve design, all fiberglass construction except for a metallic hub which shall be totally encased in the FRP construction. All components of the fan wheel shall be of the same chemical resistance as the fan housing and selected for use in a rotating structure.
9. The blades shall be hand lay-up construction, bonded to the backing plate with Permalite VI-119 adhesive as manufactured by Permalite Corp. of Costa Mesa, CA.
10. Fan wheel shall be of such construction as to permit use continuously at AMCA class II conditions.
11. Fan wheel shall be static and dynamically balanced by an accredited wheel balancing facility, or by the manufacturer. Maximum out of balance to be within .2 grams. Maximum allowable displacement .0005 in 2 planes.
12. All wheels shall be gel coated with the same resin as used in the wheel construction, to assure complete corrosion resistance.
13. Inlet cone to front plate clearance shall be less than .125 inches in order to reduce recirculation to a minimum.
14. Shaft to housing clearance to be less than 1/16" to minimize fume leakage along shaft.
15. Fan shall include a sleeve of the same material which shall extend along the shaft continuously to the first bearing. The purpose of this sleeve is to provide primary corrosion protection to this most sensitive part of the shaft.
16. All fan bases shall be manufactured from mild steel, thickness as dictated by fan size. All welding shall be heli-arc to assure good weld penetration and good quality welds.
17. The steel shall be sand-blasted to white metal, primed with two-part epoxy primer, and painted with two-part epoxy paint, to assure good corrosion and weather resistance.
18. The drive must utilize at least two (n) belts selected so that each belt can carry 1/n-1 portion of the design load utilizing standard belts. Overall drive capacity must be at least 150% of design load.
19. Fan shaft will be ground AISI 4I6 stainless steel shafting designed to operate at less than 20% of its critical speed. Bearings are to be heavy duty cast iron self-aligning pillow blocks selected to give a minimum rated L-90 life of at least 90,000 hours according to rating methods of A.S.A. B3.ll-1959.
20. All nuts, bolts, and washers used in the assembly of the fan shall be stainless steel.
21. Fan must be test run at factory after assembly, wide open at its maximum recommended speed and at the speed specified for operation. Fan performance must conform to data

supplied by fan manufacturer obtained in accordance with Standard Test Code for Air Moving Devices published by the A.M.C.A.

22. Fan assembly must be warranted in writing for one year against defects in material and workmanship. All work performed under this warranty must be performed at owners convenience relative to owners production schedules and at no cost to owner for either material or labor.
23. Fan manufacturer shall indicate in writing his capabilities of servicing the fan under warranty including availability of parts and skilled labor and nearest responsible servicing agency capable of performing the service required.
24. Arrangements of fan components will be specified on purchase order according to A.M.C.A. standard arrangements.
25. Entire drive side of fan assembly shall be protected with an FRP corrosion resistant drip cover.
26. Corrosion resistance requirements include all "wetted" parts of the fan including the interface joints and areas subject to drip or spray due to operation. The fan itself shall be resistant to the chemicals listed in the fume scrubber section.

2.3 INTERIOR COATED ALUMINUM DUCTWORK

A. Aluminum ductwork: Material and construction shall be as recommended in the latest editions of the SMACNA Duct Construction Manuals and the ASHRAE Guide.

B. Coating:

1. Acceptable Applicators:

   a. Ardco of Denver
   b. Sheet Metal Products of El Paso

2. Material: Varni-Lite 11/1400 Duct Lining System as manufactured by the Pitsker Associates, 214 Clara Street, San Francisco, California, 94107

2.4 DUST COLLECTOR

A. Manufacturer: American Air Filter.

B. Provide exhauster of size and capacity indicated on Drawings.

C. Unit shall have an overall cleaning efficiency of 99.9 plus percent by weight and be completely self-contained and weatherproofed in a compact housing that does not occupy more than the maximum square feet of ground slab area indicated on the Drawings.

D. Impeller shall be a rugged material handling, radial blade type, balanced to within 1 mil at indicated RPM, for smooth, vibration free operation. Fan and motor shall be easily accessible through the access panel located on the outlet plenum.

E. A discharge plenum silencer shall be furnished with the unit for reduced noise levels so that the unit will operate at less than 80 dba at a distance of 3 feet in any direction of the unit.

F. Filter cartridges shall be accessible through quick-opening access doors. Filter cartridges shall be one piece construction consisting of twelve, wide-spread pockets formed from a continuous piece of cotton sateen fabric. A molded Neoprene gasket on each cartridge shall provide a positive duct

seal. To insure uniform air flow and maximum dust holding capacity, each pocket shall have a rigid plastic insert to prevent pocket collapse during operation, and shall be uniformly separated by the shaker baskets.

G. Cleaning system shall provide an automatic cleaning cycle upon fan shutdown. Shaker mechanism shall consist of a 1/2 HP TEFC motor, driven cam, shaker bar, and an adjustable solid state control.

H. Unit shall be complete with a storage hopper of capacity indicated on Drawings with two slide gate type dust discharge devices integrally connected to two barrel tops with latches with flex connector for attaching to two 55-gallon barrels. (Barrels to be provided by Owner.)

I. Legs of unit shall be extended to provide indicated clearance under the hopper without violating the indicated overall maximum height restriction.

J. Provide control panel of Nema 4 construction mounted on the unit complete with transformer, contactor for the shaker motor and adjustable solid state timer with relays, all wired and tested at the factory.

K. Unit manufacturer shall furnish a push-button station of Nema 7 and 9 explosion-proof construction and a magnetic starter of proper Nema size and Nema 4 construction for fan motor operation for mounting and wiring in the field in accordance with "Electric Wiring" paragraph in Section 230529 - Basic Mechanical Materials and Methods.

L. The completed control assembly shall be capable of performing the following sequence:

1. Push remote stop button to de-energize fan.
2. Relay shall provide 2 minute power delay to shaker motor to allow fan to coast to a stop.
3. Shaker motor will then run for 2 minutes and shut off.

M. Unit manufacturer shall provide check, test and start-up of the dust collection system. A letter verifying that the dust collector is operating as per manufacturer's recommendations shall be forwarded to the Contractor for this Section 233410.

2.5 DUST COLLECTION DUCTWORK

A. Sheet Metal Ductwork:

1. Round straight duct: Galvanized steel, welded or brazed, minimum gage per following schedule:

   Up to 8" diameter - 24 gage
   8" to 18" diameter - 22 gage

2. Elbows and angle fittings: Two gages heavier than straight duct of equal diameter, all welded high pressure class.
3. Hoods: Two gages heavier than straight section of connecting branches.

B. Flexible Duct:

1. Manufacturer: Automation Industries, Inc., Flexible Tubing Division, "Spiratube TDS".
2. Nylon cover with vinyl scuff straps, galvanized steel spring helix and nylon liner with operating range of -10 to 200 deg. F.

C. Accessories:

1. Manufacturer: Kirk & Blum, Cincinnati, Ohio.
2. Blast gates: Cast Aluminum.
3. Cleanout doors: 4 x 6 inch for pipe through 8 inches and 6 x 8 inch for pipe 9 inches through 14 inches.
4. Floor sweeps: 18 gauge galvanized, factory manufactured.
5. Clamps: Stainless steel.

D. Duct Sealer:

1. Manufacturer: Hardcast, Inc., Dallas, Texas.
2. Mineral impregnated woven fiber tape and an activator/adhesive applied in accordance with manufacturer's directions.

2.6 FUME EXTRACTION ARM

A. Approved Manufacturers:

1. Nederman
2. PlymoVent
3. Monoxivent

B. Furnish a fume extraction arm assembly, including:

1. Length: 7 ft.
2. 360° swivel elbow.
3. Support flange.
4. Internal support.
5. Pre-set joints with wear discs.
6. Fiberglass reinforced PVC hose (6-1/4 in.).
7. Oval polycarbonate hood (10 in x 12 in.).
8. Damper with positive seal; Counter flange for 6 in. ventilation duct.
9. Mounting kit for wall mounting.

C. The 7 ft. Fume Extractor Arm shall have a 360° swivel elbow (less movement when the Fume Extractor Arm is wall mounted); a 180° vertical friction joint; a 230° vertical friction joint; and a four-way friction joint, 180° + 220°, at the hood. The 7 ft. Fume Extractor Arm shall have a total reach (from the center point of the Extractor Arm outlet to the center point of the Extractor Hood) of 6 ft. 6-3/4 in.

D. The material structure of the 7 ft. Fume Extractor Arm shall consist of the following: Hood shall be made of polycarbonate (PC), designated “Makrolon” UL E41613 (M) Card B; the Suspension Ring shall be made of die-casted, ($ALSI_9CU_3$), ASTM B26 (B179): SC84A; the Damper shall be made of polyamide (nylon); the Internal Tubes shall be made of aluminum extruded, Aluminum Association (AA) “Registration record of International Alloy Designation” 6063; the Tube Bend and Flange shall be made of Aluminum die-casted, ($ALSI_9CU_3$), ASTM B26 (B179): SC84A and SC12C; the Friction Discs; shall be made of brake lining material (asbestos free); the Hose shall be made of a woven glass fabric with external and internal PVC lamination, the hose shall be supported by spirally wound steel wire helix; the Décor Ring shall be made of EPDM rubber (Ethylenepropylene diene mononer); the Elbow Swivel gasket shall be made of PVC (polyvinyl chloride); the Friction Discs in the Hood shall be made of phenolic plastic.

PART 3 - EXECUTION

3.1 FUME SCRUBBER AND FUME EXHAUST FAN

A. Install equipment as indicated and in strict accordance with manufacturer's installation instructions and recommendations.

B. Do not operate fans for any purpose, temporary or permanent, until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

3.2 INTERIOR COATED ALUMINUM DUCTWORK

A. Ductwork:

1. Provide and install interior coated aluminum ductwork as shown on the drawings and specified herein.
2. All aluminum duct shall be fabricated in accordance with the latest editions of ASHRAE Guide and SMACNA Duct Construction Manual.
3. All aluminum duct shall be of the following gauges as a minimum:

Duct Diameter or Long Side Dimension	Aluminum Gauge
Up thru 8"	14
9" - 22"	14
23" - 36"	14
37" - 50"	14
51" - 60"	14
Over 60"	10

4. All duct seams shall be heli-arc welded and made liquid tight.
5. Duct joints on ducts 17 inches in diameter and smaller shall be made with sleeve type couplings with 2" insertion length. Seal all screws penetrating into the duct and the bottom, internal circumference of the duct connections with silicone sealant. Duct joints on ducts 18 inches in diameter and larger shall be flanged joints with neoprene fume resistant gaskets. Seal bottom, internal circumference of joint with silicone sealant. All flanges shall be continuously heli-arc welded to duct. All rectangular ductwork shall be flanged.
6. All screws, bolts, washers and nuts are to be stainless steel.

7. All fittings are to have continuous welds along all seams. All divided flow fittings are to be manufactured as separate fittings, not as tap collars welded into straight sections of duct in field. All fitting entrances shall be free of weld build-up, burrs or irregularities. All elbows shall be of gored construction with all seams continuously welded. Elbows shall be fabricated to a center-line radius of 1.5 times the cross-section diameter, unless shown or specifically called for otherwise on drawings. In no case should the center-line radius be less than 1 times the cross sectional diameter. All elbows shall be fabricated according to the following schedule:

Elbow Angle	Number of Gores
Less than 35 degrees	2
36 degrees - 71 degrees	3
over 71 degrees	5

8. Ducts shall be fabricated in 8-foot lengths maximum.
9. Ductwork shall be supported from the structure in accordance with applicable recommendations as shown in SMACNA Duct Construction Manual, ASHRAE Guide and Uniform Mechanical Codes. Duct shall be supported at every other joint or at a maximum of 8'-0" between supports.
10. All duct accessories such as dampers, access doors, damper operators, etc., shall be fabricated and installed in accordance with SMACNA Duct Construction Manual and coated, unless noted otherwise on plans, with Varni-Lite 11/1400.

B. Interior Coating:

1. The aluminum ducting shall be lined with the Varni-Lite 11/1400 Duct Lining System.
2. Pipe and fittings preparation: Duct and fittings shall be fabricated to minimize interior joints, cracks or crevices and shall be joined in a manner minimizing open or slip joints. Prior to lining, all pieces shall be inspected for irregularities, rough spots, weld-splatter, bad welds or sharp edges and any found shall be corrected and/or ground smooth before proceeding with lining.
3. Surface preparation: Using a suitable, clean solvent, all surfaces to be coated, shall be degreased by flooding, dipping and/or wiping with solvent soaked, clean, lint free rags, taking care to discard rags and solvent as they become contaminated. After degreasing, surfaces shall be abrasive blasted to an even anchor pattern having a profile depth of a minimum of one mil (0.001"). Before application of coating, surfaces shall be degreased again as above.
4. Pretreatment: All surfaces to receive epoxy lining shall have applied a thin film of vinyl-wash primer or other suitable acid etch primer at a rate to leave a finished dry film thickness of between one quarter and one-half mil (0.00025" - 0.0005").
5. Epoxy Primer Coat: One coat of Varni-Lite 1100 Tan Primer shall be applied to a wet film thickness of four to five mils (0.004" - 0.005"). (NOTE: When applying to maximum wet film thickness allowable, material will show an even "orange peel" effect without sagging. Upon curing and application of subsequent coats, finish will smooth out.) Epoxy materials shall be thinned only as necessary to apply an even film. Under no circumstances shall the epoxy be allowed to puddle and any runs, sags, curtains or festoons that do occur, shall be completely brushed out or wiped clean from the surface while the material is still wet.
6. Epoxy Intermediate Coat: A coat of Varni-Lite 1400 Light Grey shall be applied to wet film thickness to four to five mils (0.004" - 0.005") to a smooth even finish.
7. Epoxy Finish Coat: A coat of Varni-Lite 1400 White shall be applied to a wet film thickness of four to five mils (0.004" - 0.005") to a smooth even finish.

8. Time Between Coats: The Varni-Lite 11/1400 Duct Lining System may be air-dried at ambient temperatures, or preferably, force cured in an oven. If air-dried, the minimum time between coats shall be four to six hours or until preceding coat is tack-free. If over cured, a flash-off time of one-half to one hour shall be allowed after completion of application before placing in oven. The material shall then be baked from ten to twelve minutes at 200 degrees F. or fifteen to eighteen minutes at 180 degrees F. Regardless of curing method, subsequent coats shall be applied before the preceding coat is forty-eight hours old.
9. Final Cure Time: Upon completion of coating, a final cure time of at least ten days shall be allowed prior to exposing finished pipe to corrosives if air-dried at ambient temperatures. If force cured, material may be baked for twenty to thirty minutes at 200 degrees F or thirty to forty-five minutes at 180 degrees F after application of the finish coat.
10. Finished Film: The total dry film thickness of the system shall be a minimum of four mils (0.004") and a maximum of 8 mils (0.008").
11. Assembly of Duct System: Any scratches or damaged surfaces, shall be repaired. All joints shall be caulked with 100% solid epoxy or silicone caulking materials. Caulk internal low part of flange joint with silicone sealant to prevent chemical fume condensate accumulation.
12. Coating thickness and coating application shall be inspected and non-destructively tested by an independent inspector selected by Engineer before leaving the painting shop.

3.3 DUST COLLECTOR

A. Install as indicated on Drawings in accordance with manufacturer's instructions.

3.4 DUST COLLECTION DUCTWORK

A. General:

1. Dust collection system shall be constructed with the material specified and installed in a permanent and workmanlike manner. Interior of all ducts shall be smooth and free from obstruction with joints welded or riveted and sealed air tight with "Hardcast" mineral impregnated woven fiber tape and activator/adhesive applied in accordance with manufacturer's directions.

B. Preparation:

1. Prior to beginning fabrication of any metal ductwork for the collecting system, the Installing Contractor shall submit to the Engineer, detailed drawings of the collecting system showing duct design, joints, hanging methods, transitions, blast gates, cleanout doors, hood details, etc. The hood details shown on the Drawings are typical only. The Contractor shall visit the site after all wood working machinery is set in place, measure the equipment, design the hoods, and submit for final acceptance prior to fabrication.

C. Construction:

1. Flexible duct shall be used to connect exhaust drop ducts to machines. Flexible duct shall be kept to a length not to exceed 36".
2. Longitudinal joints of ducts shall be welded or brazed.
3. Girth joints of ducts shall be made with lap in direction of airflow, with 1" lap for ducts with diameters up to 19". These joints shall be riveted and taped with "hard cast".
4. Elbows and angles should have an inside or throat radius of two duct diameters whenever possible, but radius shall never be less than one diameter.
5. Provide dead end caps with handle for visual inspection where indicated on the Drawings.
6. Provide cleanouts every 10 feet and near each elbow, angle or duct junction in horizontal section. Door shall be gasketed to be airtight.
7. Support ducts sufficiently to place no load on connecting equipment and to carry weight of system if plugged with material. Maximum supporting interval is 12 feet for 8" or smaller ducts, 20 feet for larger ducts.
8. Provide 6" minimum clearance between ducts and ceiling, wall or floors.
9. All branches shall enter the main at the large end of the transition at an angle not to exceed 45 deg.; 30 deg. is recommended. All ductwork (turns, transitions, hoods, etc.) shall be in accordance with "Industrial Ventilation, a manual of Recommended Practice" published by American Conference of Governmental Industrial Hygienists.
10. Transition in mains and sub-mains shall be tapered; taper 8" long for each 1" change in diameter.
11. Fire dampers, explosion doors, etc., shall be installed in accordance with NFPA code or jurisdictional fire ordinances.
12. A cast aluminum blast gate shall be provided at each machine or floor sweep. They shall be mounted 6'-0" off of floor.
13. Provide a factory manufactured "floor sweep" where shown. "Home made" types will not be acceptable.

3.5 FUME EXTRACTOR ARM

A. Mount to wall following manufacturer’s instructions.

B. Verify free operation in all direction. Adjust joints as required.

END OF SECTION 233410

SECTION 233713 - AIR INLETS AND OUTLETS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Diffusers.

B. Registers.

C. Grilles.

D. Louvers.

E. Louvered penthouses.

F. Gravity roof hoods.

G. Goosenecks.

1.2 RELATED REQUIREMENTS

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements apply to this Section, and Contractor shall review and adhere to all requirements of these documents.

B. Section 230500- Basic Mechanical Requirements.

1.3 RELATED SECTIONS

A. Section 230529 - Basic Mechanical Materials and Methods: Painting of ductwork visible behind outlets and inlets.

B. Section 230593 - Testing, Adjusting and Balancing.

C. Section 233300 - Ductwork and Accessories.

D. Section 233600 - Air Terminal Units.

1.4 REFERENCES

A. AMCA 500 - Test Method for Louvers, Dampers and Shutters.

B. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

C. ARI 890-91 - Rating of Air Diffusers.

D. ASHRAE 70 - Methods of Testing for Rating the Air Flow Performance of Outlets and Inlets.

E. SMACNA - HVAC Duct Construction Standard.

F. ASTM C 636 – Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.

1.5 QUALITY ASSURANCE

A. Test and rate performance of air outlets and inlets in accordance with ASHRAE 70 and ARI 890.

B. Test and rate performance of louvers in accordance with AMCA 500.

1.6 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 90A.

1.7 SUBMITTALS

A. Submit Shop Drawings for the following items under provision of The General Conditions of the Contract:

1. Shop fabricated louvers.
2. Louvered penthouses.
3. Shop fabricated roof hoods.
4. Goosenecks.

B. Submit Product Data for the following items under provision of The General Conditions of the Contract:

1. Diffusers.
2. Registers.
3. Grilles.
4. Louvers.
5. Gravity roof hoods.

C. Submit schedule of outlets and inlets indicating type, size, location, application, and noise level.

1. Review requirements of outlets and inlets as to size, finish, and type of mounting prior to submitting product data and schedules of outlets and inlets.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS (SEE AIR DEVICE SCHEDULE ON PLANS)

A. Acceptable Manufacturers: Titus, Anemostat, Barber Colman, Krueger, Carnes, Metal-Aire, Nailor-Hart, Tempo, Air Diffusion Products, Tuttle & Bailey, TurboX, Price, Hart & Cooley.

2.2 CEILING REGISTERS AND GRILLES (SEE AIR DEVICE SCHEDULE ON PLANS)

A. Acceptable Manufacturers: Titus, Anemostat, Barber Colman, Krueger, Carnes, Metal-Aire, Nailor-Hart, Tuttle & Bailey, Price, Hart & Cooley.

2.3 CEILING SLOT DIFFUSERS (SEE AIR DEVICE SCHEDULE ON PLANS)

A. Acceptable Manufacturers: Anemostat, Tempmaster, Tempo. (No Substitutions Allowed).

2.4 CEILING LINEAR EXHAUST AND RETURN GRILLES (SEE AIR DEVICE SCHEDULE ON PLANS)

A. Acceptable Manufacturers: Titus, Barber-Colman, Metal-Aire, Anemostat, Krueger, Tuttle & Bailey, Price.

2.5 WALL REGISTERS AND GRILLES (SEE AIR DEVICE SCHEDULE ON PLANS)

A. Acceptable Manufacturers: Titus, Metal-Aire, Barber-Colman, Anemostat, Krueger, Tuttle & Bailey, Air Concepts, Price.

2.6 LINEAR WALL REGISTERS AND GRILLES (SEE AIR DEVICE SCHEDULE ON PLANS)

A. Acceptable Manufacturers: Titus, Barber-Colman, Metal-Aire, Anemostat, Krueger, Price, Tuttle & Bailey.

2.7 LINEAR SUPPLY REGISTERS AND GRILLES (SEE AIR DEVICE SCHEDULE ON PLANS)

A. Acceptable Manufacturers: Titus, Barber-Colman, Metal-Aire, Anemostat, Krueger, Price, Tuttle & Bailey.

2.8 LINEAR FLOOR REGISTERS AND GRILLES (SEE AIR DEVICE SCHEDULE ON PLANS)

A. Acceptable Manufacturers: Titus, Barber-Colman, Metal-Aire, Anemostat, Krueger, Price, Tuttle & Bailey.

2.9 DISPLACEMENT DIFFUSERS

A. Acceptable manufacturers: Halton, Krantz, Krueger, Price, Titus, Trox.

B. Materials:

1. Epoxy coated or baked enamel galvanized steel.

C. Construction:

1. Flow equalization device for even distribution out diffuser face.

D. Performance:

1. Noise:

a. Deliver rated volume at NC level noted on drawings, or NC 30 if not noted.

2. Thermal:

a. For $\Delta T = -5°F$, terminal velocity (50 fpm) is reached within a distance of 2 times the face height.

2.10 DOOR GRILLES

A. Acceptable Manufacturers: Titus, Metal-Aire, Barber-Colman, Anemostat, Krueger.

B. V-shaped louvers of 20 gauge steel, one inch deep on 1/2 inch centers.

C. Provide 20 gauge steel frame with auxiliary frame to give finished appearance on both sides of door, with factory prime coat finish.

2.11 LOUVERS

A. Acceptable Manufacturers: Dowco, Airstream, Louvers and Dampers, Inc., Ruskin, Krueger, Air Balance, American Warming and Ventilating, Arrow, C. E. Sparrow, Greenheck, Cesco, Pottorff, Air-Rite.

B. Provide 6 inch deep louvers with blades on 45 degree slope, heavy channel frame, birdscreen with 1/2 inch square mesh for exhaust and 3/4 inch for intake; Model ELF-6350DMP manufactured by Ruskin, or equal.

C. Fabricate of 16 gauge galvanized steel or 12 gauge extruded aluminum, welded assembly, with factory baked enamel or color anodized finish, custom color to be selected by Architect.

D. Furnish with flat flange for installation.

2.12 LOUVERED PENTHOUSES

A. Acceptable Manufacturers: Louvers and Dampers, Inc., Dowco, Penn Ventilator, Greenheck, Ruskin, Arrow, American Warming, Cook, Air-Rite, Carnes.

B. Louvered penthouse with 6 inch deep 45 degree slope .125 inch thick extruded aluminum stormproof louvers with corner posts, heavy channel frame with sill extension, removable birdscreen and removable roof.

C. Fabricate removable roof of sheet aluminum reinforced with aluminum angle bracing and stainless steel fasteners as required to withstand a design snow load of 40 pounds per sq. ft. plus safety factor and undercoat with mastic sound deadener or heavy ductboard acoustical insulation.

2.13 GRAVITY ROOF HOODS

A. Acceptable Manufacturers: Acme, Louvers and Dampers, Inc., Penn Ventilator, Greenheck, Ruskin, Cook, Carnes.

B. Fabricate air inlet or exhaust hoods in accordance with SMACNA Low Pressure Duct Construction Standards.

C. Fabricate of galvanized steel, minimum 16 gauge base and 20 gauge hood, or aluminum, minimum 16 gauge base and 18 gauge hood; suitably reinforced; with removable hood; birdscreen with 1/2 inch square mesh for exhaust and 3/4 inch for intake, and factory baked enamel finish.

D. Provide minimum 12 inch high insulated curb base.

E. Make hood outlet area minimum of twice throat area.

2.14 GOOSENECKS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards of minimum 18 gauge galvanized steel.

B. Mount on minimum 12 inch high curb base.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install items in accordance with manufacturers' instructions.

B. Install ceiling mounted items in accordance with ASTM C 636.

1. Ceiling mounted air terminals or services weighing less than 20 pounds shall be positively attached to the ceiling suspension main runners or to cross runners with the same carrying capacity as the main runners.
2. Terminals or services weighing 20 pounds but not more than 56 pounds, in addition to the above, shall have two No. 12 gauge hangers connected from the terminal or service to the ceiling system hangers or to the structure above. These wires may be slack.
3. Terminals or services weighing more than 56 pounds shall be supported directly from the structure above by approved hangers.

C. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, regardless of whether dampers are specified as part of the diffuser, or grille and register assembly.

E. Paint ductwork visible behind air outlets and inlets matte black.

F. Install diffusers to ductwork with air tight connection.

G. Install duct connections to fire rated UL Listed and Labeled diffusers and return grilles in strict accordance with instructions furnished by manufacturer.

END OF SECTION 233713

TABLE OF CONTENTS

SECTION 260500 – BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Provide all items, articles, materials, equipment, operations and/or methods listed, mentioned, shown and/or scheduled on the drawings and/or in these specifications, including all labor, services, permits, fees, utility charges, and incidentals necessary and required to perform and complete the electrical work described in this Division. Apply for all permits early in the project to avoid problems due to code revisions.

B. See the contract conditions (general and supplementary) and Division 1 for requirements concerning this Division including, but not limited to, submittals, shop drawings, substitution requests, change orders, maintenance manuals, record drawings, coordination, permits, record documents and guarantees.

C. Division 26 Contractor shall be responsible for all work indicated by divisions 26, 27, 28, and the electrical portions of 33 within the drawings and specifications. Any work indicated by Division 16 shall be provided and installed by the Division 26 Contractor.

1.3 RELATED WORK SPECIFIED ELSEWHERE:

A. Mechanical equipment motors to be furnished under another Division but connected under this Division. Starters to be mounted and connected by this Division, but furnished by another Division unless otherwise noted on the electrical drawings. Verify and coordinate all equipment locations and electrical characteristics with other trades involved in the work. Coordination shall be done prior to rough-in or ordering equipment.

B. Control wiring, both line and low voltage, for mechanical equipment beyond provisions shown on the Electrical Drawings shall be performed under another Division of the work.

1.4 QUALITY ASSURANCE:

A. Do all work in accordance with regulations and requirements of the National Electrical Code, state and local codes and amendments, National Fire Codes, and all other applicable Codes.

1.5 PROJECT CONDITIONS:

A. The Contractor shall inspect the job site prior to bidding and familiarize himself with existing conditions which will affect the work. Prior to start of work, obtain "As built", "Record", or other Drawings showing existing underground utilities.

B. Electrical drawings are diagrammatic indicating approximate location of outlets, lighting fixtures, electrical equipment, etc. Consult the Architectural, Structural, and Mechanical Drawings to avoid conflicts with equipment, structural members, etc. When required make all deviations from Drawings to make the work conform to the building as constructed, and to related work of others. Minor relocations ordered prior to installation may be made without added cost to Owner.

C. Call to the attention of the Engineer/Architect any error, omission, conflict or discrepancy in Drawings and/or Specifications. Do not proceed with any questionable items of work until clarification of same has been made.

D. Under no conditions are beams, girders, footings or columns to be cut for electrical items unless so shown on Drawings or written approval obtained from the Engineer/Architect.

E. Verify the physical dimensions of each item of electrical equipment to fit the available space and promptly notify the Engineer/Architect prior to roughing-in if conflicts appear. Coordination of equipment to the available space and to the access routes through the construction shall be the Contractor's responsibility.

1.6 SHOP DRAWINGS:

A. Prior to ordering equipment, and prior to Contractor’s first application for payment, the Contractor shall, within 14 days after award of this work, submit complete shop drawings, electronic PDF copy with PDF index tabs, to the Architect, of materials and equipment he proposes to furnish. It is preferred that all sections be submitted at once, however, in the event that one or more sections need approvals quickly and others are not prepared yet, the Engineer will agree to review the individual section submittals needing immediate approval. However, each individual submittal section must be complete and remaining submittals that are not a rush shall be submitted all in one package as quickly as possible. Submitting individual sections over many weeks/months will not be tolerated.

B. List shall bear Contractor’s stamp, signature or other means to show that he has inspected same and certified that submitted material is correct in regard to quantity, size, dimension, quality and is coordinated with the Contract Documents.

C. See individual sections within this Division for products requiring submittal.

D. Each shop drawing submittal shall be prepared by the manufacturer, and shall clearly show manufacturer’s name, catalog numbers, pictures, details, layout, type, size, rating, style, and all options identified in a permanent fashion. Specific items or options shall be permanently marked on sheets containing more than one option – do not rely on the Engineer to mark options. Yellow highlight by itself will not be an acceptable means of marking as it may not copy well.

E. Large equipment drawings such as panelboards, and similar large equipment shall include the size, weight, seismic rating, emissions data, elevation, and wiring diagrams in addition to the product data.

F. Some sections of this Division may require shop drawings prepared on full size floor plans in AutoCAD or other CAD software. Where required, contact the Architect for the latest version of the electronic plans and match the size and scale of the construction drawings. Drawings delivered to the contractor from the Architect/Engineer may not include addenda changes. Contractor shall only use electronic plans for purposes of the construction on this job, and not for any other use or reuse. Add any required addenda items prior to finishing shop drawings and submittals.

G. Provide complete materials (all materials) list at the beginning of each tabbed section showing “Submittal Number”, “Specification Section”, “Material Item”, “Manufacturer’s Name and Catalog Number”, and all pertinent data.

H. Provide samples where required in individual sections of this Division.

I. Contractor agrees that Shop Drawing Submittals processed by the Engineer/Architect are not Change Orders; that the purpose of Shop Drawing Submittals by the Contractor is to demonstrate to the Engineer/Architect that the Contractor understands the design concept, that they demonstrate their understanding by indicating which equipment and material they intend to furnish and install and by detailing the fabrication and installation methods they intend to use.

J. Contractor further agrees that if deviations, discrepancies or conflicts between Shop Drawings and Specifications are discovered either prior to or after Shop Drawing Submittals are processed by the Architect/Engineer, the design Drawings and Specifications shall control and shall be followed.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. All materials shall be new and bear manufacturer's name, model number, electrical characteristics and other identification. All equipment to be U.L. approved or listed by another testing agency approved by authorities having jurisdiction.

B. Material and equipment shall be standard product of manufacturer regularly engaged in production of similar material for at least five years (unless specifically exempted) and shall be manufacturer's latest design.

C. If the description of a product is in conflict with the product as specified in the catalog number, the description shall generally take precedence. Contact the Architect for clarification if this occurs.

D. All equipment must be rated and certified for the appropriate seismic design category or seismic use group for the installed geographical location. For essential or life safety equipment, provide an additional seismic factor of 1.5.

2.2 DISCONNECTS:

A. Safety and disconnect switches to be Heavy duty quick-make, quick-break, dual rated, lockable, and of such electrical characteristics as required for the load served. Switches to have defeatable cover interlock.

B. Fuse clips shall accept Class R or Class L fuses if required. Motor rated toggle switches equal to Square D Class 2510, type F with thermal overloads may be used as motor disconnects in dry locations for fractional horsepower motors.

C. Disconnect switches required by code shall be installed whether or not specifically shown on the Drawings.

D. Disconnect switches for refrigeration equipment and multiple motor HVAC equipment shall be fusible type.

E. Safety and disconnect switches (fuse, non-fuse or circuit-breaker type) to be of same manufacturer as switchgear and panelboards.

2.3 FUSES:

A. Provide fuses as indicated on the drawings, sized per NEC, or as required by the equipment manufacturer, whichever provides maximum protection, for a fully operational system.

B. All fuses shall be furnished of the same manufacturer.

C. All fuses shall be installed by the electrical contractor at job-site and only when equipment is to be energized. Fuses shall not be installed during shipment.

D. All fuses to be 200,000 AIC, Current-limiting, U.L., Time Delay, Dual-element Type as follows:

For motor circuits beyond the main and sub distribution boards, 600 volt and below:
Class RK-5 for 600 volt; FRS-R, FLS-R, & TRS-R
Class RK-5 for 250 volt; FRN-R, FLN-R, & TR-R

E. SPARE PARTS: Provide 10% spare fuses, but not less than 3 of any one size and type.

F. Approved Manufacturers, with catalog numbers listed in order: Bussman, Littelfuse, Ferraz Shawmut.

G. If the electrical contractor wishes to furnish materials other than those specified, a written request, along with a complete short circuit and selective coordination study, shall be submitted to the engineer for evaluation at least 8 days prior to the bid date. If the engineer's evaluation indicates acceptance, a written addendum will be issued listing the other acceptable manufacturer.

2.4 BOXES:

A. Outlet and junction boxes shall be sized in accordance with code requirements or as noted on the drawings.

B. Unless otherwise specified or shown on the drawings, all outlet boxes for existing work shall be surface mounted style cast metal boxes. Gangable boxes are not acceptable. Outlet boxes shall not be smaller than 4" square and 1-1/2 inches in depth, unless otherwise noted. All outlet box covers, rings, or other fittings shall be galvanized. Boxes which are exposed to the weather shall be cast metal.

C. Outlet boxes shall be designed for the intended use, and shall be installed flush with finish surface lines or not more than 1/8 inch back and shall be level and plumb. Long screws with spaces or shims for mounting devices are not acceptable. No combustible materials shall be exposed to wiring at outlets.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION METHODS:

A. All items, articles, materials, and equipment specified under this Division shall be installed per the manufacturer's installation instructions. Where the manufacturer's instructions are in conflict with the directions provided elsewhere in this Contract, the Engineer shall be notified prior to beginning rough-in.

B. Cutting or notching shall be kept to an absolute minimum and done when, and in a method approved by the Engineer/Architect. Patch and correct finished surfaces damaged by electrical work.

C. Panels, cabinets and equipment shall be level and plumb and installed parallel with structural building lines. All equipment and enclosures shall fit neatly without gaps, openings, or distortions. Provide approved devices for closing all unused openings.

D. Arrange circuit wiring as shown on the Drawings and do not alter or combine runs or homeruns without the specific approval of the Engineer/Architect. Feeder runs shall not be recombined or altered.

E. Starters and similar noise producing devices shall not be placed on classroom or office walls which are common to occupied space. They are acceptable in the shop environment, separated from the shared classroom/office wall.

F. Drivers, Ballasts, contactors, starters, VFD's, and like equipment which are found to be noticeably noisier than other similar equipment on the project will be deemed defective and shall be replaced.

G. In general, the mounting heights shall be as noted on the Drawings, or as listed below, the Architectural Interior Elevations and drawing notes taking precedence. Where no heights are indicated, request clarification from the Engineer/Architect. Consult the Architectural, Mechanical and Structural drawings to avoid conflicts prior to roughing-in and for exact locations. All dimensions are to the top of the back box or device whichever is higher. Lighting dimensions are to the bottom of suspended fixtures and center of wall mounted fixtures unless otherwise noted.

Light Switches	48 inches to center
Convenience Receptacles	18 to 42 inches to center as directed by owner
Receptacles and Outlets Over Counters	10 inches above counter or 5 inches above Backsplash to top, whichever is greater.
Panelboard	72 inches to top
Disconnects and Motor Controllers	72 inches to top
Fire Alarm Signals	96 inches to top (but at least 6" below ceiling)
Fire Call Stations	48 inches center

H. Where raceways penetrate floors, ceilings, ducts, chases, and fire walls, provide fire stopping to maintain integrity of the fire assembly. Firestopping method shall be approved by the Code Authority having jurisdiction.

I. All materials and equipment installed under this work shall be properly and adequately supported from the building structure except where ceiling construction or other provisions are specifically designed to support them. Support systems shall provide a safety factor of four. This shall apply to chains, hangers, anchors, clamps, screws, structural iron, and all other hardware and appurtenances associated with the support system.

J. Maintain the following minimum separations from voice and data cables. Power conduit - 12", transformers and motors - 40", LED and fluorescent lighting - 12".

3.2 LOW VOLTAGE WIRING METHODS:

A. Unless stated otherwise in these specifications, or on the drawings, raceways for low voltage wiring of Paging, Intercom, CCTV Cabling, Computer, and Telephone systems utilizing N.E.C. class II current limitation methods will be required in entire shop area where conductors might be exposed to physical damage. Provide Conduit homeruns complete for all low voltage systems. Plenum cabling will not be acceptable.

B. Conduits shall be concealed in all finished spaces and shall be run parallel to structural lines and supported at minimum 10' intervals from structure.

C. All low voltage cable must be suitable for the conditions in which it will be used. Prior to purchasing or installing any cable, confirm the environment cable will be installed. Where partial conduits are extended and other side is plenum, entire installation shall have plenum rated cable.

3.3 LABELING:

A. Clearly and properly label the complete electrical system to indicate the loads served or the function of each item of equipment provided under this work.

B. Permanent Engraved nameplates: shall be 1/16 inch thick, laminated three-ply plastic, center-ply white, outer-ply black (for normal power) or red (for emergency power) or orange (for UPS power) "Lamicoid" or equal. Letters shall be formed by engraving outer colored ply, exposing white center-ply, and shall be a minimum of 5/8 inch high. Nameplates shall be secured with screws or pop rivets.

C. Provide permanent engraved nameplates for the equipment listed below as well as all other similar equipment; refer to each section for specific labeling requirements:

1. Existing breakers at Switchboards

2. Panelboards

3. Motor Controllers, Variable Frequency Drives (VFD), Safety Disconnects

4. Electrical Contactors and Relays

5. Other similar electrical devices and equipment

D. Self-Adhesive Labels: shall have self-adhesive “P-Touch” or equivalent sticky backs, black lettering with a clear (see through) background.

E. Provide self-adhesive labels for the devices and equipment listed below as well as all other similar equipment; each label shall list the applicable circuit number feeding the device and devices fed from Emergency or UPS power shall also list “EMERGENCY” as applicable next to the circuit number (for example, a receptacle fed from circuit 2 in panel 1P1 would read “1P1-2” on the label):

1. Thermal Switches and Manual Starters

2. Power outlet receptacles

3. Light Switches

4. Fire alarm initiation devices (smoke detectors, heat detectors, pull stations, etc.)

5. Fire alarm notification devices (horn/strobes, etc.)

F. Provide neat and clearly legible handwritten labeling using a permanent “Sharpie” or equivalent chisel tip black marker for all junction boxes containing power and fire alarm wiring. Label each junction box with the applicable circuit number(s) for the cables contained within each junction box in a location and large enough to be clearly visible from the floor.

G. Where changes are made in existing panels, distribution boards, etc., provide new labeling and schedules to accurately reflect the changes.

3.4 SAFETY:

A. The Engineer has not been retained or compensated to provide design and construction review services relating to the Contractor's safety precautions or to means, methods, techniques, sequences or procedures required for the contractor to perform the work.

3.5 DEMOLITION:

A. It is the intent of these specifications to require the contractor to make all necessary adjustments to the electrical system, required to meet code, and accommodate installation of the new and remodeled work.

B. Remove all existing fixtures, clocks, switches, receptacles, raceways, and other electrical equipment and devices and associated wiring from walls, ceilings, floors, and other surfaces scheduled for remodeling, relocation, or demolition unless specifically shown as retained or relocated on the drawings. If existing walls, ceiling, floors, etc. are moved, extend existing devices, fixtures, and circuiting to the new location.

C. Disconnect all existing mechanical equipment scheduled for removal or relocation. See mechanical drawings for scope of work. Remove abandoned raceways and cables. Relabel panels and to reflect changes.

D. If existing junction boxes will be made inaccessible, or if abandoned outlets serve as feed through boxes for other existing electrical equipment which is being retained, new conduit and wire shall be provided to bypass the abandoned outlets. If existing conduits pass through or are mounted on partitions or ceilings which are being removed or remodeled, new conduit and wire shall be provided to route around the ceiling or wall and maintain service to the existing load.

E. Locations of items shown on the drawings as existing are partially based on as-built and other drawings which may contain errors. The Contractor shall verify the correctness of the information shown prior to bidding and provide such labor and material as is necessary to accomplish the intent of the contract documents. The plans may show some demolition conditions, but are not intended to show all of them.

F. All materials accumulated during the demolition process are the Owners property and shall be removed from the job site and delivered to an Owner storage facility as directed by the Owner. If owner does not wish to salvage materials, contractor shall remove from jobsite and dispose, or recycle materials at contractor’s discretion, in a lawful manner.

G. Where changes are made in existing panels, distribution boards, etc., provide new labeling and schedules to accurately reflect the changes.

I. Demolish and dispose of hazardous materials in a lawful manner, such as PCB containing transformers or ballasts, mercury containing lamps, or materials containing lead. All costs for proper disposal shall be paid by the contractor unless specified elsewhere in the general conditions.

3.6 POWER INTERRUPTIONS:

A. Keep outages to occupied areas to a minimum and prearrange all outages with the Owner's representative and utilities involved. Requests for outages shall state the specific dates and hours and the maximum durations, with the outages kept to these specified times. When power interruptions will last longer than 5 minutes and cover more than 10% of the building, or affect public areas, they shall be performed after school hours or on weekends.

B. Contractor shall coordinate with the Owner so that work can be scheduled not to interrupt operations, normal activities, building access, etc. Coordinate work with other crafts for proper scheduling.

C. No circuits shall be turned off without prior approval from owner. Coordinate with the Owner any interruptions which affect the operation of the remaining portions of the facility.

D. This contractor will be liable for any damages resulting from unscheduled outages or for those not confined to the preapproved times. Include all costs for overtime labor as necessary to maintain electrical services in the initial bid proposal. Temporary wiring and facilities, if used, shall be removed and the site left clean before final acceptance. Requests for outages must be submitted at least (5) days prior to intended shutdown time.

E. Include in bid cost of minimum temporary power for Fire Alarm System, Security, Telephone/Data equipment and any other equipment designated by Owner, during time when primary building power has been interrupted.

3.7 GROUNDING:

A. Ground all electric equipment, raceways and enclosures in accordance with code rules and established safety practices.

B. Install grounding conductors in approved metallic raceways unless specifically shown or specified otherwise. Bond at each end and at all intervening boxes and enclosures between the service equipment and grounding electrode.

C. No. 8 and smaller grounding conductors shall have green insulation. No. 6 and larger shall be marked with green colored tape at each end and at every box, panel, switchboard, or point where conductor is accessible.

3.8 EQUIPMENT CONNECTIONS:

A. The location and method for connecting to each item of equipment shall be verified prior to roughing-in. The voltage and phase of each item of equipment shall be checked before connecting. Motor rotations shall be made in the proper direction

B. Conduit, wire and circuit breaker sizes for mechanical, and similar equipment are based on the equipment ratings of one manufacturer. The equipment actually furnished may have entirely different electrical characteristics. Conduit, wire, circuit breakers, disconnects, etc. shall not be ordered or installed until exact electrical requirements are obtained. Responsibility for this coordination rests with the Contractor.

3.9 SEISMIC BRACING:

A. Furnish and install all seismic bracing of equipment, feeders, lighting fixtures, and other electrical items in accordance with prevailing codes. Refer to ASCE 7-10, section 13.3 and 13.6 for calculation methods. Provide and submit the required designs, calculations, certifications, and stamped drawings to the authority having jurisdiction and obtain their approval prior to installation or fabrication.

B. Where conduit, or conduit racks are attached to structures where they cross a seismic isolation interface, the electrical components shall be designed to accommodate the seismic relative displacement.

3.10 PAINTING:

A. All electrical equipment and conduit exposed in finished areas and on exterior walls are to be painted to match surrounding surfaces.

B. Contractor shall coordinate the timing of painting requirements.

C. Refer to Architectural specifications for methods and materials.

3.11 PROJECT RECORD DOCUMENTS:

A. Maintenance of Documents:

1. Maintain at Jobsite, One Record Copy of: Contract Drawings, Specifications, Addenda, Reviewed Shop Drawings, Change Orders, Other Modifications to Contract and Field Test Records.

2. Keep apart from documents used for construction.

3. Keep documents available at all times for inspection by Architect.

B. Recording:

1. Label each document "PROJECT RECORD."

2. Keep record documents current. Do not permanently conceal any work until required information has been recorded.

3. Contract Drawings, legibly mark to record actual construction; including but not limited to the following:

a. Depths of various elements; locations of underground items, with dimensions to building walls and corners; changes of dimensions and details; changes made by Addendum, Field Orders or Change Order.

b. Specifications and Addenda; legibly mark each Section to record changes made by Addendum, Field Order or Change Order.

C. As-Built Submittals:

1. At completion of project, transfer changes, addenda items, variations from drawings, exact routes of all feeders and service conduits, and locations of stubbed conduits to clean new prints and specifications which will be supplied by the Architect and deliver to the Architect as "As-reported Record" drawings. Include dimensions to all buried or concealed conduits to permanent structures.

D. Operation and Maintenance Manuals

1. At completion of project, prepare Operation and Maintenance Manuals with operation and Maintenance Data, contractors warranties, and copies of approved electrical permits. Include corrected copies of original submittals and shop drawings.

2. See Division 1 for additional requirements.

3.12 WARRANTIES:

A. Provide a minimum 1 year warranty on all electrical equipment, devices, labor, and work by Division 26 whether specified or not.

B. Provide warranties greater than 1 year as specified in other sections where stated. The warranty requirement most stringent shall be used where conflicts arise.

C. The systems listed below require warranties exceeding the minimum warranty:

1. Lighting; 5 years for Drivers and ballasts refer to Section – 26 51 00

2. Fire Alarm Systems; 2 years refer to Section – 28 31 00

D. Provide copies of all warranties to the owner upon completion of the project.

3.13 COMPLETION:

A. Complete each system as shown or specified herein and place in operation except where only roughing-in or partial systems are called for. Each system shall be tested and left in proper operation free of faults, shorts or unintentional grounds. Demonstrate system in the presence of the Architect, the Owner or their representative when requested.

3.14 FINAL OBSERVATION:

A. Contractor shall submit written certification that:

1. Contract Documents have been reviewed.

2. Contractor has inspected Project for compliance with Contract Documents.

3. Work has been completed in accordance with Contract Documents.

4. Equipment and Systems have been tested and are operational.

5. Project is completed and ready for final inspection.

B. Engineer/Architect will make final inspection as soon as possible after receipt of Certification.

C. Should Engineer/Architect consider that work is finally complete in accordance with Contract Document requirements, Contractor shall make Contract Closeout submittals.

D. Should Engineer/Architect consider that work is not finally complete:

1. He will so notify Contractor, stating reasons.

2. Contractor shall take immediate steps to remedy deficiencies, and send second written notice to Engineer/Architect certifying that work is complete.

3. Engineer/Architect will re-inspect work.

E. The Engineer/Architect will make two final inspections. The first will determine deficiencies and errors in the work and the second will determine whether or not the noted deficiencies and errors have been satisfactorily corrected.

F. If additional inspections are required because of the Contractor's failure to complete the deficiencies and errors prior to the second inspection, costs for the successive inspections will be back-charged to the Contractor by the Owner, who, in turn, will reimburse the Engineer/Architect. Charges will be based as follows:

1. Engineer/Architect time at current billing rates.

2. Travel time, and all other expenses incurred in making inspections.

G. Contractor to provide one (1) journeyman, tools, meters, instruments and other test equipment required by Engineer/Architect. Contractor to remove and replace trims, covers, fixtures, etc., for Engineer/Architect to review and test materials, systems, methods and workmanship. (Example: Removing switchboard and panel covers to take voltage/amp readings, review connections and wire size, etc.)

END OF SECTION 260500

SECTION 260519 – WIRES & CABLES (600V)

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Provide all wires and cables as herein specified and shown on the associated drawings for service conductors, feeder conductors and branch circuit conductors.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

A. Basic Material & Methods – Section 26 05 00.

B. Raceways – Section 26 05 33.

1.3 QUALITY ASSURANCE:

A. All wire and cable shall meet or exceed the following standards:

1. ASTM-B series specifications
2. ICEA S-61-402/NEMA WC 5 - Thermoplastic insulated cables 0-2000 volt
3. UL Standard 62 and 83 – Thermoplastic insulated cable
4. UL VW-1 Flame Test for sizes #12 through #1
5. National Electric Code (NFPA 70) – Latest edition

B. Manufacturer’s shall be engaged in the manufacturing of industry accepted quality wires and cables for a period of no less than 5 years for all types and sizes required.

1.4 SUBMITTALS:

A. None required.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Provide products of Southwire, Houston Wire, Rome Cable, or similar manufacturer located within the continental North American market. Cables made in Europe, Asia, South America, Africa, or other overseas markets are not acceptable.

B. Substitutions: Equivalent manufacturers are allowed at contractors option, no submittals or prior approvals are necessary if cable meets specifications.

2.2 MATERIALS:

A. Application: For use in general wiring applications for lighting and power in ducts, conduits, wireways and other approved raceways with a maximum conductor temperature of 90 degrees C in dry locations and 75 degrees C in wet locations.

B. Provide wires and cables that are chemical, gasoline, and oil resistant. Provide wires and cables that are sunlight resistant.

C. Minimum conductor size shall be No. 12 AWG unless otherwise noted.

D. Where adverse conductor exposure exists, code approved insulation suitable for the conditions encountered shall be used unless shown otherwise on the Drawings.

E. Wire and cable shall be new, shall have grade of insulation, voltage and manufacturer's name permanently marked on outer covering at regular intervals and shall be delivered in complete coils or reels with identifying size and insulation tags.

2.3 COPPER CONDUCTORS:

A. For No. 10 AWG and smaller provide solid conductors or soft drawn stranded copper conductors with type THHN/THWN insulation.

B. For No. 8 AWG and larger provide soft drawn stranded, Class B stranded copper conductors with type THHN/THWN insulation.

2.4 ALUMINUM AND/OR METAL CLAD (MC) CABLING OPTIONS:

A. Aluminum and MC Cabling not acceptable – Provide copper only conductors.

2.5 COLOR CODE:

A. All wires shall be fully colored in sizes 12 through 6 AWG, and color banded at each end with colored tape at all terminations, panels, equipment, junction boxes, and pull boxes for sizes 4 AWG and larger.

B. Color Code throughout the project shall be:

1. 480Y/277V System

Phase A	Brown
Phase B	Orange
Phase C	Yellow
Neutral	Grey
Neutral A (dedicated)	Grey w/brown stripe #12 & #10
Neutral B (dedicated)	Grey w/orange stripe #12 & #10
Neutral C (dedicated)	Grey w/yellow stripe #12 & #10
Equipment Ground	Green

2. 208Y/120V System

Phase A		Black
Phase B	Red	
Phase C	Blue	
Neutral		White
Neutral A (dedicated)		White w/black stripe #12 & #10
Neutral B (dedicated)		White w/red stripe #12 & #10
Neutral C (dedicated)		White w/blue stripe #12 & #10
Equipment Ground		Green
Isolated Ground		Green w/yellow stripe #12 & #10
		Green and Yellow bands #8 and up

C. Provide a permanent, plastic engraved label on the inside of each branch-circuit panelboard throughout the project identifying the Color Code used throughout the project. Refer to NEC 200.6 (D).

2.6 SPLICES AND TERMINATIONS:

A. Splices shall utilize Scotch "Hyflex" or "Ideal" wing nut connector installed properly. Crimp on splices designed to be used without wire stripping are not acceptable.

B. Splices for No. 8 and larger wires shall be made with mechanically applied pressure type connectors.

C. All taped joints shall be with "Scotch 33+" or equal, applied in half-lap layers without stretching to deform.

D. Where splice box is subject to rain, weather, or moisture, provide “Rain Tight” termination device.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Inspect exposed cables for physical damage and remove as length allows.

B. Utilize pulling compound on long pulls. Ensure that cable reels and pulling apparatus are firmly secured prior to pulling. Use pulling attachments and materials including approved swivel connections, pulling eyes, and/or friction tape as applicable. Carefully follow all applicable safety requirements when pulling cables.

C. Do not exceed manufacturers recommendations for maximum allowable tension, or side wall pressure. In all cases, pulling tension applied to the conductors shall be limited to 0.008 lbs. per circular mil of conductor cross-section area.

D. Do not exceed manufacturers recommendations for minimum allowable bending radius. For training of cables, minimum bend radius to inner surfaces of cable shall be 12 times cable diameter. Where cable is pulled under tension over sheaves, conduit bends, or other curved surfaces, make minimum bend radius 50% greater than specified above for training.

E. Provide dedicated neutrals on all branch power receptacle circuits of 120/208 volt.

3.2 BRANCH CIRCUIT GROUNDED CONDUCTOR (NEUTRAL) WIRING METHODS:

A. Dedicated (separate) neutral wiring methods

1. Provide dedicated neutral wiring for the following system(s):

a. Lighting

b. Receptacles

c. Other than lighting and receptacle branch circuits

2. Provide dedicated (separate) neutral for each branch circuit; shared/common neutral wiring is not allowed.

3. For dedicated neutral branch wiring, there shall be no more than six (6) current carrying conductors allowed within a single raceway unless specifically allowed otherwise in the drawings. All neutral conductors shall be considered current carrying. Provide all required wire size increases to account for the applicable NEC wire ampacity deratings.

4. Provide dedicated neutral cables with colored stripe as required in wire color coding section for identification.

3.3 PARALLELED CONDUCTORS:

A. Under no condition shall conductors less than #1/0 AWG copper be run in parallel. Where paralleled runs are used, the contractor must cut to exact length on each phase leg. Where parallel conductors are run in parallel conduits, each conduit shall carry all phase legs as well as neutral, equipment ground, and/or isolated ground conductor as applicable.

B. Size parallel ground conductors as per NEC 250.

3.4 SPLICES AND TERMINATIONS:

A. Splices are to be made up complete promptly after wire installation.

B. Single wire pigtails shall be provided for fixture and device connections. Wirenuts may be used for fixture wire connections to single wire circuit conductor pigtails.

C. Install wing nut connector properly, according to manufacturers written instructions. Crimp on splices designed to be used without wire stripping are not acceptable.

D. Torque bolted connections to manufacturer's recommendations. Torque both ends of the cable, or parallel cables to the same Torque level.

E. Insulation shall be removed with a stripping tool designed specifically for that purpose. A pocket knife is not an acceptable tool. All conductors shall be left nick-free.

F. Thermoplastic insulated wire and cable shall not be installed or handled in temperatures below +14 degrees F (-10 C). Cross-linked polyethylene insulated wire and cable may be installed to -40 degrees F (-40 C).

3.5 LABELING:

A. Feeders – Provide an engraved laminated 3-ply plastic "Lamicoid" or equal label with feeder name attached with a nylon wire tie to the feeder at each entry and exit from pullboxes, wireways and any other similar locations.

B. Branch Circuits – Clearly mark and identify the circuit number(s) at each junction box and similar location with a permanent black marker or equivalent that is clearly visible. For concealed junction boxes the marking shall be made on the outside coverplate; for exposed boxes or boxes with finished coverplates marking shall be made on the interior of the box where visible when removing the coverplate.

3.6 COMMISSIONING AND TESTING:

A. Contractor shall provide for access and inspection of installed wires and cables by the Architect/Engineer, owner and commissioning agent.

B. Document all tests and provide written copies in the O&M manuals.

C. Perform continuity tests and resistance measurements through bolted connections to ensure correct cable connections.

D. Perform insulation resistance test on all feeder conductors exceeding 100 amps, size #2 and larger. Values shall not be less than 50 megaohms.

END OF SECTION 260519

SECTION 26 05 26 – GROUNDING AND BONDING

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Provide all grounding and bonding as code required and as herein specified and shown on the associated drawings.

1.2 APPLICATION:

A. All grounding and bonding shall be by copper only connectors, copper cable and wire, and/or copper braids.

1.3 RELATED WORK SPECIFIED ELSEWHERE:

A. Basic Material & Methods – Section 26 05 00.

B. Wires & Cables – Section 26 05 19.

1.4 QUALITY ASSURANCE:

A. All installation of grounding and bonding conductors shall meet or exceed the following standards:

1. ANSI/IEEE 142 for service ground electrode resistance (5 ohms).
2. Ground electrode resistance at manholes and pad vaults (5 ohms)
3. Ground electrode resistance at transformers (10 ohms)
4. ASTM B 8 stranded conductors
5. ICEA S-61-402/NEMA WC 5 - Thermoplastic insulated cables 0-2000 volt
6. UL Standard 62 and 83 – Thermoplastic insulated cable
4. UL VW-1 Flame Test for sizes #12 through #1
7. National Electric Code (NFPA 70) – Latest edition
8. UL listing is required

B. Manufacturers shall be engaged in the manufacturing of industry accepted quality grounding connectors for a period of no less than 5 years for all types and sizes required.

1.5 SUBMITTALS:

A. None required.

PART 2 - PRODUCTS

2.1 GROUNDING CONNECTORS AND GROUND RODS:

A. ACCEPTABLE MANUFACTURERS: Subject to compliance with all requirements, provide products of one of the following manufacturers for grounding connectors:

a. Chance/Hubbell

b. Copperweld Corporation

c. Erico Inc., Electrical Products Group

d. Burndy Electrical

e. Kearney/Cooper Power Systems

f. O-Z/Gedney Co

g. Raco/Hubbell

h. Thomas & Betts Electrical

B. Provide products of a quality manufacturer located within the continental North American market. Grounding connectors made in Europe, Asia, South America, Africa, or other overseas markets are not acceptable.

C. Provide products that are listed and labeled by UL for all applications used, and for specific types, sizes and combinations of conductors and other items connected.

D. For buried connections, provide crimp style connections or welded type connections. For accessible connections, provide bolted pressure-type, torque as per manufacturers recommendations.

E. Substitutions: Equivalent manufacturers are allowed at contractor’s option, no submittals or prior approvals are necessary if ground connectors and rods meet specifications.

2.2 CONDUCTORS:

A. Provide copper or tinned-copper wire and cable insulated for 600 volt unless otherwise required by applicable code or authorities with jurisdiction.

B. Provide minimum of #6 AWG copper stranded grounding electrode conductor for the portion of the conductor which is the sole connection to the ground rod grounding electrode. The minimum conductor size shall comply with NEC table 250.66.

C. Provide No. 4 and/or No. 6 AWG stranded conductor for bonding conductors.

D. Bonding Jumper: Provide copper tape, braided copper conductors, terminated with copper ferrules, 1-5/8 inches wide and 1/16 inch thick.

PART 3 - EXECUTION

3.1 GROUNDING INSTALLATION:

A. Ground all electric equipment, raceways and enclosures in accordance with code rules and established safety practices.

B. Install insulated equipment grounding conductors in all types of raceways for all power feeders and branch circuits

C. Route grounding electrode conductors along the shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subject to strain, impact, or damage.

D. Grounding electrode conductors and bonding jumper connections to grounding electrodes shall be accessible (unless allowed by NEC 250.68(A) exceptions) and provide a continuous effective grounding path.

E. No. 8 and smaller grounding conductors shall have green insulation. No. 6 and larger shall be marked with green colored tape at each end and at every box, panel, switchboard, or point where conductor is accessible.

F. For equipment subject to vibration, install bonding jumper so that vibration is not transmitted through the grounding connection.

3.2 CONNECTIONS

A. For equipment grounding connections #10 and smaller, grounding conductors may be terminated with appropriate winged pressure type connectors (wirenuts). For #8 and larger, use pressure-type grounding lugs.

B. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturers published torque-tightening values. If manufacturers data is not available, tighten according to UL468A.

C. For compression type connections, use hydraulic compression tools and dies to provide the correct circumferential pressure for all connectors. Use only tools and dies as recommended by the connector manufacturer. Provide embossing die code or other standard method to make a visible, permanent indication that a connector has been adequately compressed onto the grounding conductor.

3.3 COMMISSIONING AND TESTING:

A. Contractor shall provide a time for access and inspection of grounding system for the Architect/Engineer. Correct all defects and flaws found prior to testing.

B. Demonstrate electrical continuity at selected connections to the architect/engineer using an electrical ohmmeter. Point to point resistance values shall not exceed 0.5 ohms. Provide additional bonding as necessary to ensure these resistance values are less than 0.5 ohms.

END OF SECTION 260526

SECTION 260533 - RACEWAYS

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Provide all raceways, wireways, and associated fittings as herein specified and shown on the associated drawings.

1.2 APPLICATION:

A. Electric metallic tubing (EMT), galvanized rigid conduit (GRC), intermediate metal conduit (IMC), and flexible metal conduit may be used. PVC and Electric Non-metallic Tubing (ENT) may not be used.

B. GRC and IMC shall be used in locations subject to mechanical injury, for penetrations of building walls. GRC and IMC may be used: outside, where exposed to weather, in wet locations, in hazardous locations (as approved by code). Schedule 80 PVC may not be substituted for GRC and IMC.

C. EMT may be used only in dry and protected locations. EMT may not be used: outside, where exposed to weather, in hazardous locations or where subject to mechanical injury.

D. Flexible metal conduit (FMC) will be permitted only where flexibility is necessary. FMC may be used only where flexibility is necessary in dry protected locations, such as: connections to recessed light fixtures, work fished into existing concealed dry locations, stud or wood frame construction. Flexible metal conduit shall be used for connection to all equipment subject to movement or vibration such as motors. Length shall not exceed 6 feet unless fishing in existing construction.

E. Liquid-Tight Flexible Metal Conduit (LFMC) shall substitute only in those locations where flexible metal conduit is required and additional moisture protection is desired or needed. LFMC may be used: for connections to motors or fixed equipment where subject to moisture or weather and subject to movement or vibration. Length shall not exceed 6 feet unless specified otherwise.

F. Drawing notes requiring a specific type of raceway shall take precedence over the specifications.

G. Surface Metal Raceways and/or wireways of appropriate size to contain all wires and devices shall be used where indicated. For device locations on existing masonry, or where switching boxes are installed at new ADA height, Surface Metal Raceway equal to Wiremold V500 or V700 series may be used with appropriate mating device box.

H. Surface Plastic raceways (Wiremold) shall not be used as plastic raceways do not survive vandalism in a High School environment.

I. Electrical wiring shall be in U.L. approved raceways and enclosures throughout.

1.3 RELATED WORK SPECIFIED ELSEWHERE:

A. Basic Material & Methods – Section 26 05 00.

B. Wires and cables (600V) – Section 26 05 19.

C. Seismic Restraint for Electrical – Section 26 05 48

1.4 QUALITY ASSURANCE:

A. All installation of conduits and raceways shall meet or exceed the following standards:

1. Rigid Metal Conduit (RMC): in accordance with ANSI C80.1.

2. Electric Metallic Tubing (EMT): in accordance with ANSI C80.3.

3. Seismic Bracing: ASCE 7-10, Section 13.6, latest edition

4. National Electric Code (NFPA 70) – Latest edition

5. UL listing is required

B. Manufacturer's shall be engaged in the manufacturing of industry accepted quality raceway for a period of no less than 5 years for all types and sizes required.

1.5 SUBMITTALS:

A. Conduit and conduit fitting product data submittals are not required.

B. Submit seismic bracing calculations, bracing and anchoring products, and bracing designs for suspended conduits and conduit racks as a deferred submittal as required per section 26 05 48. Submittal shall be as early as possible in the contract and prior to installing suspended conduits and conduit racks. Installation shall comply with the deferred submittal including all components and anchors used.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Provide products of a quality manufacturer located within the continental North American market. Conduit and Raceways and Fittings made in Europe, Asia, South America, Africa, or other overseas markets are not acceptable.

B. Substitutions: Equivalent manufacturers are allowed at contractor's option, no submittals or prior approvals are necessary if conduit and fittings meet specifications.

2.2 RACEWAYS:

A. Galvanized Rigid Metal Conduit (GRC): Provide zinc-coated, hot-dipped galvanized, rigid metallic conduit in sizes indicated on the drawings. Provide RMC in ¾ inch minimum size.

B. Intermediate Metal Conduit (IMC): Provide hot-dipped galvanized, intermediate metal conduit in sizes indicated on the drawings. Provide IMC in ¾ inch minimum size.

C. Electric Metallic Tubing (EMT): Provide electric metal tubing in sizes indicated on the drawings.

Provide EMT in ¾ inch minimum size;

D. Liquid-Tight Flexible Metal Conduit: Provide liquid-tight, flexible metal conduit, constructed of single strip, flexible continuous, interlocked, and double-wrapped steel, galvanized inside and outside, coated with liquid-tight jacket of flexible Polyvinyl Chloride (PVC). Provide Liquid-Tight Flexible conduit in ¾ inch minimum size.

E. Aluminum conduit is not acceptable.

2.3 FITTINGS:

A. Provide listed fittings and connectors that are suitable for the application and the environment installed.

B. EMT Connectors and couplings shall be steel, set screw type for interior application. EMT connectors and couplings where located outside in protected locations or where subject to damp environments shall use compression type connections.

C. For EMT connections to panelboards and boxes that exceed one inch size, or where #4 or larger conductors are pulled, or for any size conduit where subject to vibration, provide with insulated throats on connectors or other identified fitting providing a smoothly rounded insulating surface integral to the fitting. Use insulated throat set-screw connectors for smaller conduit sizes up to one inch, and use O-Z/Gedney type SBT/SB insulated bushings or equal selected by the contractor for sizes 1-1/4 inch and larger.

D. Aluminum fittings, Die-cast fittings or fittings made from pot metal shall not be allowed. Indenter type fittings are not acceptable.

E. Plastic only bushings are not to be used on power conduits.

F. GRC and IMC shall be coupled and terminated with threaded fittings. Provide fully-threaded, malleable steel fittings, rain-tight and concrete-tight as applicable. Provide double locknuts and metal bushings with insulated throat at all conduit terminations at boxes, panels, cabinets, switchboards, and stub-outs Fittings of O-Z/Gedney type B or equal As selected by the contractor are acceptable for these applications.

G. FMC and LFMC fittings shall be in accordance to industry standards.

H. Sealing bushings are to be provided equal to O-Z/Gedney Type FSK, WSK or CSMI as required by application. Provide equal to O-Z/Gedney Type CSB for internal sealing busings.

I. Expansion fittings shall be equal to O-Z/Gedey AXDX.

2.4 SUPPORT AND SEISMIC BRACING COMPONENTS

A. Provide C clamps, beam clamps, and other type clamps for direct installation on structural beams or wall structures.

B. For suspended conduits, refer to section 26 05 48 for required deferred submittals and seismic bracing design requirements. Provide rigid support for all conduits, tie wire and systems that utilize wire as main vertical support are not allowed, wire may be used for horizontal and longitudinal bracing only if calculated and detailed in the contractors deferred submittal and approved by the shop drawing process.

C. As necessary and as shown in deferred submittal for suspended conduits, provide the following components for vertical support and lateral/longitudinal seismic bracing:

1. Strut: Unistrut (or equal) P1000 Metal Framing Channel

2. Allthread: Stainless Steel, 3/8 minimum size

3. Angles/Hinges: Bline B335-2 or Mason Industries SCB Swivel Anchor

4. Expansion anchors: Hilti Kwik Bolt II (or equal) minimum 3/8 inch x 2-1/4 inch depth

5. Hardware: Miscellaneous cap screw/spring nuts and other hardware required for a complete system.

6. Other hardware as designed in the contractors deferred submittal per section 26 05 48.

2.5 BOXES

A. Refer to section 26 05 00 for appropriate boxes.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Provide pull boxes where shown or required to limit the number of bends in any run to not more than three 90 degree bends. Use code gauge galvanized sheet steel boxes of code required size with removable covers, installed so that covers will be accessible after work is completed. Verify with the Engineer/Architect any locations in finished areas.

B. Exposed raceways shall be parallel to structural lines and location must be approved by Architect/Engineer prior to installation.

C. Do not place conduits within 1-1/2 inches of the upper flutes of roof decking.

D. Maintain a minimum of 6 inches spacing from Hot water and/or steam lines, and 2 inches from Chilled Water and Culinary Water lines. Do not support conduit from other utility services.

E. All conduit leaving building envelope (e.g. site lighting, roof mounted HVAC requirement, etc.) to be 0.75" minimum.

F. Field bends and offsets shall be made without flattening, kinking, rippling or destroying the smooth internal bore or surface of the conduit and to not less than NEC minimum radius. Conduit that shows signs of rippling or kinking shall not be installed. Any conduits installed with wrinkles or kinks or otherwise in an unworkmanlike manner shall be replaced at no additional cost to owner.

G. Precaution shall be exercised to prevent accumulation of water, dirt, concrete, or other foreign matter in the conduits during the execution of the project. Conduits in which water or foreign matter has been permitted to accumulate shall be thoroughly cleaned or the conduits runs replaced where such accumulation cannot be removed by methods approved the engineer.

H. Permanently cap all spare conduits. Cap or plug conduit ends during construction to prevent entrance of foreign material.

I. For metal conduit systems, provide electrically continuous conduit systems throughout.

J. Where drilling through existing floors or walls, use x-ray or penetrating location device to identify steel elements prior to drilling. Avoid cutting existing reinforcing bars. If nicked or damaged, consult with a licensed structural engineer for repair and support methods and provide required materials and repair.

K. Provide ground wire within all conduits sized per NEC code.

3.2 SUPPORT AND SEISMIC BRACING INSTALLATION:

A. Individual suspended conduits and conduit racks shall be adequately braced for Seismic Restraint, as required per ASCE 7-10, section 13.3, latest edition. All life safety conduits, all conduits 2 inches and larger exceeding 12 inch suspension, and all multi-conduit racks exceeding 12 inch suspension shall be calculated and braced using the calculations methods of the ASCE and reviewed by the Architect/Engineer. Contractor shall perform the required calculations as early as possible in the contract and prior to installing suspended conduit racks.

B. For 3 or more conduits install conduit racks with trapeze style hanging system, with stainless steel 3/8 inch all-threads hanging down to a Galvanized steel strut assembly. Provide conduit clips to rigidly clip conduit to strut.

C. Provide a diagonal lateral seismic restraint braces at maximum 10 foot intervals (alternating directions), and a longitudinal brace (alternating directions) at maximum 30 foot intervals. Braces must be made of strut or similar rigid material, and will be tied directly to trapeze strut with hinges or rigid angles. Wire ties for bracing will not be acceptable. All hardware made for bracing shall be seismically rated.

D. If a large number of suspended conduit feeders (more than 12 each exceeding 2-1/2 inches in size) are grouped together, the contractor shall review the layout with the structural engineer, provide estimated weights, and obtain approval for the proposed layout.

E. Hanger rods shall be fastened to structure in an approved manner. Pullout resistance shall have a safety factor of 4.

F. Support individual suspended feeder conduits by metal ring or trapeze hangers with threaded steel rods.

G. Support spacing shall be in accordance with the following table, in addition to these maximum spacing requirements the seismic support and bracing may require additional support and/or spacing supports less than the maximum distance indicated below; the most stringent requirement and shortest spacing distances shall be enforced.

Conduit Type:	Conduit Size:	Maximum Distance Between Conduit Supports:	Maximum Distance From outlet box, junction box, cabinet, fitting, conduit termination or bends larger than 22 degrees.
IMC/GRC	½" to ¾" 1" 1.25" to 1.5" 2" to 2.5" 3" and larger	10 feet 12 feet 14 feet 16 feet 20 feet	3 feet for all sizes
EMT	All Sizes	10 feet	3 feet
FMC	All Sizes	4.5 feet	1 foot
LFMC	All Sizes	4.5 feet	1 foot

3.3 FIELD CUTS AND THREADS:

A. Cut all conduits perpendicular and square. Remove all sharp or rough edges and ream all burrs, inside and outside.

B. Provide clean sharp threads on RMC and IMC. Engage at least five full threads on all RMC and IMC fittings.

C. Before couplings or fittings are attached, apply one coat of red lead or zinc chromate to male threads of RMC or IMC.

D. Apply coat of red lead, zinc chromate or special compound recommended by manufacture to conduit where conduit protective coating is damaged.

3.4 EXPANSION AND SEISMIC JOINTS

A. Expansion Joints:

1. All conduits three inches and larger where not cast in concrete shall be rigidly secured to the building structure on opposite sides of a building expansion joint with an expansion-deflection fitting across the joint, equivalent to O-Z/Gedney AXDX, installed per manufacturer's recommendations.

2. All conduits less than three inches where not cast in concrete shall be provided with junction boxes securely fastened on both sides of the expansion joint, connected together with 15 inches of slack (a minimum of 15 inches longer than the straight line length) flexible conduit and copper green ground bonding jumper. In lieu of this flexible conduit, an expansion-deflection fitting, as indicated for conduits three inch and larger, may be installed.

B. Seismic Joints:

1. All conduits shall be provided with junction boxes securely fastened on both sides of the seismic joint, connected together with 15 inches of slack (a minimum of 15 inches longer than the straight line length) flexible conduit and copper green ground bonding jumper. Prior to installation, verify with Architect that the 15 inches is adequate for the designed movement, and if not, increase this length as required.

3.5 CLEANING:

A. Pull a mandril and swab through all conduits before installing conductors. Raceways shall be left clean and free of debris.

B. Provide a pull string in all empty conduits.

3.7 COMMISSIONING AND FINAL INSPECTION:

A. Contractor shall provide a time for access and inspection of raceway system for the Architect/Engineer. Correct all defects and flaws found prior to wall and ceiling installation and prior to cabling installation.

B. Demonstrate electrical continuity at selected joints to the Architect/Engineer using an electrical ohmmeter.

C. Demonstrate rigid seismic bracing to ensure minimal movement of the raceways on suspended racks in a seismic event. Demonstration shall be by pushing with at least 25 pounds force laterally and longitudinally at selected (mid-span) locations along the length of the suspended raceway rack. Rack shall not move more than 2 inches during these demonstrations.

END OF SECTION 260533

SECTION 260548 – SEISMIC RESTRAINT FOR ELECTRICAL WORK

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. This section includes seismic anchoring, and seismic bracing and restraints and other earthquake damage reduction measures for electrical systems, and electrical components. It complements seismic construction requirements located in other sections of the specification.

B. Provide seismic bracing and support Design for all electrical and life safety components for the facility. Provide structural design of all components by a licensed Structural Engineer in the State of Utah, qualified as indicated in Quality Assurance section 1.5 below. All calculations and designs shall have a professional engineering stamp. The licensed structural engineer shall be hired by the Contractor as a payed consultant on the project upon bid award, and shall visit the project site during construction to verify the installation meets the calculations prepared by the Engineer.

C. The 2015 IBC Chapter 16, section 1613.1; and the ASCE 7-10 American Society of Civil Engineering "Minimum Design Loads for Buildings and Structures", section 13, shall define the minimum requirements for seismic design of nonstructural systems.

D. Submit calculations and Shop drawings showing design intent, anchors, materials to the Architect/Engineer and the Authority Having Jurisdiction as a deferred submittal.

E. It should be noted that the design of the seismic bracing depends heavily on the components and manufacturers purchased in the various electrical divisions. Other electrical divisions will need to have approved submittals prior to completing the submittals for this section. Time is of the essence in providing submittals promptly to avoid construction delays.

F. Provide all seismic supports, and associated fittings as herein specified and shown on the associated drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

A. Basic Material & Methods – Section 26 05 00.

B. Raceways – Section 26 05 33.

1.3 REFERENCES

A. International Building Code, Current Edition in use by Jurisdictional Authority.

B. NFPA Bulletin 90A, Current Edition.

C. UL Standard 181.

1.4 SYSTEM DESCRIPTION

A. The Division 26 Contractor shall be responsible for supplying and installing equipment, vibration isolators, flexible connections, rigid steel frames, anchors, inserts, hangers and attachments, supports, and bracing to comply with the following:

1. Short period design spectral response acceleration coefficient S_{DS}= _____. Reference USGS site mapping tool for specific latitude and longitude of the site: http://earthquake.usgs.gov/designmaps/us/application.php

2. One-second period design spectral response acceleration coefficient S_{D1}= _____.

3. Site ClassD.

B. The following components have a component importance factor I_P of 1.5:

1. Fire Alarm System
2. Life Safety Egress Lighting

C. All other components have an importance factor I_P of 1.0.

1.5 QUALITY ASSURANCE

A. All supports, hangers, bases, anchorage and bracing for all isolated equipment and non-isolated equipment shall be designed by a Professional Engineer licensed in the state where the project is located, qualified with Seismic experience in bracing for electrical equipment, and referred to as the Seismic Engineer. Shop drawings included with deferred submittal for earthquake bracing and anchors from the restraint manufacturer shall bear the Engineer's signed professional seal. All calculations/design work required for the seismic anchorage and restraint of all Division 26, 27, and 28 equipment and systems shall be provided by a single firm.

B. The above qualified Seismic Engineer shall determine specific requirements for equipment anchorage and restraints, locations and sizes based on shop drawings for the electrical equipment which have been submitted, reviewed and accepted by the Architect/Engineer for this project.

C. The Seismic Engineer shall field inspect final installation and certify that bracing and anchorage are in conformance with the Seismic Engineer’s design, the requirements of this specification section, and all seismic restraint requirements of the building code. Provide a certificate of compliance stating all Division 26, 27, and 28 raceway systems and equipment have been anchored and restrained in accordance with the requirements of the building code and ASCE 7. The certificate of compliance shall include the Seismic Engineer’s signed Professional Engineer’s seal. Include a copy of the certificate in each copy of the Operation and Maintenance Manual.

D. The Division 26 Contractor shall require all equipment suppliers to furnish equipment that meets the seismic code, with bases/skids/curbs designed to receive seismic bracing and/or anchorage. All isolated and non-isolated electrical equipment bracing to be used in the project shall be designed from the equipment submittals and certified to be code-compliant by the equipment manufacturer for seismic description loads defined above, with direct anchorage capability.

E. Manufacturers shall be engaged in the manufacturing of industry accepted quality supports for conduits and raceways for a period of no less than 5 years for all types and sizes required.

1.5 SUBMITTALS:

A. Deferred Submittals: Provide Seismic Certificate from manufacturer of all electrical equipment indicating that the equipment will withstand the forces, and has been tested using the IEEE method or calculated with the ASCE method using appropriate site acceleration and importance factors for the installed location and occupancy classification expected. Simply labeling it “Seismic Zone 4” under the old Uniform Building Code or “California Seismic approved” is not acceptable and will be rejected. Certificate shall be by an independent testing laboratory or licensed structural engineer. OSHPD certification may be substituted for independent certification, but must show on each component of the equipment with exact model number.

B. Deferred Submittals: Provide drawings and details showing sizes, types, and assemblies of all seismic bracing and anchoring in sufficient detail to submit to the authority having jurisdiction at the State of Utah. Include stamped and signed calculations from a professional structural engineer licensed in the State of Utah.

C. Product Data: Submit product data that illustrates and indicates type, styles, materials, strength rating, fastening provisions, and finish for each type and size of seismic restraint component used.

1. Anchor bolts and studs: Tabulate types and sizes, complete with report numbers and rated strength in tension and shear as evaluated by an independent agency.

2. Cable and wire rope assemblies: Tabulate types and sizes, complete with report numbers on rated strength in tension and shear as evaluated by an independent agency.

3. Details: Contractor shall provide details of assembly arrangement, including attachment to differing types of structures. Show attachment locations, methods, spacing’s, identifying components and listing their strengths. Indicate direction and value of forces (calculated or tested) transmitted to structure during seismic events.

4. The support seismic – restraint designs must be signed and sealed by a qualified professional structural engineer, licensed in the State of Utah, paid for by the contractor.

B. Coordination Drawings: Show coordination of seismic bracing of electrical components with other systems and equipment in the vicinity, including mechanical ductwork and piping. Show bridging elements to assure that all electrical components anchor to the structure, rather than into ductwork or piping supports.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Provide products of a quality manufacturer located within the continental North American market. Supports made in Europe, Asia, South America, Africa, or other overseas markets are not acceptable. The following manufacturer's products may be incorporated into the work:

1. Amber/Booth Company, Inc.
2. B-Line Systems, a division of Cooper
3. Erico, Inc.
4. California Dynamics Corporation
5. Hilti, Inc.
6. Loos&Co: Seismic Earthquake Division
7. Mason Industries
8. TOLCO Incorporated; a brand of NIBCO Inc
9. Unistrut; Tyco International, Ltd.
10. GS Metals Corp.
11. Powerstrut
12. Thomas and Betts Corp.
13. Vibro Acoustics

B. Substitutions: Equivalent manufacturers are allowed at contractor's option, no submittals or prior approvals are necessary if supports meet specifications and are detailed in the deferred submittal by the licensed structural engineer.

2.2 COMPONENTS:

A. Rigid Channel Support Systems: Shop or field fabricated assembly made of slotted steel channels with accessories for attachment to braced component at one end and to the building structure on the other end. Provide corrosion resistant coating.

B. Restraint Cables: ASTM A 603 galvanized steel cables with end connections made of thimbles, brackets, swivels, and bolts designed for restraining cable service, and with a minimum of two clamping bolts for cable engagement.

C. Hanging rod Stiffener: Steel tube or steel slotted channel support systems sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.

D. Bushings for Floor Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.

E. Bushing Assemblies for Wall Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.

F. Resilient Isolation Washers and Bushings: One-piece, oil resistant, water resistant, molded neoprene, with a flat washer face.

2.3 ANCHOR BOLTS:

A. Mechanical Anchor: Drilled in and stud-wedge or female-wedge type in zinc-coated steel for interior applications. Provide Stainless steel for exterior applications. Select anchors with strength required for anchor and as tested in accordance with ASTM E 488. Minimum length shall be eight times the diameter.

B. Adhesive Anchors: Drilled in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injection polymer or hybrid mortar adhesive. Verify that Adhesive meets all LEED requirements. Provide anchor bolts in zinc-coated steel for interior applications. Provide stainless steel for exterior applications. Select anchors with strength required for anchor and as tested in accordance with ASTM E 488.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Install seismic restraints in accordance to applicable codes and regulations as approved by authorities having jurisdiction.

B. Examine structure for reinforcing and avoid structural reinforcing in concrete before drilling. Where depth and location is unknown, employ X-ray and/or radio frequency locating prior to drilling.

3.2 SUPPORT AND SEISMIC BRACING INSTALLATION:

A. Conduit racks and suspended conduits shall be adequately braced for Seismic Restraint, as required per ASCE 7-10, latest edition.

B. Install conduit racks with trapeze style hanging system, with stainless steel 3/8 inch all threads hanging down to a Galvanized steel strut assembly. Provide conduit clips to rigidly clip conduit to strut.

C. Provide a diagonal lateral seismic restraint braces at maximum 10 foot intervals (alternating directions), and a longitudinal brace (alternating directions) at maximum 30 foot intervals. Braces must be made of strut or similar rigid material, and will be tied directly to trapeze strut with hinges or rigid angles. Wire ties for bracing will not be acceptable. All hardware made for bracing shall be seismically rated.

D. If a large number of suspended conduit feeders (more than 12 each exceeding 2-1/2 inches in size) are grouped together, the contractor shall review the layout with the structural engineer, provide estimated weights, and obtain approval for the proposed layout.

E. Hanger rods shall be fastened to structure in an approved manner. Pullout resistance shall have a safety factor of 4.

F. Support individual suspended feeder conduits by metal ring or trapeze hangers with threaded steel rods.

3.7 COMMISSIONING AND FINAL INSPECTION:

A. Contractor shall provide a time for access and inspection of seismic support system for the Architect/Engineer, the Seismic Engineer they hired, the Owner, and the commissioning agent. Correct all defects and flaws found prior to ceiling installation and prior to cabling installation.

B. Demonstrate rigid seismic bracing to ensure minimal movement of the raceways on suspended racks in a seismic event. Demonstration shall be by pushing with at least 25 pounds force laterally and longitudinally at selected (mid-span) locations along the length of the suspended raceway rack. Rack shall not move more than one inch during these demonstrations.

END OF SECTION 260548

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Provide new branch circuit panelboard as herein specified and shown on the drawings.

B. Provide new breakers in existing panelboards and switchboards to remain, with manufacturer and breaker series to match the existing panel rating.

1.2 SUBMITTALS:

A. Submit complete and descriptive shop drawings indicating dimensions and compliance with the specifications herein. Submit in accordance with the General Conditions, Division 01, and Section 26 05 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Breaker Panels: Square D, Siemens, General Electric, Cutler-Hammer/Westinghouse,

B. Requests for substitution of other products will be considered if submitted in accordance with the General Conditions, Division 01, and Section 26 05 00.

2.2 EQUIPMENT:

A. Panels shall be factory pre-assembled using bolt-on circuit breakers, equivalent to Square D NQOD series. Separate feeder lugs shall be provided for each feeder conductor.

B. Breakers in branch panelboards shall be not less than 3/4 inch on centers. Each breaker shall be securely fastened to prevent movement and trims shall fit neatly and tightly to the breaker assembly. Two and three pole breakers shall be single breaker assembly rather than two or three single pole breakers with the handles tied together externally.

C. Panel finish shall be a flat, light gray finish suitable for painting over or being left with factory finish. Flush mounted panels in finished walls shall be painted to match wall, paint and paint preparation to be as specified by Architect. Panel covers to be painted off wall, then installed over painted wall surface. Trims to be separately packed and protected from scratching and marring. Refer to labeling requirements in 26 05 00 Basic Materials and Methods.

D. Panel covers to be “Door in Door” or “Hinged Trim Front” style to permit authorized personnel to open the outer door and have access to the entire interior of the can. The inner door shall access only the breaker handles. Provide flush stainless steel cylinder lock with catch and coil spring loaded door pull. All panels shall be keyed alike, but inner and outer doors shall not be keyed alike.

E. Where grounding conductors are shown or specified, provide each panel and distribution center with grounding bus to which the grounding conductors shall be connected, each having its own terminal or lug.

F. Panelboards rated 400 amps or less shall not exceed 6" depth.

G. Provide Fully rated equipment greater than or equal to the interrupting capacities indicated on the drawings.

H. Provide all copper bus bars, 100% rated neutral bus, and ground bus. Lugs shall be rated for copper only, CU-AL rated lugs shall not be allowed.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Install surface mounted panelboards plumb and parallel to building lines. Fill all previous holes in masonry with sealant prior to installing new panelboard. Extend all existing circuit wires and conduits into the new panelboard and repair/replace or add conduit support within 3 ft of the panelboard as required by code.

B. Where necessary, trace all branch circuits and note existing devices and circuits to remain on panelboard label.

3.2 LABELING:

A. No brand labels or other marking shall be on the outside of the panels. Where changes are made in existing panels, distribution boards, etc., provide new labeling and schedules to accurately reflect the changes; hand written revisions will not be acceptable.

B. Provide engraved nameplate for all panelboards permanently mounted inside door for flush panels and on the outside face of the door for surface panels; include the following minimum information:

1. Panelboard name

2. Source feeding panel

3. Voltage, Size (amps), number of phases, number of wires, and AIC rating

C. Engraved nameplates shall be have a black back ply, an inner white ply with outer colored ply as follows: Black for normal power, Red for Emergency (Legally Required or Optional Standby) power.

D. Provide typewritten branch panel schedules with protective clear, transparent covers accounting for every breaker installed. Use actual room designations assigned by name or number near completion of the work, and not the designations shown on drawings.

E. Provide a permanent engraved label or include with the panel schedule information indicating the conductor insulation color for: (1) all ungrounded conductors (2) grounded conductor (3) equipment grounding conductor. This shall be documented at each panelboard in a readily visible location; refer to Wires and Cables Section 26 05 19 for conductor color coding.

3.3 COMMISSIONING:

A. All current carrying devices and terminations within this section shall be inspected by performing a thermographic survey with normal load conditions applied to the system.

B. Inspect distribution systems with thermal imaging equipment capable of detecting a minimum temperature difference of 1° C at 30° C.

C. Equipment shall detect emitted radiation and convert it to a visual signal.

D. Perform thermographic survey during periods of maximum possible loading.

E. Perform actions to correct any and all deficiencies.

F. Provide a certified report including the following:

1. Equipment to be tested

2. Any and all discrepancies

3. Temperature difference between concern area and reference area

4. Probable cause of temperature difference

5. Areas inspected, any areas and equipment which are unobservable

6. Actual load conditions at time of inspection

7. Provide photographs and thermograms of the deficient area

8. Action to correct deficiencies

G. Re-test all areas with deficiencies that have been adjusted to verify acceptable temperature differences.

END OF SECTION 262416

SECTION 262726 – WIRING DEVICES

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Provide all switches, receptacles, and other devices as herein specified and shown on the associated drawings.

B. Provide cord caps on existing welder machines to match and mate with the new receptacles. There are a total of 19 existing machines that will get cord cap replacements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Bryant, Arrow-Hart, Eagle, LeGrand, General Electric, Leviton, Hubbell are acceptable.

2.2 MATERIALS:

A. The following list of wiring devices covers the most commonly specified items and establishes the grade of device. Should the Drawings indicate a device other than those listed herein without reference to catalog number, such device shall be of the same grade and manufacturer as like devices.

Single Pole Switches	Hubbell #1221
Duplex Receptacles - 20 amp	Hubbell #5362
Duplex Receptacles – GFCI	Hubbell
NEMA rated receptacles, 208 V	Hubbell

All wiring devices and plates to be specification grade. Receptacles shall be mounted vertically with the ground pin down unless otherwise noted.

B. Color of devices and plates to be selected by Architect. Provide galvanized plates throughout the shop area.

C. All device plates shall have panel and circuit designation labeled on face, and highlighted in a contrasting color.

PART 3 - EXECUTION

3.1 GENERAL:

A. Coordination with General Contractor and Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials such as paint over devices or interior of boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables. Clean before device and coverplate installation.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

B. Provide a separate GFI type receptacle for each receptacle noted on plans as GFI. Standard receptacles fed from an up-steam GFI type receptacle are not acceptable.

C. Install outlets and switches in a neat manner with plates covering all gaps between box and adjacent wall surface.

D. Extend mudrings to flush out with surrounding panels and walls. In sheetrock, the mudring shall not be less than 1/8 inch recessed from surrounding wall surface, and shall not protrude more the 1/16 inch.

E. Faceplates, devices, and boxes shall be square with floor, and door lines. Outlet plates of adjacent outlets shall be vertically aligned to within 1/16 inch.

F. Bond ground terminal of each receptacles to equipment ground conductor, and provide green bonding jumper to box grounding screw when used with metal boxes.

G. Devices to be installed flush with faceplate. Do not overtighten and crack or warp the coverplate

3.2 DEVICE INSTALLATION:

A. Replace all devices that have been in temporary use during construction or that show signs of where or damage, that they were installed before building finishing operations were complete.

B. Keep each wiring device in its package or otherwise protected until it is time to install and connect conductors.

C. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.

D. Provide pigtails to connect building branch circuits to devices using pigtails that are not less than 6 inches in length.

E. Side wiring to binding-head screw is the required method of termination when available. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw and torque as recommended by the manufacturer.

F. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.

G. Tighten unused terminal screws on the device to minimize risk of accidental shock.

H. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

I. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

J. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening

3.3 LABELING:

A. Provide self-adhesive labels for all switches and receptacles in compliance with Part 3.3 of Section 26 05 00.

B. Where switches control remote lighting or power outlets, or where switches in the same outlet (two or more) serve different purposes, such as light, power, intercom, etc. or different areas, such as corridor and outside, provide self-adhesive labels clearly indicating the function of each switch or outlet.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or plug in device with illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Using the test plug of the testing instrument, verify that the device and its outlet box are securely mounted.
2. Test at least one receptacle per circuit, or 20 percent of installed receptacles with instrument or testing device and write down results for O&M manuals. The tests shall be diagnostic, indicating potential damaged or misconnected conductors, poor connections, inadequate ground current path, defective devices, or similar problems.
3. Line Voltage: Where testing instrument or device indicates problems, test the actual voltage to the device. Acceptable range is 107 to 127 V.
4. Ground Impedance: Where test instrument or device shows ground issues, test the value of ground resistance. Values of up to 5 ohms are acceptable.
5. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

C. Correct circuit conditions after testing, remove malfunctioning units and replace with new ones, and retest as specified above.

D. Provide device testing report in O&M manuals. Indicate pass/fail results and actual values before and after corrections.

END OF SECTION 262726

SECTION 262900 – MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Extent of motor controller and starter work is indicated by drawings, schedules and specified herein.

B. Work includes the complete installation, electrical connections, testing, and commissioning of starters and combination disconnect/starters.

C. Verify compatibility of motor controllers and starters with motors supplied under Division 22 and 23. Review Division 22 and 23 specifications, plans, schedules, etc., to issue compatibility.

1.2 QUALITY ASSURANCE:

Comply with NEC, and NEMA Standards as applicable to wiring methods, construction and installation of motor controllers, starters, and combination disconnects/starters. Provide complete packaged units which have been UL-listed and labeled by Underwriters Laboratory or ETL Testing Laboratories, Inc. Note: The entire unit shall carry the label, not just components.

1.3 SUBMITTALS:

A. Submit complete and descriptive shop drawings indicating dimensions and compliance with the specifications herein. Submit manufacturer's installation instructions under provisions of general conditions.

B. Submit dimensions of all units.

C. Equipment list and ratings: list motors to be controlled, with motor identification, function and location, starter characteristics, size, voltage, phase and current ratings, control equipment and accessories as specified, scheduled or noted.

D. Coordinate all motor starter sizes and requirements with Division 22 and 23 Contractor prior to submittal for approval.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. COMBINATION STARTER/DISCONNECTS – STAND ALONE UNITS: Subject to compliance with requirements, provide products manufactured by one of the following:

Square D
GE

Siemens
Cutler Hammer

2.2 COMBINATION STARTERS

A. Starters: combination type with fused disconnect switch with time delay dual element, 3 pole, UL Class RK-5 fuses as scheduled; full voltage, non-reversing magnetic starter unless otherwise shown or noted. Provide quick make, quick break disconnect. Starters shall have electronic resettable thermal overload elements for all three phases with settings sized for the actual final motor nameplate full load current. Minimum starter size shall be NEMA 1. For sizes 4 and above, provide electronic soft start system starter. Exterior starters shall be rated NEMA 3R.

2.3 STARTERS

A. Each magnetic starter shall include:

a. Hand-Off-Automatic selector switch unless otherwise shown or noted. HOA switch to be of a type that is field convertible to "On/Off" or "Auto/Off".

b. A thermal element reset button.

c. A red transformer type pilot light to indicate when the motor is running.

d. A 120V holding coil.

e. A 480/120V control transformer with primary and secondary fuse protection; of sufficient VA to handle the holding coil and associated controls. One leg of the transformer secondary shall be grounded.

f. Two normally open and two normally closed auxiliary contacts.

g. A nameplate engraved with motor identification and Horsepower, Nameplate, HOA switch, reset button and pilot light shall be mounted in cubicle door. A door mounted keypad display with indicators, allowing user to program

B. Each electronic solid state starter shall include the items indicated above, plus the following items:

a. Ramp time, type of start, type of step. Display to show motor current, power factor, and fault status.

b. Phase loss protection and phase reversal protection.

1. The solid state starter shall utilize an 18 pulse converter design, to maintain minimal AC line distortion and low harmonics.

2. The Solid State Starter and all components shall be rated to 100,000 AIC.

4. The starter shall have an adjustable ramp start of 0.5 to 180 seconds, and an adjustable current limit of 0% to 85% of Locked Rotor Current. The starter shall also have an adjustable Soft Stop from 0 to 60 seconds.

5. The starter shall have fault isolation, to automatically disconnect the power supply to protect the motor in the event of a semi-conductor fault.

6. The starter shall be equipped with an Electronic Timing Relay, adjustable from 0.1 to 60 seconds, to delay the start of the motor.

7. Provide an elapsed Time Meter on door to indicate pump run time.

8. Finish: Fronts shall be made of cleaned phosphatized steel with rust-inhibiting primer and electro-deposited baked enamel finish, manufacturer's standard color.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Starters shall be installed level, plumb and anchored to the mounting surface in accordance with the manufacturer's instructions. The equipment shall be protected if stored during construction.

B. Seismic restraints: Provide anchor bolts, angle irons and fasteners to attach the combination starters rigidly to the building structure per IBC seismic requirements.

C. Inspect operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.

D. Touch-up scratched or marred surfaces to match original finish.

E. Clean interiors of motor controllers and starters prior to energization.

3.2 LABELING:

A. Where changes are made to existing motor controllers, provide new labeling to accurately reflect the changes; hand written revisions will not be acceptable.

B. Provide engraved nameplate for all motor controllers mounted on the outside face of the Controller; include the following minimum information:

1. Name of Motor or Equipment Controlled

2. Source feeding Motor Controller

3. Voltage, NEMA starter size, number of phases

4. Disconnect size in amps (where applicable), fuse size in amps (where applicable)

C. Engraved nameplates shall be have a black back ply, an inner white ply with outer colored ply as follows: Black for normal power, Red for Emergency (Legally Required or Optional Standby) power, Orange for UPS power.

3.3 TESTING:

A. When all motors are connected and the pre-energizing tests have been completed, the contractor shall operate the equipment to demonstrate that all control equipment and overcurrent protective devices perform as specified. Any deficiencies found shall be corrected and tests repeated. All test results and dates shall be recorded and submitted to the Engineer and the Owner's Representative with statement certifying that the equipment is safe and ready for use.

END OF SECTION 262900

SECTION 265100 - LIGHTING

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Provide light fixtures with lamps and accessories as herein specified and shown on the drawings.

1.2 QUALITY ASSURANCE:

A. If the catalog number of a specified fixture should conflict with the fixture description or the general lighting specifications, such conflicts shall be brought to the attention of the Architect prior to bidding.

B. The dimensions shown on the luminaire schedule are for general reference only. Refer to the manufacturer's shop drawings for exact dimensions prior to rough in.

1.3 SUBMITTALS:

A. Submit product data and shop drawings for fixtures, ballasts, and lamps in accordance with the General Conditions, Division 1, and Section 26 05 00.

B. Verify that fixture description matches that which is indicated by the specified catalog number.

C. All features mentioned in the fixture list shall be marked on the submitted items.

D. Submit written confirmation that dimming ballasts and dimming controls are compatible.

E. Submit Operation and Maintenance data in accordance with the General Conditions, Division 1, and Section 26 05 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. See Luminaire Schedule for acceptable manufacturers.

B. Requests for substitution of other products will be considered if submitted in accordance with the General Conditions, Division 1, and Section 26 05 00.

C. Substitution requests for fixtures equal to those specified shall include complete construction and photometric data including, if applicable, candlepower distribution curve, spacing to mounting height ratio, table of coefficients of utilization, isofootcandle curve, ANSI beam spread classification, efficiency, etc.

D. Submittals and substitution requests for fluorescent fixtures shall include the sheet metal gauge of the housing and the lens thickness, material, and pattern.

2.2 MATERIALS:

A. Polystyrene lenses and lenses less than 0.125 inches nominal thickness shall not be permitted unless otherwise noted.

B. Provide luminaires with Area Coverage, damp, or wet label if required for the application indicated.

C. All luminaires shall be free of light leaks.

2.3 DRIVERS AND BALLASTS:

A. All drivers and ballasts shall be capable of providing reliable operation of the lamps at the lowest temperature normally encountered. The contractor shall confirm that the ballasts are appropriate for the ambient conditions.

B. The contractor shall verify the ballast voltage prior to submittal.

C. Drivers and Ballasts deemed excessively noisy shall be replaced without cost to the Owner.

D. Spare Parts: Provide a minimum of three spare Drivers for each type of LED light fixture.

E. DIMMING DRIVER LED: Provide integral 0-10 volt dimming driver capable of continuous dimming that works with any standard 0-10V dimmer, unless noted otherwise on Luminaire Schedule:

UL listed and CSA certified.
Comply with IESNA LM-79 and LM-80 standards.
Recognized Testing Laboratory listed, thermally protected, resetting, Class P, For use in insulated ceilings.
Power factor equal to or greater than 90%.
Meet all current Federal, State and Power Co. efficiency and efficacy standards, and rebate program requirements.
Meet all current ANSI, IEEE, and FCC regulations for EMI/RFI, harmonic distortion, and transient protection.
Compatible with occupancy sensor switching.

Dimming will be future use, initial design has 100% full output.

2.4 LAMPS:

A. Permanently wired LED fixtures shall have LED lamps, on removable/replacable metal arrays.

B. Screw-in base fixtures shall have LED replaceable lamps

C. All lamps and fixtures shall be in proper operation at the time of acceptance.

D. SPARE LAMPS: For Screw –in lamps, provide ten percent spare lamps, with a minimum of two, for each size and type used.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Luminaires installed under this work shall be properly and adequately supported from the building structure except where ceiling construction or other provisions are specifically designed to support the fixture units. Fixture support systems shall provide a safety factor of four. This shall apply to chains, hangers, anchors, clamps, screws, and all other hardware and appurtenances associated with the support system.

B. Fixture supports shall provide proper alignment and leveling of fixtures, and shall be arranged to maintain the alignment at all times. The final decision as to adequacy of alignment shall be given by the Enigneer/Architect.

C. All light outlets shall be supplied with a fixture. Outlet symbols on the drawings without a type designation shall have a fixture the same as those used in similar or like locations.

D. Fixture stem or chain lengths for industrial reflector or bare lamp strip fixtures shall be appropriate for the space and for coordination with other work such as ducts and piping. Provide swivel hangers for stem-hung fixtures.

E. Fixtures shall be left clean at the time of acceptance of the work and every lamp shall be in operation. The responsibility for cleaning or protecting fixtures from dirt, dust, paint, debris, etc. shall rest with the Contractor performing this division of work.

F. Prior to the purchase of any luminaire, the finish shall be verified with the Engineer/Architect and the voltage shall be verified based on the panelboard voltage.

G. Fixtures of a given description may be used in more than one type of ceiling. Consult the Architectural Reflected Ceiling plan to obtain this information. Some ceiling types may have changed immediately prior to bidding or by addenda or change order and the changes may not be reflected in the fixture list or fixture designations as shown on the plans. The contractor shall compare the electrical plans with the reflected ceiling plan and confirm that the specified fixtures are compatible with the ceiling system prior to ordering.

H. Provide seismic support wires for all recessed fixtures where ceiling framing is not designed for fixture support.

I. Where fixtures are installed in physically restricting spaces, the contractor shall verify that the fixtures will fit the space prior to ordering.

3.3 WARRANTY:

H. Provide a 5 year complete parts and replacement labor by manufacturer for all LED Drivers.

END OF SECTION 265100

SECTION 283100 – FIRE ALARM SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. The Contractor shall interconnect new devices to existing fire alarm system, as specified herein and indicated on the drawings.

B. The system signals initiating devices, audible and visual alarm devices, a wiring system and all accessory devices required to provide a complete operating system. Equipment wiring shown on the drawings is diagrammatic and shows only the intended function. New notification devices shall be synchronized with existing notification devices.

C. The system shall comply with the applicable provisions of the National Fire Alarm Code (NFPA 72), Americans with Disabilities Act, and meet all requirements of the local authorities having jurisdiction. All equipment and devices shall be listed by the Underwriters' Laboratories, Inc., or approved by the Factory Mutual Laboratories.

D. NFPA 72 requires audible devices to be heard above the ambient noise levels in all areas of the building. Audible devices shown on the drawings represent a generic layout. Different devices have varying dB output levels and may not provide the performance required by NFPA 72 based on the device layout shown on the drawings. The Contractor shall review the layout with his fire alarm supplier prior to bidding, and if necessary, add additional audible devices to meet the alerting requirements of NFPA 72. This is a performance specification. Any additional devices required shall be shown on a plan and submitted with the shop drawings. Shop drawing checking by the Engineer will be only for aesthetic coordination and not for performance as a warning system.

1.3 SUBMITTALS:

A. Submit complete and descriptive shop drawings in accordance with Division1 and Section 26 05 00.

B. Submit plans and specifications to the governing Building Official. Obtain his written acceptance of, and procure and pay for all permits for the system prior to beginning work and ordering equipment.

1.4 ELECTRONIC MEDIA:

A. The Engineer will furnish electronic media for the Contractors use if requested. Title blocks will be removed and small addenda drawings will be removed as well. Addenda and change orders will usually not have been incorporated into the files and it is the Contractors responsibility to add that information. The

Contractor or Vendor that will ultimately use the files will be required to sign a hold harmless agreement.

B. Conversion to formats other than the current version of Autocad will be billed based on time expended in making the conversion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Silent Knight

B. Requests for substitution of other products will be considered if submitted in accordance with the general conditions and Section 26 05 00.

2.2 EQUIPMENT:

A. The existing IntelliKnight fire alarm control panel shall detect the operation of any new signal initiating device, display on the control panel the English language description of the alarm and the area of the alarm condition, print on the printer the alarm type, location, time, and date, close all fire and smoke doors, operate all alarm and auxiliary devices and in addition, shall function as follows:

A. A trouble lamp and trouble buzzer, operating together shall signal any trouble condition. Failure of the building service supply, derangement of system wiring, or alarm condition shall cause the trouble lamps to come on and the trouble buzzer to sound.

B. A self-restoring silencing switch shall be provided to silence the trouble buzzer which shall be so arranged that the trouble lamp will remain on until the system is restored to normal.

C. All alarm signals shall be automatically locked in at the control panel until the operated device is returned to its normal condition, and the panel is manually reset.

D. A switch shall be provided on the control panel for silencing the alarm devices. The manual switch and the alarm silencing switch shall be self-restoring type which cannot be left in an abnormal position.

E. Each circuit shall be supervised and shall be so arranged that a fault condition in any circuit, or group of circuits, will not affect the proper operation of any other circuit. Supervision shall be the NFPA style appropriate for the occupancy type.

F. Circuit fuses shall be provided in the control panel for each signal initiating circuit and each alarm circuit. A blown fuse shall cause the audible and visual trouble signals to operate.

G. All control panel components shall be contained in a 16 gauge steel cabinet with hinged door and key lock finished in red baked enamel.

H. Provide a digital transmitter with terminals and other necessary facilities in the control panel to permit transmission of trouble and alarm signals over leased or privately owned telephone cable to a remote station receiving panel. Provide two RJ31X telephone jacks at the fire alarm panel and extend two telephone cables to the main telephone board for this purpose.

I. Provide a key operated "Drill" switch to simulate operation of an initiating device. The "Drill" switch shall not trip the device which transmits a signal to the fire department, operate the elevator return system, or roll down guillotine type fire doors.

J. The contractor shall determine and furnish the appropriate number of transponders (data gathering panels) needed for proper operation. All transponders shall have at least 20 percent spare points.

K. The panel shall be approved as a limited energy system.

B. Audio/Visual Alarm Signal

A. Furnish and install new notification devices to match existing combination audio-ADA visual alarm assemblies.

B. All new visual strobes shall be 1 Hz synchronized flash and shall comply with ADA Standards.

2.3 SOFTWARE:

A. The Field Configuration Program shall provide all of the programmable operating instructions for the system. The resident program shall be stored on non-volatile EPROM.

B. Programming shall be performed at the location of the fire alarm control using a lap-top computer. It shall be possible to program the system without shutting the system down. Programming shall be done off line. Installing the program into the system shall be done by one man from in front of the control panel using a data transfer command. A hard copy of the system programming software shall be made available to the facility manager for his/her use at his/her option. Software will allow the user to reprogram system points, add system points, add or change point descriptions and update the data file.

C. Programmed control point activation shall include selective control of HVAC, door holder release, elevator recall, fire pump control, stairwell pressurization fans, etc.

2.4 INITIATING & WARNING DEVICES:

A. Call stations shall visually indicate if they have been tripped and shall not have glass or breakable element in them. A special key must be used to reset them.

B. Audible devices shall be as indicated on the drawings. Horns shall be semi-flush mounted. Chimes shall be electronic type with adjustable volume. Strobe lights shall be behind a white translucent cover with the word "FIRE" on it in red letters. No single audible device shall have a sound level over 100db.

C. Annunciators shall be a display module indicating alarm/trouble conditions in English language with the description and location of the event.

D. Every initiating device shall have a unique address.

E. Provide an addressable relay at one of the energy management system DDCU panels to indicate that the fire alarm system is in alarm.

PART 3 - EXECUTION

3.1 WIRING:

A. Furnish and install all required wiring in accordance with local and National codes.

B. Unless otherwise specified, minimum wire size shall be 16 gauge for audible alarm circuits, and 18 gauge for signal initiating circuits. Strobes shall be wired separately from audible devices, including combination horn/strobe units.

C. All point monitors and relays for control of auxiliary devices such as fans, dampers, solenoids, elevators, etc. are to be located within three feet of the device they control.

D. Mount all detectors in accordance with the requirements of NFPA 72E.

3.2 LABELING:

A. Where changes are made in existing panels, provide new labeling to accurately reflect the changes; hand written revisions will not be acceptable.

B. Provide permanent engraved labels for all fire alarm control panels, notification appliance circuit (NAC) power supply panels, transponder panels, and speaker system panels in compliance with Part 3.3 of Section 26 05 00. Include the following information:

A. Panel name, date of installation (month/year)

B. Circuit number feeding the panel

C. Provide self-adhesive labels for the following devices in compliance with Part 3.3 of Section 26 05 00:

A. All initiating devices (smoke detectors, heat detectors, duct detectors, beam detectors, pull stations, monitor modules, control modules, etc.); for addressable devices provide unique address, for zone devices provide zone address.

B. All notification appliances (horn/strobes, strobes, horns, etc.); provide NAC panel supplying device along with circuit number.

D. Label all fire alarm system junction boxes with a permanent black marker indicating circuits.

E. Fire alarm system conduit shall be labeled by one of the following means unless raceway is run exposed within finished spaces:

A. Red painted conduit or MC cable (if MC cable is allowed)

B. With 2" wide red painted or red taped bands on the conduit at no less than 8 feet on center increments and at every end or termination of the conduit.

F. Fire alarm system junction boxes shall be provided with red coverplates unless they are installed exposed within finished spaces.

G. Identify the circuit disconnecting means for the fire alarm equipment as "FIRE ALARM CIRCUIT" with red identification.

3.3 DEVICE LOCATION

A. Consult Engineer for minor relocations of devices that may be required to avoid obstructions, or for ease of installation or concealment. Mark all such relocations on record drawings. Contractor shall relocate devices up to 15 feet without any additional charge to the contract.

B. Devices that are not required to be installed at the final sign-off of the fire alarm system by the Fire Department shall be issued to the Owner for credit.

C. System programming cost shall also be included to program the new devices.

3.4 FIELD QUALITY CONTROL:

A. A factory trained representative of the manufacturer shall supervise the prefinal testing of the system. Pretest all installed devices to ensure compliance prior to the final test.

B. The final test shall be subject to the approval and acceptance of the responsible Architect/Engineer, and the Fire Marshal. Provide all appropriate equipment to complete the testing.

C. On completion of the acceptance tests, the Owner or his representative shall be instructed in the operation and testing of the system.

3.5 CERTIFICATION/CLOSEOUT:

A. Submit a statement to the Engineer that indicates the system has been designed, tested, and installed in accordance with all applicable codes and regulations.

B. Submit diskette or CD, with all appropriate programming updates to the owner.

C. Submit testing report to the Engineer and Fire Marshal showing results of tests.

3.6 WARRANTY

D. Submit letter of warranty, guaranteeing the new portion of the fire alarm system parts and labor for 2 years. Provide a 24 hour response upon failure of any component of the fire alarm system. The vendor and the contractor are required to participate as necessary for any warranty work during the warranty period.

END OF SECTION 283100