9121 Fire Suppression
210501 Common Work Results for Fire Suppression
211000 Water-Based Fire-Suppression Systems
9122 Plumbing
220501 Common Work Results for Plumbing
220519 Meters and Gages for Plumbing Piping
220533 Electric Self-Regulating Hot Water Temperature Maintenance Cable
221116 Domestic Water Piping System
221119 Plumbing Piping Specialties
221123 Plumbing Pumps and Accessories
221316 Sanitary Piping System
221323 Grease/Oil/Acid Interceptors
221413 Storm Piping System
221500 Compressed Air System
223100 Domestic Water Softener Equipment
223200 Domestic Water Filtration Equipment
223400 Domestic Water Heating System
224000 Plumbing Fixtures
226313 Gas Piping Systems
9123 Heating, Ventilating, and Air Conditioning
230501 Common Work Results for HVAC
230507 HVAC Piping
230514 Variable Frequency Drives
230519 Meters and Gages for HVAC Piping
230523 General Duty Valves for HVAC Piping
230525 Roof Curbs
230529 Hangers and Supports for HVAC
230548 Vibration and Seismic Control for HVAC
230553 Identification for HVAC
230593 Testing, Adjusting, and Balancing for HVAC
230719 HVAC Insulation
230923 HVAC Direct Digital Controls
230993 Sequence of Operation for HVAC
231101 Liquid Petroleum Gas Piping
232113 HVAC Piping Specialties
232117 Glycol Heat Transfer Fluid
232119 HVAC Flow Control
232123 HVAC Hydronic Pumps
232300 Refrigerant Piping
232500 HVAC Water Treatment
233113 Low-Pressure Ductwork
233115 Medium-Pressure Ductwork
233117 Flexible Ductwork
233300 Ductwork Accessories
233313 Exterior Wall Louvers
233400 HVAC Fans
233423 Rooftop Intake, Exhaust,& Relief Ventilators
233513 Dust Collection System
233515 Welding Exhaust System
233600 Variable Air Volume Terminals
233713 Air Outlets and Inlets
233716 Fabric Air Distribution Devices
233718 Underfloor Air Distribution System
233800 Kitchen Hood Ventilation System
234323 Air Cleaning System

235100 Breeching, Chimneys, and Stacks
235213 Electric Boilers
235216 Flue Gas Condensing Boilers
235223 Cast Iron Boilers
235225 Steel Firebox Boilers
235233 Flexible Water Tube Boilers
235239 Packaged Firetube Boilers
235700 Heat Exchangers
236213 Refrigerant Condensing Units
236215 Multiple-Compressor Refrigerant Condensing Units
236416 Packaged, Centrifugal Water Chiller
236423 Packaged, Scroll Water Chiller
236426 Packaged, Rotary Screw Water Chiller
236440 Refrigerant Monitoring Systems
236500 Packaged Cooling Towers
236533 Closed Circuit Fluid Coolers
237119 Ice Storage System
237200 Air to Air Energy Recovery Equipment
237313 Modular Indoor Air Handling Units
237323 Custom Indoor Air Handling Units
238113 Unitary Air Conditioning Equipment
238123 Computer Room Air Conditioners
238146 Water Source Heat Pumps
238156 Ground Source Heat Pumps (Geothermal)
238219 Fan Coil Units – Four Pipe
238223 Unit Ventilators – Four Pipe
238233 Convectors
238239 Cabinet Unit Heaters
238240 Propeller Unit Heaters
238316 Radiant Heating Hydronic System

9126 Electrical
260513 Medium Voltage Cables 2001 to 35,000 v
260519 Low Voltage Electrical Power Conductors and Cables
260526 Grounding and Bonding of Electrical Systems
260529 Hangers and Supporting Devices
260533 Raceway and Boxes for Electrical Systems
260536 Cable Tray for Electrical Systems
260543 Underground Ducts and Raceways for Electric Systems
260923 Lighting Control Devices
261200 Medium Voltage Transformers
261300 Medium Voltage Switchgear
262200 Low Voltage Transformers
262413 Switchboards
262416 Panelboards
262419 Motor Control Centers
262726 Wiring Devices
262813 Fuses and Fuse Holders
262816 Enclosed Switches and Circuit Breakers
262913 Enclosed Controllers
263213 Package Engine Generators
263600 Transfer Switches
264313 Transient Voltage Suppression for Low-Voltage Electrical Power Circuits
265100 Interior Lighting
265561 Theatrical Dimming System
265600 Exterior Lighting

21 DIVISION

FIRE SUPPRESSION

TABLE OF CONTENTS

DIVISION 21: FIRE SUPPRESSION

210501 Common Work Results for Fire Suppression
211000 Water-Based Fire-Suppression Systems

SECTION 210501

COMMON WORK RESULTS FOR FIRE SUPPRESSION

GENERAL GUIDELINES

1.1 SECTION INCLUDES QUALITATIVE REQUIREMENTS FOR:

A. Pipe and pipe fittings.

B. Dielectric fittings.

C. Mechanical sleeve seals.

D. Piping specialties.

E. Installation requirements common to piping systems and specification sections.

F. Installation requirements common to equipment specification sections.

G. Testing and repair.

H. Final completion.

I. Record drawings.

J. Maintenance and operating manuals.

K. Lubrication and packing.

L. Piping systems and equipment per NFPA, state, and local codes.

M. Requirements for a fire pump, jockey, controllers and equipment if required.

1.2 SUBMITTALS

A. Submittal data is required for dielectric fittings, flexible connectors, mechanical sleeve seals, and piping specialties.

B. Refer to specific sections of this specification for additional submittal requirements.

1.3 QUALITY ASSURANCE

A. Any manufacturer other than basis of design shall be responsible for any additional requirements for electrical service, physical space limitations, and capacities at no additional cost to the project.

B. Materials and installation shall comply with requirements of governing regulations and controlling agencies.

C. All materials used shall be first grade of their kind and shall be new and in first-class condition when installed.

D. Work done by the Contractor shall include the services of an experienced superintendent.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Piping and tubing shall include factory-applied end caps.

B. All piping and tubing shall be elevated from grade for onsite storage.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

D. Protect fire pump, jockey pump and controllers from moisture and dirt.

1.5 SEQUENCING AND SCHEDULING

A. Coordinate equipment installation with other building components.

B. Arrange for pipe spaces, chases, slots, and openings in the building structure during progress of construction.

C. Coordinate installation sleeves and supporting devices with concrete and structural components.

D. Coordinate connection of piping systems with underground and overhead utilities and services.

E. Coordinate requirements for access panels and doors.

F. Coordinate installation of identifying devices.

1.6 PROJECT CONDITIONS

A. Piping support shall only be permitted at steel joist panel points.

B. Any supplemental steel required for support between building structural members shall be the responsibility of the Div. 21 Contractor.

1.7 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21 piping sections for pipe, tube, and fitting materials and joining methods.

1.8 JOINING MATERIALS

A. Refer to individual Division 21 piping sections for special joining materials not listed below.

1.9 DIELECTRIC FITTINGS

A. Fittings shall be zinc plated with a thermoplastic liner, rated for 250 degrees F maximum.

1.10 MECHANICAL SLEEVE SEALS

A. Seals shall be designed with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve and shall include connecting bolts and pressure plates.

1.11 PIPING SPECIALTIES

A. Piping sleeves shall be constructed of galvanized sheet metal or steel pipe. Steel pipe shall meet requirements of ASTM A 53, Type E, Grade A, Schedule 40. Sleeves for copper piping shall be of compatible material to prevent interaction of piping materials.

B. Escutcheons shall be manufactured wall, ceiling, and floor plates, split-type, and of heavy chrome-plated construction.

1.12 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Division 21 piping section specifies unique installation requirements.

B. Install components with pressure rating equal to or greater than system operating pressure.

C. Install all piping at right angles or parallel to the building walls. Diagonal runs are prohibited.

D. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for panel removal.

E. Install all piping specialties to meet manufacturer's requirements.

F. Install pipe sleeves at all wall penetrations. Provide Schedule 40 steel pipe.
   1. PVC pipe sleeves are not permitted.
   2. Do not install sleeves through structural members.

G. Maintain fire rating at fire wall penetrations through the use of approved fire sealant materials installed in pipe sleeve.

1.13 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to facilitate service, maintenance, and repair or replacement of components.

B. Maintain lubrication gaskets and packing during construction and assure that at time of acceptance by the Owner, equipment is in first-class operating condition.

1.14 EQUIPMENT START-UP

A. Start-up of all fire pump equipment shall be video-taped by the Div 21 contractor. Two DVD copies shall be turned over to the Owner's maintenance staff.

1.15 TESTING AND REPAIR

A. All piping systems shall be throughly cleaned and flushed prior to final testing.

B. Pressure testing shall be completed for the piping systems:

C. All testing must be witnessed and accurately recorded noting methods of testing, times, dates, and results.

D. Any damage as a result of tests shall be repaired or damaged materials replaced at no cost to the Owner.

1.16 FINAL COMPLETION

A. All work shall be cleaned prior to issuance of Substantial Completion.

B. Retouch or repaint factory painted prime and finish coats where scratched or damaged.

C. Deliver extra sprinkler heads as required by this Specification, to Owner and obtained signed receipts of delivery.

D. Clean equipment, restore damaged materials, and leave the Work in acceptable condition.

E. Remove all site tools, equipment, surplus materials and rubbish continuously at no additional cost to the Owner.

F. Contractor shall submit written certificates warranting each item of equipment.

1.17 RECORD DRAWINGS

A. The Contractor shall keep a running record of each change and deviation from the Drawings on a clean and undamaged set of Drawings.

B. The final Project Record Drawings shall be submitted to the Engineer for approval at the completion of the project.

C. Record Drawings shall include the location of concealed piping and ductwork.

1.18 MAINTENANCE AND OPERATING MANUALS

A. The Maintenance and Operating Manuals shall comply with other Sections of this Specification. Submit in triplicate for inclusion in Maintenance and Operating Manuals.

B. Bind the written operating instructions, approved shop drawings, equipment catalog cuts, equipment warranties, and manufacturer's instructions into a binder.

END OF SECTION

SECTION 211000

WATER-BASED FIRE SUPPRESSION SYSTEMS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for piping systems, sprinkler equipment, fire pumps, controls, tank and accessories, standpipes/hose cabinets, and double detector check valves.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, and materials. Submit hydraulic calculations and drawings showing the sprinkler piping layout with the sprinkler designer's registration seal.

1.3 QUALITY ASSURANCE

A. Piping shall be installed per NFPA 13, state and local fire codes.

B. Testing of the piping shall be per NFPA 13.

C. Sprinkler heads shall be UL and FM labeled and shall be located on spacing requirements as noted in NFPA 13 according to the hazard designation. Extended coverage sprinkler heads are acceptable.

D. Fire pumps shall be UL and FM labeled.

E. Stand pipes and hose cabinets shall be provided per NFPA 14, state and local codes.

F. Backflow preventers shall meet the current requirements of ASSE 1015, ASSE 1047 and/or ASSE 1048.

1.4 PIPING SYSTEMS

A. Piping to include schedule 40 black steel and/or schedule 10 thin wall steel.

B. Grooved piping with ductile iron couplings and EPDM gasket may be used in lieu of threaded pipe.

C. An option to the final connection to the sprinkler head shall be flexible braided stainless steel hose assembly per UL, FM, and NFPA 13 requirements.

1.5 SPRINKLER EQUIPMENT

A. The types of heads shall be used in the following locations;
   1. Unfinished exposed spaces and mechanical spaces - brass heads.
   2. Finished spaces with ceilings – concealed or semi recessed heads.
   3. Finished spaces in storage rooms and janitor closets - white pendent heads.
   4. Corridors, locker/shower rooms, restrooms - concealed white head assemblies.
   5. Heads in the gym shall have wire guards.
   6. If heads are exposed in the locker/shower rooms, use a wire guard on each head.

B. Provide vane type water flow indicator with tamper switch and electronic retard.

C. Provide valve position supervisory switch for monitoring all valves.

D. Provide test station with valve and drain assembly for testing sprinkler system.

E. Provide a fire department siamese connection on the exterior of the building or a free standing siamese post for connection to the building sprinkler system.

F. Provide a wall indicator wall or post indicator valve for shutoff of the sprinkler system supply. The valve shall be supervised with a tamper switch.

1.6 FIRE PUMPS, CONTROLS, AND ACCESSORIES

A. Provide a UL labeled fire pump, controls and accessories.

B. The fire pump shall be [vertical turbine] [horizontal split case] [vertical in line] fire pump.

C. Power to the pump shall be [limited service electric motor] [shaft coupled diesel engine].

D. Controls shall be for a limited service motor.

E. A transfer switch shall be provided if there is more than one power supply feeding the fire pump.

F. The jockey pump shall be provided to pressurize the piping system for detection of a head activating by a fire or by a trouble condition.

G. In the case of a condition where a local water supply must be provided, a tank or tanks shall be installed to provide an adequate amount of water to fight a fire based on NFPA 13 requirements for the flow rate and duration based on the hazard designation. Types of tanks shall include concrete or fiberglass. Level controls shall be installed in the tank to maintain the water level and indicate an alarm for an inadequate water supply.

1.7 STANDPIPES/HOSE CABINETS

A. Cabinets on the stage shall be surface mounted.

1.8 DOUBLE DETECTOR CHECK VALVES

A. The double detector check valve assembly shall consist of two spring loaded double check valves, with a cast iron body with epoxy lining or stainless steel body UL and FM approved. Provide a detector water meter if required by the local fire authority. Provide inlet and outlet resilient seated O.S. & Y. gate valves. Provide bypass piping with test cocks. Provide inlet and outlet pressure gauges.

1.9 INSTALLATION

A. Piping shall be installed from approved hangers located at steel joist panel points.

B. When required by inadequate water pressure and flow conditions, furnish and install the fire pump, jockey pump, controls, transfer switch and required piping.

C. Piping in gymnasiums shall be above the bottom chords of the roof structure.

D. Heads in the corridors shall be centered between the corridor walls. All others heads in the finished spaces with ceilings shall be located within 6 inches of the ceiling grid.

E. Install double detector check assembly with water meter on the incoming water supply to the sprinkler system.

F. Clean pipe to prevent MIC (microbially influenced corrosion).

END OF SECTION

THIS PAGE HAS BEEN LEFT INTENTIONALLY BLANK.

22 DIVISION

PLUMBING

TABLE OF CONTENTS

DIVISION 22: PLUMBING

220501	Common Work Results for Plumbing
220519	Meters and Gages for Plumbing Piping
220533	Electric Self-Regulating Hot Water Temperature Maintenance Cable
221116	***Domestic Water Piping System***
221119	Plumbing Piping Specialties
221123	Plumbing Pumps and Accessories
221316	Sanitary Piping System
221323	Grease/Oil/Acid Interceptors
221413	Storm Piping System
221500	Compressed Air System
223100	Domestic Water Softener Equipment
223200	Domestic Water Filtration Equipment
223400	Domestic Water Heating Systems
224000	Plumbing Fixtures
226313	Gas Piping Systems

SECTION 220501

COMMON WORK RESULTS FOR PLUMBING

GENERAL GUIDELINES

1.1 SECTION INCLUDES QUALITATIVE REQUIREMENTS FOR:

A. Pipe and pipe fittings.

B. Dielectric fittings.

C. Mechanical sleeve seals.

D. Piping specialties.

E. Installation requirements common to piping systems and specification sections.

F. Installation requirements common to equipment specification sections.

G. Testing and repair.

H. Final completion.

I. Record drawings.

J. Maintenance and operating manuals.

K. Lubrication and packing.

1.2 SUBMITTALS

A. Submittal data is required for dielectric fittings, flexible connectors, mechanical sleeve seals, and piping specialties.

B. Refer to specific sections of this specification for additional submittal requirements.

1.3 QUALITY ASSURANCE

A. Any manufacturer other than basis of design shall be responsible for any additional requirements for electrical service, physical space limitations, and capacities at no additional cost to the project.

B. Materials and installation shall comply with requirements of governing regulations and controlling agencies.

C. All materials used shall be first grade of their kind and shall be new and in first-class condition when installed.

D. Work done by the Contractor shall include the services of an experienced superintendent.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Piping and tubing shall include factory-applied end caps.

B. All piping, tubing, and equipment shall be elevated from grade for on-site storage.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

D. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.5 SEQUENCING AND SCHEDULING

A. Coordinate mechanical equipment installation with other building components.

B. Arrange for pipe spaces, chases, slots, and openings in the building structure during progress of construction.

C. Coordinate installation sleeves and supporting devices with concrete and structural components.

D. Coordinate connection of plumbing systems with underground and overhead utilities and services.

E. Coordinate requirements for access panels and doors.

F. Coordinate installation of identifying devices.

1.6 PROJECT CONDITIONS

A. Piping support shall only be permitted at steel joist panel points unless noted otherwise.

B. Any supplemental steel required for support between building structural members shall be the responsibility of the Plumbing Contractor.

1.7 PIPE AND PIPE FITTINGS

A. Pipe threads shall meet ASME B1.20.1 for factory-threaded pipe and pipe fittings.

B. Pipe-flange gasket materials shall meet ASME B16.21, nonmetallic, flat, asbestos-free.

C. Pipe Flanges
1. Full face shall be Class 125, cast iron and cast-bronze material.
2. Narrow face shall be Class 250, cast-iron and cast steel material.

D. Flange bolts and nuts shall meet ASME B18.2.1.

E. Solder filler materials shall meet ASTM B 32.
1. Alloy Sn95 and Sn94 shall be used.

F. Brazing filler materials shall meet AWS A5.8.

G. Welding filler metals shall comply with AWS D10.12.

H. Solvent materials shall meet standard solvent cement requirements.
   1. PVC piping shall meet ASTM D 2564. Include primer according to ASTM F 656.
   2. Plastic pipe seals shall meet ASTM F 477
   3. Flanged, ductile-iron gasket, bolts, and nuts shall meet AWWA C 110.

1.8 DIELECTRIC FITTINGS

A. Fittings shall be zinc plated with a thermoplastic liner, rated for 250 degrees F maximum.

1.9 MECHANICAL SLEEVE SEALS

A. Seals shall be designed with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve and shall include connecting bolts and pressure plates.

1.10 PIPING SPECIALTIES

A. Piping sleeves shall be constructed of galvanized sheet metal or steel pipe. Steel pipe shall meet requirements of ASTM A 53, Type E, Grade A, Schedule 40. Sleeves for copper piping shall be of compatible material to prevent interaction of piping materials.

B. Escutcheons shall be manufactured wall, ceiling, and floor plates, split-type, and of heavy chrome-plated construction.

1.11 PLUMBING PIPING SYSTEMS - COMMON REQUIREMENTS

A. Division 22 piping sections specify unique installation requirements.

B. Install components with pressure rating equal to or greater than system operating pressure.

C. Install all piping at right angles or parallel to the building walls. Diagonal runs are prohibited.

D. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for panel removal.

E. Install all piping specialties to meet manufacturer's requirements.

F. Install pipe sleeves at all wall penetrations. Provide Schedule 40 steel pipe.
   1. PVC pipe sleeves are not permitted.
   2. Do not install sleeves through structural members.

G. Maintain fire rating at fire wall penetrations through the use of approved fire sealant materials installed in pipe sleeve.

H. Install unions in piping 2 inch and smaller adjacent to each valve and at final connection to each piece of equipment.

I. Install flanges in piping 2-1/2 inch and larger adjacent to flanged valves and at final connections to equipment with flanged pipe connections.

1.12 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to facilitate service, maintenance, and repair or replacement of components.

B. Maintain lubrication gaskets and packing during construction and assure that at time of acceptance by the Owner, equipment is in first-class operating condition.

1.13 EQUIPMENT START-UP

A. Start-up of all plumbing equipment shall be video-recorded by the plumbing contractor. Two DVD copies shall be turned over to the Owner's maintenance staff.

1.14 TESTING AND REPAIR

A. All piping and ductwork systems shall be throughly cleaned and flushed prior to final testing.

B. Pressure testing shall be completed for the following piping systems:
   1. Domestic water, sanitary and vent, storm and gas piping systems, and other systems as noted on the plans.

D. All testing must be witnessed and accurately recorded noting methods of testing, times, dates, and results.

E. Any damage as a result of tests shall be repaired or damaged materials replaced at no cost to the Owner.

1.15 FINAL COMPLETION

A. All work shall be cleaned prior to issuance of Substantial Completion.

B. Retouch or repaint factory painted prime and finish coats where scratched or damaged.

C. Deliver any equipment as required by this Specification to Owner and obtained signed receipts of delivery.

D. Clean equipment, restore damaged materials, and leave the Work in acceptable condition.

E. Remove all site tools, equipment, surplus materials and rubbish continuously at no additional cost to the Owner.

F. Contractor shall submit written certificates warranting each item of equipment.

1.16 RECORD DRAWINGS

A. The Contractor shall keep a running record of each change and deviation from the Drawings on a clean and undamaged set of Drawings.

B. The final Project Record Drawings shall be submitted to the Engineer for approval at the completion of the project.

C. Record Drawings shall include the location of all piping systems.

1.17 MAINTENANCE AND OPERATING MANUALS

A. The Maintenance and Operating Manuals shall comply with other Sections of this Specification. Submit in triplicate for inclusion in Maintenance and Operating Manuals.

B. Bind the written operating instructions, approved shop drawings, equipment catalog cuts, equipment warranties, and manufacturer's instructions into a binder.

END OF SECTION

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK.

SECTION 220519

METERS AND GAGES FOR PLUMBING PIPING

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for thermometers and fittings, as well as pressure gauges and fittings.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, and dimensions.

1.3 COMPONENTS

A. Thermometers: 1-percent accuracy.
1. Liquid-in-Glass Type: Organic filled 9 inch long industrial type.
2. Direct-Mounting Filled-System Dial Type: Vapor actuated, thermal bulb, precision brass gear.
3. Remote-Reading, Filled-System Dial Type: Vapor actuated, thermal bulb; precision brass gear.
4. Bimetal Dial Type: Direct mounting, bimetal coil.
5. Insertion Dial Type: Bimetal coil.

B. Pressure Gauges: Phosphor-bronze Bourdon-tube gages, 1-percent accuracy.
1. Vacuum Range: 30 inches Hg of vacuum to 15 psig of pressure .
2. Pressure Range: Two-times operating pressure.

1.4 INSTALLATION

A. Provide thermometers at the following locations:
1. Inlet and outlet domestic water heaters.
2. Outlet of the hot water storage tank.
3. Inlet and outlet hot water at the main thermostatic mixing valve.
4. Domestic circulation pump outlet.

B. Provide pressure gauges at the following locations:
1. Outlet piping of each water heater with 200 MBH input or greater.
2. Inlet and outlet of the main reduced pressure backflow preventer.

END OF SECTION

SECTION 220533

ELECTRIC SELF-REGULATING HOT WATER TEMPERATURE MAINTENANCE CABLE

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for hot water maintenance cable.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. Follow manufacturer's requirements for installation.

B. Cable shall be UL listed, CSA certified and FM approved.

C. Cable system shall conform to ANSI/IEEE Standard 515.1.

D. Cables designed for freeze protection of water lines will not be allowed.

1.4 WARRANTY

A. Cable – Minimum 10 year warranty.

B. Follow manufacturer's installation and testing requirements.

1.5 MAINTENANCE CABLE

A. The self-regulating cable shall consist of (2) nickel-coated copper bus wires embedded in a radiation cross-linked conductive polymer core. The cable shall be capable of varying its heat output along its entire length to maintain the water in the selected temperature range.

B. Provide electronic controller for temperature control and energy savings.

1.6 INSTALLATION

A. Refer to the manufacturer's hot water temperature maintenance design guide for design details, insulation requirements, maximum circuit lengths, and accessory information.

B. The cable shall not be installed in a concealed space.

END OF SECTION

SECTION 221116

DOMESTIC WATER PIPING SYSTEM

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for domestic water piping.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. Follow manufacturer's requirements for installation.

B. Welding procedures per ANSI/ASME Section 9, AWS D10.9 and D1.1 and the National Certified Pipe Welding Bureau.

C. Brazing procedures per ANSI B31.5 and the ASME Boiler and Pressure Vessel Code SFA-5.8, Section II.

D. Soldering procedures per ANSI B16.18.

E. Comply with ANSI B31 pressure code for pressure piping.

1.4 PLUMBING PIPING

A. Domestic water piping (hot water, cold water, hot water return) shall be type L copper conforming to ASTM B88. Fittings shall be wrought copper conforming to ANSI B16.22.
   1. Grooved copper piping with ductile iron or bronze couplings and EPDM gasket may be used as an option.
   2. Copper press fittings may be used as an option per ASTM B16.18 or ASTM B16.22. O-Rings shall be EPDM.

B. An option to A. for domestic hot and cold water shall be as follows:
   1. Cross linked polyethylene (PEX) plastic tubing per ASTM F876,F877. Installed in a conduit or sleeve***, if under slab.***
   2. Polypropylene Schedule SDR 7.4 and ***SDR*** 11 meeting NSF14, 61 and 51. Piping shall also meet ASTM F2389 and Plumbing Code Chapter 605. Piping installed in air plenums shall have a Foil Wrap to meet the 25/50 smoke and fire ratings for plenum spaces. Follow manufacturer's instructions for installation and hanger requirements. Verify expansion requirements.

1.5 INSTALLATION

A. Provide pipe and tube of type, joint type, size and weight (wall thickness or class) indicated for cold water, hot water, and hot water return.

END OF SECTION

SECTION 221119

DOMESTIC WATER PIPING SPECIALITIES

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for vacuum breakers, backflow preventers, plumbing thermostatic mixing valves, strainers, outlet boxes, hose bibbs, wall hydrants, water hammer arresters, trap-seal primer systems, domestic hot water return balancing device (manual), and clothes washer connection.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. Vacuum breaker wall hydrants and freeze resistant wall hydrants shall meet ASSE Standard 1019.

B. Provide backflow prevention devices wherever possible sources of undesirable materials are connected to the potable water system.

C. The backflow prevention devices shall meet the standards set by the American Society of Sanitary Engineers and the latest edition of the Plumbing Code and air gap standards under American National Standards Institute A112.1.2-1943(1979).

D. The backflow prevention devices shall be approved for use by the Foundation for Cross-Connection Control and Hydraulic Research at the University of Southern California.

E. Atmospheric vacuum breaker per ANSI/ASTM 1020.

F. Hose connection vacuum breaker per ASSE 1011 and CSA B64.2.

G. Reduced pressure vacuum breaker per ASSE 1013, AWWA C511, CSA B64.5.

H. Pressure type backflow preventer per ANSI/ASSE 1035.

I. Dual check valve per ANSI/ASSE 1024, CSA B64.6.

J. Thermostatic mixing valves shall meet the Ohio Plumbing Code and the requirements of ASSE 1017.

K. Strainers shall meet NSF 61 and ASTM B 62.

L. Hose bibbs and wall hydrants shall meet ASSE 1019.

M. Water hammer arresters shall meet ANSI/ASME A112.26.1M and ASSE 1010.

N. Trap seal primers shall meet ASSE 1018.

O. Clothes washer connection shall meet ANSI/ASSE 1035.

P. Emergency mixing valves shall meet ANSI 2.358.1-1998.

1.4 COMPONENTS

A. Atmospheric vacuum breaker shall have brass body, stainless steel working parts, integral strainer, rubber discs, maximum pressure, maximum 175 psi operation, unions.

B. Hose connection vacuum breaker shall have ¾ inch female hose inlet connection, ¾ inch male outlet connection, non-removal feature, plain brass finish.

C. Reduced pressure backflow preventer shall have fused epoxy coated cast iron check valve body and relief valve, replaceable bronze seats, bronze ball check valve test cocks, maximum 175 psi operation, stainless steel internal parts, air gap connection for relief piping to drain.

D. Pressure type backflow preventer shall have atmospheric vent, all brass construction, in-line continuous operation, maximum 125 psi operation.

E. Dual check valve shall have straight line poppet type check modules, replaceable seats, brass construction.

F. Water Hammer Arresters: Shall be the stainless steel bellow type.

G. Balancing devices shall be bronze with adjustable control.

H. Domestic hot water anti-scald thermostatic mixing control valve unit shall include swivel action check stops, removable cartridge with strainer, stainless steel piston and liquid fill thermal motor with bellows element mounted out of water. The mixing valve shall control the domestic hot water temperature distributed throughout the building. The mixing valve shall have a thermostatic sensing unit. The mixing valve shall fail to the cold water side. Flow rate shall determine whether a single valve shall be required or a high/low valve with pressure reducing valves is required to provide the correct temperature at the minimum and maximum hot water flow in the building.

I. Strainers: Shall be bronze threaded, flanged, or soldered.

J. Outboxes: Shall be recessed with pressure backflow preventer.

K. Hose bibbs and Wall Hydrants: Shall be recessed or surface with vacuum breakers.

L. Exterior Wall Hydrants: Shall be non-freeze, self-draining with copper/bronze construction with recessed wall box with loose key.

M. Clothes Washer Connection Box and Refrigerator Supply: Metal recessed box complete with hot and/or cold water shut-off valves and drain connection.

N. Emergency thermostatic mixing valve: shall be liquid or bi-metal thermostats, cold water bypass, high limit stop, locked temperature regulator.

1.5 INSTALLATION

A. Provide vacuum breakers on all threaded hose bibb connections.

B. Install reduced pressure principle backflow preventer in irrigation and incoming domestic water service.

C. Install pressure type vacuum breakers in lines under continuous pressure and at least 12 inches above the highest outlet downstream of the unit.

D. Provide drain line from reduced pressure backflow preventer discharge outlet; extend to nearest drain.

E. Units shall be installed in strict accordance with manufacturer's written instructions.

F. Test each backflow device and submit test data.

G. Provide thermostatic mixing valves to regulate the hot water temperature to a fixture.

H. Provide a recessed washer box ***at*** each domestic clothes washer.

I. Provide a recessed box to supply water to each refrigerator.

J. Wall hydrants with hose connections shall be provided in the mechanical room and boiler room.

K. Provide a water hammer arrestor at each solenoid valves or piece of equipment that has a quick closing type valve. Water hammer arrester for down-feed risers to be at top of riser. Size shock absorber according to fixture unit count. Provide shock absorbers at each group of water closets and urinals. Shock absorber shall be easily accessible for repair or replacement.

L. Provide trap seal primers on all floor drains to prevent trap seals from drying up.

M. Provide emergency thermostatic mixing valve with inlet and outlet thermometers to regulate tempered water to the emergency eye wash and/or showers.

END OF SECTION

SECTION 221123

PLUMBING PUMPS AND ACCESSORIES

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for recirculation pumps and water pressure booster pump system.

1.2 SUBMITTALS

A. Submittals are required and shall include capacities, warranties, product data noting materials, sizes, and dimensions.

B. Pressure booster system panel shall be UL listed and labeled.

1.3 QUALITY ASSURANCE

A. Each pump shall be capable of providing the scheduled flow in gpm and head required.

B. Pump motors shall be high efficiency type.

C. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

1.4 RECIRCULATION PUMPS

A. The pump shall be all bronze, horizontal in line, oil lubricated, and 125 psi working pressure.

B. Aquastat with voltage thermostat shall start/stop pump or start/stop by the temperature control system.

1.5 WATER PRESSURE BOOSTER PUMP SYSTEM

A. The pump system shall consist of two pumps providing a constant water pressure to the piping system. The control system shall provide alternation of the pumps, on/off operation and an alarm system.

B. Provide expansion pressure tank with a bladder insert for storage capacity required, sized accordingly to meet flow requirements.

1.6 INSTALLATION

A. Provide the correct gpm, head and voltage required.

1. Inlet piping shall consist of a line size valve and strainer. Outlet piping shall consist of a line size check valve and valve.
2. The pump shall be supported by the inlet and outlet piping.

B. Pressure Booster System

1. Install the pressure booster pump system according to the manufacturer's recommendations. Provide inlet and outlet piping and valves. Install the expansion tank with size as required.

END OF SECTION

SECTION 221316

SANITARY PIPING SYSTEM

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for sanitary piping and vent, as well as acid waste piping and vent.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. Follow manufacturer's requirements for installation.

B. Obtain list of Owner's chemicals to review against pipe material chemical resistance chart for acid waste piping.

1.4 SANITARY AND VENT PIPING

A. Sanitary and vent piping materials below slab

1. Schedule 40 PVC with solvent joints per ASTM D2665, D2564, D2665.
2. Cast iron hub and spigot per ASTM A74 and C 564.

B. Sanitary and vent piping above finish floor.

1. Schedule 40 PVC with solvent joints per ASTM D2665, D2564, D2665.
2. Cast iron no hub and fittings per ASTM.

C. Sanitary and vent piping above ceiling in plenum space

1. Cast iron no hub and fittings per ASTM.
2. PVC piping is not permitted in a return air plenum or in a chase exposed to the plenum.

D. Acid waste piping below slab and above slab.

1. Schedule 40 polypropylene per ASTM D4101 and ASTM 3311.
2. Schedule 40 CPVC with solvent joints per ASTM D1784, F493, F441, D3311, and NSF Standard 14.

E. Acid waste piping in plenum space and chases open to plenums

1. Schedule 40 polyvinylidene fluoride per ASTM D3222 or glass per ASTM C1053-90.

F. Underground waste and vent piping in kitchen space.

1. Cast iron hub and spigot.

1.5 INSTALLATION

A. Terminate vent piping through roof, a minimum of 12 inches above the roof.

B. Location of vent on the roof shall be a minimum of 20 feet from any rooftop or wall louver outside air intake or rooftop HVAC equipment outside air intake.

END OF SECTION

SECTION 221323

GREASE/OIL/ACID INTERCEPTORS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for grease interceptors, solids interceptors, clay traps, and acid waste neutralizing sumps.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. Grease interceptors, solid interceptors, and clay traps shall meet the latest edition of PDI Seal of Approval and Ohio Plumbing Code.

B. Acid sump shall meet Ohio Plumbing Code.

1.4 GREASE INTERCEPTORS

A. The interceptor shall be a minimum of 500 gallons, constructed of concrete, cast iron, or fiberglass. Verify size with local health authority.

B. Provide cleanouts at each end of the tank with access up to grade.

C. Provide access to grade, using a 2'-0" diameter concrete collar with a cast iron frame and lid, 4 inches above finish grade.

1.5 SOLIDS INTERCEPTORS

A. Interceptors shall be acid resistant coated fabricated steel, heavy duty cover. Provide extension to finish floor as required.

1.6 CLAY TRAPS

A. Clay trap shall be acid resistant coated fabricated steel, stainless steel mesh screen basket, gasketed cover.

1.7 ACID NEUTRALIZING SUMP

A. Tank shall be polypropylene or HDPE with bolt down gasketed lid, inlet and outlet piping, vent, flanged connections.

B. Provide access to grade, using a 5'-0" diameter concrete or corrugated metal collar with a cast iron frame and lid in a 6 inch thick reinforced concrete cover, 4 inches above finish grade.

C. A single 5 gallon sump can be specified for a single sink requiring acid neutralization.

1.8 GREASE INTERCEPTORS

A. Provide a minimum of 2'-0" cover over the tank.

B. Set tank on a 6 inch bed of compacted granular material. Backfill around the tank to within 12 inches of grade with compacted granular material.

C. The interceptor shall be located on the exterior of the building, 10'-0" minimum distance from the building.

D. Do not locate the interceptor in a drive area without providing adequate support over the tank.

E. Vent the interceptor into the building, up through the roof.

1.9 SOLIDS INTERCEPTORS

A. Piping invert under the floor to the tank will determine if an extension of the interceptor will be required to meet finish floor elevation.

B. Provide adequate clearance above the lid for cleaning and basket removal.

C. The interceptor can be located on or in the floor slab.

D. Provide access to the lid for cleaning.

1.10 CLAY TRAPS

A. Provide adequate clearance above the lid for cleaning and basket removal.

B. If the trap is installed within the casework, set on floor inside the base cabinet. Adjust the outlet piping extending to the wall to meet the invert.

C. Cleaning of the trap shall not constitute removal of the trap.

D. Piping connections shall have unions.

1.11 ACID NEUTRALIZING SUMP

A. Set basin on a 6 inch concrete slab, with the diameter the same as the outside diameter of the collar.

B. Provide stone around the basin, to just below the lid.

C. The access lid shall allow the removal of the basin lid. Size accordingly.

D. The lid and frame shall be set in a 6 inch concrete lid, 12 inches in diameter larger than the collar.

E. Fill the sump with water and the required amount of limestone chip, with size as recommended by the manufacturer.

F. Piping connections to the tank shall be flanged.

G. The sump shall be located on the exterior of the building, 10'-0" minimum distance from the building.

H. Do not locate the interceptor in a drive area without providing adequate support over the tank.

I. Vent the acid sump into the building, up through the roof.

1.12 SINGLE AND NEUTRALIZING SUMP (1 sink)

A. Provide adequate clearance above the lid for cleaning and basket removal.

B. If the trap is installed within the casework, set on floor inside the base cabinet. Adjust the outlet piping extending to the wall to meet the invert.

C. Cleaning of the sump shall not constitute removal of the trap.

D. Fill sump with water and limestone chips.

E. Piping connections shall have unions.

END OF SECTION

SECTION 221413

STORM PIPING SYSTEM

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for storm piping.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. Follow manufacturer's requirements for installation.

1.4 STORM PIPING

A. Storm piping materials below slab
   1. Schedule 40 PVC with solvent joints per ASTM D2665, D2564, D2665.
   2. Cast iron hub and spigot per ASTM A74 and C 564.

B. Storm piping above finish floor.
   1. Schedule 40 PVC with solvent joints per ASTM D2665, D2564, D2665.
   2. Cast iron no hub and fittings per ASTM.

C. Storm piping above ceiling in plenum space
   1. Cast iron no hub and fittings per ASTM.
   2. PVC piping is not permitted in a return air plenum or in a chase exposed to the plenum.

1.5 INSTALLATION

A. Connect to roof drains and/or secondary roof drains as required.

END OF SECTION

SECTION 221500

COMPRESSED AIR SYSTEM

GENERAL GUIDELINES

1.1 SECTION INCLUDES
A. Qualitative requirements for compressed air piping, compressor, regulator, and air dryer.

1.2 SUBMITTALS
A. Submittals are required and shall include product data noting materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE
A. Follow manufacturer's requirements for installation.

B. Comply with ANSI B31 pressure code for pressure piping.

1.4 COMPRESSED AIR PIPING
A. Compressed air piping shall be galvanized steel, schedule 40, per ASTM A53. Fittings shall be threaded, class 150 per ASME A733 and B1.20.1.

1.5 AIR COMPRESSOR
A. Provide single or two stage air compressor as required by air pressure requirements.

B. Provide vibration isolation.

C. Consider noise factor as to where compressor is placed.

D. Provide ASME constructed air tank.

E. Provide air cooled after cooler.

F. Provide inlet and outlet valves, unions, and flexible connections.

1.6 AIR REGULATOR
A. Provide quick disconnect hoses.

B. Provide valve to each drop.

1.7 AIR DRYER
A. Provide air dryer to match air compressor CFM.

B. Provide refrigerated unit with high temperature inlet capabilities.

C. Provide inlet and outlet valves, unions, and flexible connections.

1.8 INSTALLATION
A. Branch air connection shall connect to the top of the air main.

B. Provide proper CFM air regulator to match system use.

END OF SECTION

SECTION 223100

DOMESTIC WATER SOFTENER EQUIPMENT

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for the water softener system.

1.2 SUBMITTALS

A. Submittals are required and shall include product data, noting materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. The water softener shall meet with the approval of the OEPA when installed in association with a water well.

B. The softener shall be sized to meet the requirements concerning the amount of water to be softened between regenerations based on the grains hardness.

1.4 WATER SOFTENER SYSTEM

A. The tank shall be fiberglass, rated for 100 psi working pressure.

B. The backwash distributor shall be of the radial hub design.

C. The control valve shall initiate regeneration, backwash, rinse, brine draw and brine tank refill. Initiation of the regeneration sequence shall be by a volumetric water meter coupled to a timer control, preset at a specific gallons used. The timer will not let the regeneration begin until a preset time.

D. The mineral tank will be provided with a correct amount of resin, having a minimum exchange rate of 30,000 grains when regenerated with 15 lbs of salt per cubic foot.

E. A hardness test kit shall be included with the softener.

1.5 INSTALLATION

A. Provide and install the softener complete with inlet and outlet valves and unions, and bypass piping around the inlet and outlet connections.

B. Install sampling tees/valves in inlet and outlet piping to the mineral tank for testing the water.

END OF SECTION

SECTION 223200

DOMESTIC WATER FILTRATION EQUIPMENT

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Quantitative requirements for the iron filter system.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. The iron filter system shall meet with the approval of the OEPA when used in conjunction with a water well.

B. The iron filter shall be sized to meet the requirements concerning the amount of water to be filtered between regenerations based on the iron content.

C. The iron filter system shall remove all ferrous, ferric or bacterial iron from the incoming water supply without the use of chemicals.

1.4 IRON FILTER SYSTEM

A. The main service valve shall be diaphragm operated. No raw water bypass is allowed. If controller maintenance is required, the system will remain in service.

B. An automatic flow controller shall be provided to maintain backwash and rinse rates over variable operating pressures.

C. A factory assembled cycle controller shall incorporate an adjustable time switch with multi-ported pilot valve to control all steps of automatic regeneration with provisions for manual regeneration.

D. The muti-ported pilot control valve shall automatically pressure activate the main operating service/backwash valves through the steps of regeneration and return to service. In the event of a power failure, a complete regeneration can be performed by manual operation of the pilot valve.

E. The electrical time clock shall be adjustable to initiate regeneration at any time of the day and any number of days in a minimum of a 12 day period.

F. The mineral shall require no chemical regeneration. Periodic regeneration shall only be required.

G. The air induction system to introduce oxygen into the water for the oxidation process shall be of the venturi type. Forced air injection is not acceptable.

H. Attrition loss of mineral shall not exceed 3 to 5 percent per year.

I. The distribution shall be factory installed with a washed quartz gravel bed.

1.5 INSTALLATION

A. Install all equipment and associated piping and valves.

B. Install sampling tees/valves in the inlet and outlet piping to the mineral tank for testing the water.

C. Provide bypass piping around the inlet and outlet connections.

END OF SECTION

SECTION 223400

DOMESTIC WATER ***HEATING SYSTEMS***

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for instantaneous gas fired water heaters, hot water storage tanks, electric booster heater, tank type under fired heaters, and combination power vented heaters installed in a common tank.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. Gas units shall meet CSA requirements.

B. Units must meet ASHRAE 90.1, ADDM 90 1 b.

C. The gas heater shall be ASME certified for 125 psi operation and National Board listed.

D. Heater shall be rated at a minimum of 82 percent thermal efficiency.

1.4 WARRANTY

A. Water heater heat exchanger - 5 year.

B. Storage tank - 5 year limited.

C. Booster heater - 3 year limited.

D. Combination heat exchanger/storage tank – 5 year.

E. Gas-fired units shall have sealed combustion.

1.5 INSTANTANEOUS GAS FIRED WATER HEATER

A. Two pass copper fin tubes.

B. Cast iron headers.

C. Built-in draft diverter.

D. Insulated jacket.

E. ASME temperature and pressure relief valves.

F. Electronic controls.

G. Integral bronze circulation pump.

H. Flow switch.

I. Electronic ignition.

J. Cupro nickel heat exchanger.

1.6 HOT WATER STORAGE TANKS

A. Vertical storage tank.

B. Glass lining.

C. ASME constructed.

D. Insulated.

E. 150 psi work pressure.

D. Inlet and outlet piping.

1.7 COMBINATION 2 HEATERS AND STORAGE TANK

A. Vertical storage tank.

B. Polymer-lined tank.

C. ASME constructed.

D. Insulated.

E. 150 psi working pressure.

F. Inlet and outlet piping.

G. Submerged combustion heat exchangers.

H. Electronic flame safeguard.

1.8 ELECTRIC BOOSTER HEATERS

A. The tank construction shall have a 150 psi working pressure. The interior of the tank shall be glass lined. The jacket surrounding the tank shall be stainless steel front with baked enamel sides and back with 6 inch adjustable legs

B. The control circuit shall consist of a pilot switch with indicator light, built in thermostat and hi-limit, and magnetic contactors.

C. Heater elements shall be copper-sheathed, furnished with 4 bolt flange for disassembly without removing the booster head.

D. Provide ASME temperature and pressure relief valve, temperature and pressure gauge.

1.9 TANK TYPE UNDER FIRED HEATER

A. Multi-flue design.

B. Working pressure - 150 psi.

C. Glass lined.

D. ASME constructed.

E. Insulated with minimum 2 inch foam insulation.

F. Heavy jacket.

G. Vent damper control.

H. Spark ignition.

1.10 HEAT MAINTENANCE CABLE

A. Wrap piping with self-regulating cable to maintain temperature in piping.

B. Provide controller for adjusting temperature and night and weekend set back.

C. Provide cable temperature to match intended service.

D. The cable shall meet a 10-year limited warranty period.

E. Install with correct thickness of insulation.

F. Follow manufacturer's installation instructions.

1.11 INSTANTANEOUS ELECTRIC WATER HEATER

A. Use heater for one or multiple sinks and lavatories.

B. Install heater(s) above ceiling or away from student access.

C. Size per GPM requirements.

D. Verify water quality concerning excessive buildup of minerals on interior heating surfaces.

E. Provide thermostatic mixing valve if required.

1.12 INSTALLATION

A. The heater shall be designed to produce the required gallons per hour at the temperature required based on the Btu input.

B. Where two or more heaters are shown, pipe for equal flow through the heaters. Provide unions and shutoff valves at each heater connection.

C. Follow manufacturer's recommendations for installation, space requirements, and piping sizing.

D. Provide temperature and pressure gauge in the upper 1/3 portion of the tank.

E. The booster heater shall boost the 140 degree water to 180 degrees for the dishwasher final rinse.

E. Time of day control shall be provided to disable domestic water heater system when building is unoccupied.

END OF SECTION

SECTION 224000

PLUMBING FIXTURES

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for plumbing fixtures and plumbing specialties.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes and dimensions.

1.3 QUALITY ASSURANCE

A. Meet requirements of the current Plumbing Code.

B. Water closets shall meet ANSI A112.19.1M. Trim shall meet ANSI A112.19.5.

C. Urinal shall meet ANSI 2124.4, ASME A112.19.2M, and ASME A112.19.6. Trim shall meet ANSI A112.19.5. The optional waterless urinal shall meet ASTM A112.19.2M and A-117.1 and 1APMO 1 GC 161-2000 and ANSI Z124.9-94.

D. Lavatories shall meet ANSI A112.19.1M and Z 124.3.

E. Drinking water coolers shall meet ANSI A112.19.2M.

F. Sink shall meet ANSI A112.19.1M and A112.19.2M.

G. Sinks shall meet ANSI A112.19.1M and A112.19.2M.

H. All fixtures shall meet the governmental regulations for low-flow operation.

I. Drinking fountains shall meet ASME A112.19.1, A112.19.2, or A112.19.9, and ANSI 117.1.

J. Drinking water coolers shall meet ARI 1010 and ANSI 117.1.

1.4 PLUMBING FIXTURES AND SPECIALTIES

A. Water closets shall be wall mounted, white vitreous china with white seat and flush valve. Water closets for kindergarten students can be floor mounted. Automatic/battery or direct wired flush valve is optional.

B. Urinals shall be white vitreous china with flush valve. Automatic/battery or direct wired flush valve is optional. An option to the urinal with flush valve shall be the waterless type vitreous china urinal with a removable ABS plastic trap.

C. Lavatories shall be wall hung, white vitreous china with hot and cold blade handle faucet on 4 inch centers. An option to the lever handles shall include commercial grade single lever faucets with a ceramic disc. An option to the lever handle faucet shall be a battery or hardwired infrared faucet.

D. Showers shall be pressure balancing, single lever with vandal resistant shower head.

E. Drinking water coolers and fountains shall be wall mounted and shall meet ADA requirements.

F. Sinks shall be 302 or 304 stainless steel, single, double, or triple compartment with faucet with hot and cold blade handles and swing spout. An option to the lever handles shall include commercial grade single lever faucets with a ceramic disc.

G. Science lab sinks shall be acid resistant for high school applications. Provide acid resistant strainer and tailpiece. Science casework contractor shall provide sink and trim.

H. Service sinks shall be floor mounted molded stone, 10 A high, 24" x 24", 3" outlet and a wall faucet with pail hook and vacuum breaker.

I. Washfountains shall be terrazzo or stainless steel or modified acrylic (complying with ANSI 2124.3 and ANSI 2124.6) with infrared sensing for water activation, ADA accessible, and floor or wall mounted.

J. Emergency eye wash shall be wall mounted, ADA accessible and set at ADA height. Also provide supply from thermostatic mixing valve per ANSI Z358.1, latest edition.

K. Emergency shower shall have a 10 inch diameter shower head, vertical or horizontal supply and have a ADA accessible handle. Also provide supply from thermostatic mixing valve per ANSI Z358.1, latest edition.

1.5 PLUMBING FIXTURES AND SPECIALTIES (cont.)

O. Provide a stainless steel, wall mounted drinking fountain for exterior installations. Unit shall be freezeproof, have push button activation and be ADA accessible. Mount to the exterior building wall.

1.6 INSTALLATION

A. Lavatories, water closets, and urinals shall have carriers attached to the floor.

B. All fixtures and trim so noted for handicap installation shall meet ADA requirements.

C. Clay trap installation for an ADA sink shall not interfere with the space requirements under the sink. Locate next to the sink casework.

D. The power transformer for the washfountain shall be a plug-in type located within the housing of the washfountain, and plugged into a duplex receptacle.

END OF SECTION

SECTION 226313

GAS PIPING SYSTEMS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for natural gas piping, gas valves, and gas regulators.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, performance ratings, and installation instructions.

1.3 QUALITY ASSURANCE

A. Conformance to National Fuel Gas Code.

B. Material and installation requirements shall follow NFPA 54, state and local gas company codes.

C. Conformance to ANSI B31.

D. Gas regulators shall be AGA rated.

1.4 GAS PIPING

A. Gas piping shall be schedule 40 black steel piping.

B. Gas piping installed external to the building from the service main to the gas meter shall be as per the gas company requirements.

C. Final connection from the building gas piping system to the gas turret in the science room can be corrugated stainless steel tubing per NFPA 54, state and local gas company requirements.

1.5 GAS VALVES

A. Gas valves 2 inches and smaller shall be full port all brass screwed gas service stops with lever handles and check.
1. (option) Gas valves 2” and smaller may be ¼ turn ball valves.

B. Gas valves 2-1/2 inches and larger shall be semi-steel, straightway flanged, 125 pounds swp, square head wrench operated, lubricated plug valve.

C. Kitchen Hood – Spring loaded (N.C.) gas valve or manual reset electric solenoid valve.

D. In the science and art rooms, provide the following:
1. A manual reset, solenoid operated shut-off valve with 120v operation with remote push button operation and fire alarm system activation.

1.6 GAS REGULATORS

A. Gas regulators shall be die cast aluminum alloy diaphragm, external vent connection, interchangeable brass orifices, cast iron body, Buna-N with nylon fabric insert diaphragm.

1.7 INSTALLATION

A. Unions and valves are not permitted in the gas piping in a return air plenum.

B. Piping 1-1/2 inches and smaller shall have threaded joints.

C. Piping 2 inches and larger shall have welded joints.

D. All regulators shall be separately vented full size to the exterior, with a turndown elbow and insect screen. Vent outlet shall not terminate next to a combustion or fresh air intake.

E. Provide a valve, union, and dirt leg at connection to each appliance. Lubricate all valves before putting the valves into service.

F. Provide 1/2 inch elastomeric insulation around all piping in walls and through floors.

G. Test all gas piping per NFPA 54.

H. Gas piping shall be accessible.

I. Science room auto shut-off valves can be located in teacher's demo unit, under sink, or exposed in storage room.

END OF SECTION

23 DIVISION

HEATING, VENTILATING, and AIR CONDITIONING

TABLE OF CONTENTS

DIVISION 23: HEATING, VENTILATING, and AIR CONDITIONING

230501 Common Work Results for HVAC
230507 HVAC Piping
230514 Variable Frequency Drives
230519 Meters and Gauges for HVAC Piping
230523 General Duty Valves for HVAC Piping
230525 Roof Curbs
230529 Hangers and Supports for HVAC
230548 Vibration and Seismic Control for HVAC
230553 Identification for HVAC
230593 Testing, Adjusting, andBalancing for HVAC
230719 HVAC Insulation
230923 HVAC Direct Digital Controls
230993 Sequence of Operation for HVAC
231101 Liquid Petroleum Gas Piping
232113 HVAC Piping Specialties
232117 Glycol Heat Transfer Fluid
232119 HVAC Flow Control
232123 HVAC Hydronic Pumps
232300 Refrigerant Piping
232500 HVAC Water Treatment
233113 Low-Pressure Ductwork
233115 Medium-Pressure Ductwork
233117 Flexible Ductwork
233300 Ductwork Accessories
233313 Exterior Wall Louvers
233400 HVAC Fans
233423 Rooftop Intake, Exhaust,& Relief Ventilators
233513 Dust Collection System
233515 Welding Exhaust System
233600 Variable Air Volume Terminals
233713 Air Outlets and Inlets
233716 Fabric Air Distribution Devices
233718 Underfloor Air Distribution System
233800 Kitchen Hood Ventilation System
234323 Air Cleaning System
235100 Breeching, Chimneys, and Stacks
235213 Electric Boilers
235216 Flue Gas Condensing Boilers
235223 Cast Iron Boilers
235225 Steel Firebox Boilers
235233 Flexible Water Tube Boilers
235239 Packaged Firetube Boilers
235700 Heat Exchangers
236213 Refrigerant Condensing Units
236215 Multiple-Compressor Refrigerant Condensing Units
236416 Packaged, Centrifugal Water Chiller
236423 Packaged, Scroll Water Chiller
236426 Packaged, Rotary Screw Water Chiller
236440 Refrigerant Monitoring Systems
236500 Packaged Cooling Towers
236533 Closed Circuit Fluid Coolers
237119 Ice Storage System
237200 Air to Air Energy Recovery Equipment
237313 Modular Indoor Air Handling Units
237323 Custom Indoor Air Handling Units
238113 Unitary Air Conditioning Equipment
238123 Computer Room Air Conditioners
238146 Water Source Heat Pumps
238156 Ground Source Heat Pumps(Geothermal)
238219 Fan Coil Units – Four Pipe
238223 Unit Ventilators – Four Pipe
238233 Convectors
238239 Cabinet Unit Heaters
238240 Propeller Unit Heaters
238316 Radiant Heating Hydronic System

SECTION 230501

COMMON WORK RESULTS FOR HVAC

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES QUALITATIVE REQUIREMENTS FOR:

A. Pipe and pipe fittings.

B. Dielectric fittings.

C. Mechanical sleeve seals.

D. Piping specialties.

E. Installation requirements common to piping systems and specification sections.

F. Installation requirements common to equipment specification sections.

G. Testing and repair.

H. Final completion.

I. Record drawings.

J. Maintenance and operating manuals.

K. Lubrication and packing.

1.2 SUBMITTALS

A. Submittal data is required for dielectric fittings, flexible connectors, mechanical sleeve seals, and piping specialties.

B. Refer to specific sections of this specification for additional submittal requirements.

1.3 QUALITY ASSURANCE

A. Any manufacturer other than basis of design shall be responsible for any additional requirements for electrical service, physical space limitations, and capacities at no additional cost to the project.

B. Materials and installation shall comply with requirements of governing regulations and controlling agencies.

C. All materials used shall be first grade of their kind and shall be new and in first-class condition when installed.

D. Work done by the Contractor shall include the services of an experienced superintendent.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Piping and tubing shall include factory-applied end caps.

B. All piping and tubing shall be elevated from grade for onsite storage.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

D. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.5 SEQUENCING AND SCHEDULING

A. Coordinate mechanical equipment installation with other building components.

B. Arrange for pipe spaces, chases, slots, and openings in the building structure during progress of construction.

C. Coordinate installation sleeves and supporting devices with concrete and structural components.

D. Coordinate connection of mechanical systems with underground and overhead utilities and services.

E. Coordinate requirements for access panels and doors.

F. Coordinate installation of identifying devices.

1.6 PROJECT CONDITIONS

A. HVAC support shall only be permitted at steel joist panel points.

B. Any supplemental steel required for support between building structural members shall be the responsibility of the HVAC Contractor.

1.7 PIPE AND PIPE FITTINGS

A. Pipe threads shall meet ASME B1.20.1 for factory-threaded pipe and pipe fittings.

B. Pipe-flange gasket materials shall meet ASME B16.21, nonmetallic, flat, asbestos-free.

C. Pipe Flanges
   1. Full face shall be Class 125, cast iron and cast-bronze material.
   2. Narrow face shall be Class 250, cast-iron and cast steel material.

D. Flange bolts and nuts shall meet ASME B18.2.1.

E. Solder filler materials shall meet ASTM B 32.
   1. Alloy Sn95 and Sn94 shall be used.

F. Brazing filler materials shall meet AWS A5.8.

G. Welding filler metals shall comply with AWS D10.12.

H. Solvent materials shall meet standard solvent cement requirements.
   1. CPVC piping shall meet ASTM F 493.
   2. PVC piping shall meet ASTM D 2564. Include primer according to ASTM F 656.
   3. Plastic pipe seals shall meet ASTM F 477
   4. Flanged, ductile-iron gasket, bolts, and nuts shall meet AWWA C 110.

1.8 DIELECTRIC FITTINGS

A. Fittings shall be zinc plated with a thermoplastic liner, rated for 250 degrees F maximum.

1.9 MECHANICAL SLEEVE SEALS

A. Seals shall be designed with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve and shall include connecting bolts and pressure plates.

1.10 PIPING SPECIALTIES

A. Piping sleeves shall be constructed of galvanized sheet metal or steel pipe. Steel pipe shall meet requirements of ASTM A 53, Type E, Grade A, Schedule 40. Sleeves for copper piping shall be of compatible material to prevent interaction of piping materials.

B. Escutcheons shall be manufactured wall, ceiling, and floor plates, split-type, and of heavy chrome-plated construction.

1.11 HVAC PIPING SYSTEMS - COMMON REQUIREMENTS

A. Division 23 piping/ductwork sections specify unique installation requirements.

B. Install components with pressure rating equal to or greater than system operating pressure.

C. Install all piping and ductwork at right angles or parallel to the building walls. Diagonal runs are prohibited.

D. Install piping and ductwork tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for panel removal.

E. Install all piping specialties to meet manufacturer's requirements.

F. Install pipe sleeves at all wall penetrations. Provide Schedule 40 steel pipe.
   1. PVC pipe sleeves are not permitted.
   2. Do not install sleeves through structural members.

G. Maintain fire rating at fire wall penetrations through the use of approved fire sealant materials installed in pipe sleeve.

H. Install unions in piping 2 inch and smaller adjacent to each valve and at final connection to each piece of equipment.

I. Install flanges in piping 2-1/2 inch and larger adjacent to flanged valves and at final connections to equipment with flanged pipe connections.

1.12 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to facilitate service, maintenance, and repair or replacement of components.

B. Maintain lubrication gaskets and packing during construction and assure that at time of acceptance by the Owner, equipment is in first-class operating condition.

1.13 EQUIPMENT START-UP

A. Start-up of all HVAC equipment shall be video-taped by the HVAC contractor. Two copies shall be turned over to the Owner's maintenance staff.

1.14 TESTING AND REPAIR

A. All piping and ductwork systems shall be throughly cleaned and flushed prior to final testing.

B. Supply, return, and exhaust air ductwork systems shall be pressure tested to a minimum leakage rate.

C. Pressure testing shall be completed for the following piping systems:
   1. Heating water, chilled water, heat pump condenser loop water, and cooling tower condenser water systems.

D. All testing must be witnessed and accurately recorded noting methods of testing, times, dates, and results.

E. Any damage as a result of tests shall be repaired or damaged materials replaced at no cost to the Owner.

1.15 FINAL COMPLETION

A. All work shall be cleaned prior to issuance of Substantial Completion.

B. Retouch or repaint factory painted prime and finish coats where scratched or damaged.

C. Deliver filters, belts, and equipment, as required by this Specification, to Owner and obtained signed receipts of delivery.

D. Clean equipment, restore damaged materials, and leave the Work in acceptable condition.

E. Remove all site tools, equipment, surplus materials and rubbish continuously at no additional cost to the Owner.

F. Contractor shall submit written certificates warranting each item of equipment.

1.16 RECORD DRAWINGS

A. The Contractor shall keep a running record of each change and deviation from the Drawings on a clean and undamaged set of Drawings.

B. The final Project Record Drawings shall be submitted to the Engineer for approval at the completion of the project.

C. Record Drawings shall include the location of concealed piping and ductwork.

1.17 MAINTENANCE AND OPERATING MANUALS

A. The Maintenance and Operating Manuals shall comply with other Sections of this Specification. Submit in triplicate for inclusion in Maintenance and Operating Manuals.

B. Bind the written operating instructions, approved shop drawings, equipment catalog cuts, equipment warranties, and manufacturer's instructions into a binder.

END OF SECTION

SECTION 230507

HVAC PIPING

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for HVAC piping.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. Follow manufacturer's requirements for installation.

B. Welding procedures per ANSI/ASME Section 9, AWS D10.9 and D1.1 and the National Certified Pipe Welding Bureau.

C. Brazing procedures per ANSI B31.5 and the ASME Boiler and Pressure Vessel Code SFA-5.8, Section II.

D. Soldering procedures per ANSI B16.18.

E. Comply with ANSI B31 pressure code for pressure piping.

1.4 HVAC PIPING

A. Heating, Chilled, Cooling Tower Condenser, and Heat Pump Condenser Water Supply and Return Piping

1. Black steel piping
   a. Piping shall be standard weight black steel for 2-1/2 inch and smaller per ASTM A53 or A120. Fittings shall be class 125 cast iron threaded per ANSI B16.4.
   b. Piping shall be standard weight black steel for 3 inch and larger per ASTM A53 or A120. Fittings shall be butt welded.
2. Copper piping
   a. Piping 2-1/2 inches and smaller shall be type L copper per ASTM B88. Fittings shall be wrought copper per ANSI B16.22.
3. Grooved piping (option)
   a. Grooved piping with ductile iron or bronze couplings and EPDM gaskets.
   b. Copper and steel pipe shall be as listed above.
4. Copper press fittings may be used as an option per ASTM B16.18 or ASTM B16.22. O-Rings shall be EPDM.
5. Underground piping
   a. Piping shall be pre-insulated piping system with copper or steel pressure carrier pipe, polyurethane insulation and PVC jacket.
   b. Piping system shall include o-ring seals and expansion compensation.
   c. Piping system shall incorporate thrust blocks and other accessories as recommended by system manufacturer.

B. Underground, Ground Source Heat Pump System Piping
   1. High density polyethylene piping
      a. Material classification per ASTM D-1248.

C. Air Conditioning Condensate Drain Piping
   1. Piping shall be Schedule 40 PVC with solvent joints per ASTM D2665, D2564, D2665.
   2. In air plenums and through fire walls, Piping shall be type L copper per ASTM B88. Fittings shall be wrought copper per ANSI B16.22

1.5 INSTALLATION

A. Terminate vent piping through roof, a minimum of 12 inches above the roof.

B. Refer to Section 232500 HVAC Water Treatment for flushing, cleaning, and water treatment requirements.

C. All piping on site must be capped and sealed from contamination and debris throughout the construction cycle.

END OF SECTION

SECTION 230514

VARIABLE FREQUENCY DRIVES

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for electronic variable frequency drive with motor starter.

1.2 SUBMITTALS

A. Submittals are required and shall include product descriptive literature demonstrating compliance with written specification and, at a minimum, shall include the following:
1. Inverter efficiency and power factor curves.
2. Performance curves.
3. Substantiating data for Mean Time Between Failure (MTBF).

1.3 QUALITY ASSURANCE

A. Variable frequency drives shall comply with applicable requirements of the latest standards of ANSI, IEEE, NEMA, and NEC.

B. Each drive shall be UL Listed.

C. Drives used throughout a project site shall be provided by the same manufacturer for all applications (fans and pumps).

D. Audible motor drive noise shall be no more than 5 db louder than across line starter operation.

1.4 WARRANTY/TRAINING

A. Manufacturer shall warrant complete drive system for a period of 1 year.

B. A factory trained representative shall provide a minimum of 8 hours on-site training to Owner selected personnel on the operation and maintenance of each drive installed.

1.5 ELECTRONIC REQUIREMENTS

A. Each drive shall be microprocessor based, fully transistorized with 3 phase, full wave diode bridge input, and pulse-width-modulating sine-coded output waveform.

B. Output transistors shall be of the Insulated Gate Bipolar Transistor (IGBT) type.

C. Minimum 20 years MTBF required.

D. Maximum switching frequency of 15 KHZ.

E. Displacement power factor shall be 0.98 or better over the entire operating frequency and load range.

1.6 PROTECTIVE FEATURES

A. Drive enclosure shall be NEMA 1 and shall be wall-mount or free standing as indicated on the Drawings.

B. Controlled acceleration and deceleration shall be adjustable from 3 to 600 seconds. Current limits shall prevent overflow trips.

C. Minimum switching frequency shall be adjustable from 0 to 100 percent of base frequency.

D. Maximum switching frequency shall be adjustable from 110 to 0 percent of base frequency.

E. Automatic boost for 100 percent starting torque.

F. Hand-off-auto switch mounted in front door of mounting enclosure.

G. Fault contact for remote indication.

H. Contact closure for remote indication that drive is operating.

I. Automatic restart on fault that is programmable for 0 to 5 restarts.

J. Minimum of 2 critical frequency avoidance points with programmable deadband.

K. Output signal for motor speed shall be 0 to 10 vdc or 4-20 milliamp.

L. Output voltage regulation.

M. Continued operation of drive at 80 percent of last speed reference input if control command is lost.

1.7 OPERATION PROTECTION

A. Current limit control for protection against normal transients and surges from incoming power lines, grounding systems, or runaway incoming speed reference signal.

B. Protection from phase-to-phase and phase-to-ground faults.

C. Torque limit control.

D. Capabilities to start into a spinning load and windmilling operation.

E. Instantaneous overcurrent trip to monitor peak currents and provide shutdown without component failure.

F. Input line reactors with a minimum of 3 percent rating on all incoming phase lines.

G. DC link choke to reduce current and voltage harmonics reflected to the AC power supply.

1.8 OPERATING CONDITIONS

A. Unit shall comply to the following operating conditions:
   1. Line voltage: +10 percent, -10 percent of rating.
   2. Line frequency: + or - 5 percent
   3. Overload: 100 percent
   4. Ambient temperature: 0 degrees to 40 degrees C.
   5. Altitude: 3,300 feet or less
   6. Atmosphere: 95 percent relative humidity, noncondensing
   7. Efficiency: 97 percent at 100 percent load, 100 percent base speed. 80 percent at 12.5 percent load, 80 percent speed.
   8. Fundamental power factor shall be 0.98 at all speeds and loads.

B. Digital operator/keypad is required and shall include the following features:
   1. Motor speed indication, in RPM, percent speed, or frequency (Hz)
   2. Speed reference signal
   3. Alpha-numeric fault trip annunciation
   4. Output current
   5. Output power
   6. Output voltage
   7. Bus voltage

C. Indicator lights as follows:
   1. Power on light
   2. Run light
   3. VFD trip light
   4. External fault light

1.9 INSTALLATION

A. Install in accordance with manufacturers requirements.

B. A factory authorized and trained technician shall preform the initial startup on all drives.

END OF SECTION

SECTION 230519

THERMOMETERS AND GAUGES FOR HVAC EQUIPMENT

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for thermometers and fittings, as well as pressure gauges and fittings.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, and dimensions.

1.3 COMPONENTS

A. Thermometers: 1-percent accuracy.
1. Direct-Mounting Filled-System Dial Type: Vapor actuated, thermal bulb, precision brass gear.
2. Remote-Reading, Filled-System Dial Type: Vapor actuated, thermal bulb; precision brass gear.
3. Bimetal Dial Type: Direct mounting, bimetal coil.
4. Insertion Dial Type: Bimetal coil.
5. Non-toxic, organic filled liquid-in-glass, column type thermometer.

B. Pressure Gauges: Phosphor-bronze Bourdon-tube gages, 1-percent accuracy.
1. Vacuum Range: 30 inches Hg of vacuum to 15 psig of pressure .
2. Pressure Range: Two-times operating pressure.
3. Liquid filled pressure gauge where appropriate. ***Liquid shall be non-toxic, organic type.***

1.4 INSTALLATION

A. Provide thermometers at the following locations:
1. Inlet and outlet chilled water connection to chillers
2. Inlet and outlet heating water connections to boilers.
3. Heating water, heat pump condenser loop, and chilled water supply and return loop to and from the building if primary/secondary pumping is used or if a 3-way valve is used to reset the building heating water temperature.
4. At all coil connections at main air handling units.
5. Condenser water supply and return piping.
6. Heat exchanger inlet and outlet piping.

B. Provide pressure gauges at the following locations:
1. One pressure gauge with 2 independent needle valves piped to the suction and discharge piping of all pumps except coil recirculating pumps.
2. Inlet and outlet piping of each chiller.
3. Outlet piping of each boiler unless integral to the boiler.
4. Domestic cold water fill connection to the HVAC hydronic loop downstream of the pressure reducing valve.

END OF SECTION

SECTION 230523

GENERAL DUTY VALVES FOR HVAC PIPING

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for valves.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting type materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. The following standards apply.
1. ANSI B16.10, MSS SP-67-90 Butterfly Valves.
2. MSS SP-70-90 Cast Iron Gate Valves, Flanged or Threaded Ends.
3. MSS SP-78-92 Cast Iron Plug Valves Flanged and Threaded.
4. MSS SP-80-87 Bronze Gate, Globe, and Check Valves.
5. MSS SP-85-85 Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.
6. MSS SP-110-92 Ball Valves Threaded, Socket-Welded, Solder Joint, Grooved and Flared Ends.

1.4 COMPONENTS

A. Gate Valves
1. 2-1/2 Inch NPS and Smaller: Cast-iron body with threaded connections for steel piping systems. Bronze body with soldered or threaded connections for copper piping systems, solid-bronze wedge, Class 125 or 150, rising stem, and soldered or threaded connections.
2. 3 Inch NPS and Larger: Cast-iron body and bonnet, Class 125, solid cast-iron wedge, outside screw and yoke, and flanged connections.

B. Ball Valves
1. Bronze body and bonnet, two-piece construction, chrome-plated ball, standard port for 2-1/2 inch NPS and smaller and full port for 3 inch NPS valves, Class 150, with stem extensions for insulated piping and memory stops.

C. Globe Valves
1. 2-1/2 Inch NPS and Smaller: Cast-bronze body and bonnet, Class 125 or 150, with threaded or soldered connections.
2. 3 Inch NPS and Larger: Cast-bronze body and bonnet, Class 125, outside screw and yoke, with flanged connections.

D. Butterfly Valves: Cast-iron body and bonnet, Class 250, 200 psig working pressure, stainless-steel stem; lug, or grooved style connections. (For HVAC systems only)
   1. Disc Type: [Aluminum bronze] [stainless steel]
   2. Operator:
      a. Standard lever handle.
      b. Standard lever handle with memory stop.
      c. Lever handle with latch lock.
      d. Gear with position indicator.
      e. Gear with position indicator and chain wheel.
      f. Chain wheel.

E. Check Valves
   1. Swing Type, 2-1/2 Inch NPS and Smaller: Bronze body, Class 125 or 150, horizontal swing, with threaded or soldered connections.
   2. Swing Type, 3 Inch NPS and Larger: Cast-iron body, Class 125, horizontal swing, with flanged or grooved connections.
      a. Wafer Type: Class 125, cast-iron body, bronze disc, with stainless-steel pins and springs.
      b. Lift Type: Class 125, bronze body and cap, horizontal or vertical pattern, bronze disc, with threaded or soldered connections.

1.5 INSTALLATION

A. Install all threaded valves with a union joint on the downstream side of the valve.

B. Provide valves to isolate all equipment and coils.

C. Provide valves of like material as the piping systems.

D. Provide dielectric connections between all dissimilar metals.

END OF SECTION

SECTION 230525

ROOF CURBS

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for roof curbs for equipment mounting and piping penetrations.

1.2 SUBMITTALS

A. Submittals are required and shall include material, quantities, and dimensions.

1.3 COMPONENTS

A. Roof Curbs

1. Roof curb shall be constructed of galvanized steel with welded corner beams and pressure treated 2 by 2 wood nailer.
2. Curbs shall be preinsulated with 1-1/2 inch rigid insulation.
3. Top of curb shall set dead level.
4. Base of curb shall match roof slope.
5. Provide 18 inches for kitchen hood exhaust fans.

B. Box Curb

1. Box section curbs shall be constructed of welded, heavy gauge galvanized steel with mitered and welded corners, integral base plate, and pressure treated wood nailer.
2. Curb shall be insulated with minimum 1-1/2 inch rigid insulation.

C. Equipment Support

1. Rails shall be 18 gauge welded galvanized steel with a welded galvanized counterflashing. Unit to have integral base plate, and 2 by 4 pressure treated wood nailer.
2. Rails to be of the length and strength required to support the specified equipment.
3. Equipment rails shall be internally reinforced to conform with manufacturers load bearing factors.

D. Pipe Roller Supports

1. Pipe support shall be constructed from heavy gauge galvanized steel with continuous welded corner seams, 2 by 4 treated wood nailer, galvanized steel counterflashing and galvanized steel channel track.

E. Pipe Curbs

1. Pipe curb shall consist of a heavy gauge galvanized steel roof curb of unitized construction, with integral base plate, 3 pound density insulation, and 2 by 2 nailer. Curb shall be covered with a thermoplastic cover, fastening screws, graduated step boots with stainless steel adjustable clamps.

1.4 INSTALLATION

A. Roof curbs and equipment rails shall be mounted with top dead level, properly anchored to the deck.

B. Roof curbs for metal roof systems shall be provided by the metal roof system manufacturer.

END OF SECTION

SECTION 230529

HANGERS AND SUPPORTS FOR HVAC

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for piping hangers and supports, and equipment hangers and supports.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, and types.

1.3 COMPONENTS

A. Hangers, supports, and components shall be factory fabricated according to MSS SP-58, the latest edition.

B. Hangers for piping shall be of a compatible material or coating.

C. Continuous threaded rod shall be used wherever possible. ***An engineered cable support system is acceptable.*** Chain, wire, or perforated straps shall not be permitted.

D. Concrete inserts into poured concrete floor systems are permitted.

E. Beam clamps, trapeze hangers, and clevis hangers shall be permitted.

F. Supports from roof decking systems are not permitted.

G. Concrete inserts into precast concrete plank are permitted.

H. Powder activated fasteners are not allowed.

1.4 INSTALLATION

A. All hangers and supports shall be attached to the building structural steel system.

B. Support from steel joist panel point is required.

C. All hangers, supports, and fastening methods used shall be suitable for the weight of the components being supported.

END OF SECTION

SECTION 230548

VIBRATION and SEISMIC CONTROL for HVAC

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for vibration isolators, equipment bases, and flexible connectors.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting calculations, materials, sizes, and dimensions.

1.3 COMPONENTS

A. Vibration isolators as follows:
1. Isolator Pads: Oil- and water-resistant [rubber] [fiberglass or cork].
2. Rubber Isolator Mounts: Double-deflection type.
3. Spring Isolators: Freestanding, laterally stable, open-spring type.
4. Restrained Spring Isolators: Vertically restrained, freestanding, laterally stable, steel open-spring type.
5. Rubber Hangers: Double-deflection type.
6. Spring Hangers: Combination spring and elastomeric hangers with coil spring and elastomeric insert in compression.

B. Equipment bases as follows:
1. Concrete filled, steel constructed inertia bases.
2. Structural steel bases without inertia pad.

C. Flexible piping connectors as follows:
1. Molded reinforced neoprene construction with steel flanges and control rods.
2. Flexible steel braided construction with steel flanges.

1.4 INSTALLATION

A. Installation of vibration isolation, piping connections, and inertia bases shall be in accordance with the manufacturer's recommendation.

B. Rigid connections between vibrating equipment and the building shall not be permitted.

END OF SECTION

SECTION 230553

IDENTIFICATION FOR HVAC

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for HVAC identification methods, materials and devices.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, and dimensions for identification systems.

B. Submittals are required of valve schedules.

1.3 QUALITY ASSURANCE

A. Identification requirements shall meet ASME A13.1.

1.4 COMPONENTS

A. Equipment Nameplates: Aluminum, permanently fastened to equipment, engraved or stamped.

B. Stencils: Standard stencils shall be black enamel on a white background or white enamel on a dark background.

C. Snap-on Plastic Pipe Markers: Preprinted, semi-rigid type, color-coded.

D. Pressure-Sensitive Pipe Markers: Preprinted, color-coded, vinyl type with permanent adhesive.

E. Pipe Markers: Full band type.

F. Plastic Duct Markers: Laminated plastic, color coded, and engraved with the service.

G. Plastic Tape: Color-coded, pressure-sensitive, self-adhesive vinyl.

H. Valve Tags: Polished tags with numbers and letters.

I. Access Panel Markers: Engraved plastic laminate.

J. Engraved Plastic-Laminate Signs: Sizes required to contain message.

K. Plastic Equipment Markers: Standard color-coded, laminated plastic.

L. Plasticize Tags: Preprinted, accident prevention.

M. Valve Location Tags: 3/4 inch diameter colored, pressure-sensitive adhesive paper circles.

1.5 VALVE CHARTS

A. Valve charts shall be furnished by each respective Contractor and shall include the following items:
   1. Valve identification
   2. Location
   3. Purpose

B. Valve charts shall be included in the Maintenance and Operating Manuals.

1.6 INSTALLATION

A. Piping, equipment and valve identification shall be completed prior to issuance of Substantial Completion.

END OF SECTION

SECTION 230593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for the testing, adjusting, and balancing of the HVAC air and water systems; includes the performing contractor's certification requirements.

1.2 SUBMITTALS

A. Submittals are required and shall include the complete certified report for all air and water system pressure testing and balancing including all electrical performance of each piece of HVAC equipment.

B. Prior to commencement of the work described in this Section, the testing, adjusting, and balancing contractor shall submit verification of his AABC or NEBB certification to the Design Professional for acceptance.

1.3 QUALITY ASSURANCE

A. The testing, adjusting, and balancing contractor shall be either AABC or NEBB certified for the work described herein.

B. Project will be Commissioned. Refer to section 9101-01900 for additional information.

1.4 COMPONENTS

A. The Contractor shall provide his own properly calibrated equipment to pressure test, air balance, water balance and to measure electrical characteristics of each piece of HVAC equipment. ***Include a list of instruments to be used for procedures, along with Proof of Calibration.***

1.5 REQUIREMENTS

A. Testing, adjusting, and balancing plan.

B. Systems readiness checks.

C. Testing, Adjusting, and Balancing Procedures: AABC's National Standards or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems".

D. Equipment settings marked to show final settings.

E. Balancing shall be performed to meet the requirements of ASHRAE Standard 90.1.

F. Pumps with variable speed drives shall be balanced with all valves 100% open (not including balancing valves at coils).

G. For variable speed fans, fan and motor pulleys shall be replaced (or adjusted, when applicable) so that motor is fully loaded at 100% speed. Balance to design air flow by adjusting maximum variable speed drive output below 100%.

1.6 HVAC SYSTEMS AIRFLOW AND WATER FLOW RATE TOLERANCES

A. Supply, Return, and Exhaust Fans: Plus 5 percent to plus 10 percent.

B. Air Outlets and Inlets: 0 to minus 10 percent.

C. Heating Water Flow Rate: 0 to minus 10 percent.

D. Cooling Water Flow Rate: 0 to minus 5 percent.

1.7 REPORTING

A. Initial Construction Phase Report: Based on examination of Contract Documents, on adequacy of design for systems balancing devices.

B. Status Reports: As Work progresses.

C. Draft "Pencil Copy" Report: Provide draft air balance report when the balancing is complete to the Engineer and Commissioning Authority for review before final report.

D. Commissioning Verification Report: Commissioning Authority will randomly verify TAB work and produce report. TAB Contractor shall make corrections based on this report.

E. Final Report: Certification sheet, with content and format according to AABC or NEBB standard forms.

F. Seasonal Testing: If initial TAB procedures were not performed during near peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near peak summer or winter conditions.

G. 11 month Warranty Walk: TAB to perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to report unusual conditions with recommendation of adjustments. TAB Contractor shall allow two (2) days for this work.

END OF SECTION

SECTION 230719

HVAC INSULATION

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for interior and exterior pipe insulation, jackets, and accessories.

B. Qualitative requirements for field-applied insulation on hot and cold equipment surfaces.

C. Qualitative requirements for exterior and interior duct and plenum insulation and accessories.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, thickness for each service or piece of equipment, aged thermal qualities, and accessories.

1.3 QUALITY ASSURANCE

A. Fire performance characteristics in accordance with ASTM E 84 for flame spread of 25 and smoke developed of 50.

B. Materials and installation in accordance with NFPA 255 and UL 723.

C. Insulation thickness shall meet the requirements of ASHRAE Standard 90.1.

1.4 MATERIALS

A. Glass Fiber: All-purpose jacket and vapor-barrier coated.

1.	Preformed:	ASTM C 547, Class I, rigid, jacketed, and vapor-coated.
2.	Board:	ASTM C 612, Type 2, rigid and semi-rigid.
3.	Blanket:	ASTM C 553, Type II, Class F-1.
4.	Adhesive:	UL classification; nonflammable.
5.	Maximum “K” Value:	0.23 at 75 degrees F.

B. Cellular Glass: Insulation with factory-applied, laminated-foil, flame-retardant, vinyl facing.

1.	Piping:	Preformed foamed or cellulated glass, jacketed pipe insulation.
2.	Facing:	ASTM C 921, Type 1.
3.	Blocks:	ASTM C 552, Type I.
4.	Boards:	ASTM C 552, Type IV.
5.	Special Shapes:	ASTM C 552, Type III.
6.	Maximum “K” Value:	0.35 at 75 degrees F.

C. Flexible Elastomeric Cellular: Flexible cellular elastomeric material, molded or sheet.
   1. Preformed: ASTM C534, Type II ***for sheet materal and Type I for tubular material.***
   2. Adhesive: Waterproof vapor retarder.
   3. Maximum "K" Value: ***0.25*** at 75 degrees F.

D. Calcium Silicate
   1. Piping: Rigid molded block insulation, asbestos free ASTM C553, Type I.
   2. Maximum "K" Value: 0.40 at 300 degrees F.

E. Duct Liner Insulation
   1. Material: Flexible blanket, ASTM C518 ***or elastomeric linear per ASTM C534.***
   2. Coating: ASTM C1071. Microbial growth resistant.
   3. Adhesive: UL listed waterproof.
   4. Fasteners: Galvanized steel pins (welded or mechanically fastened) ***with adhesive.***
   5. Maximum "K" Value: 0.25 at 75 degrees F.
   6. Standards: NFPA 90A, NFPA 90B and 25/50 flame and smoke spread.

F. Insulating Cements
   1. Mineral fiber, hydraulic-setting insulating and finishing cement.
   2. Expanded or exfoliated vermiculite.

G. Adhesives: MIL-A-3316C, Classes 1 and 2, Grade A ***for fiberglass. MIL-A-24179A, Type II, Class 1 for elastomerics.***

H. Jackets shall be adjusted for the application.
   1. Piping: PVC or aluminum
   2. Equipment: Foil and paper.
   3. Ductwork: Foil and paper.

I. Polyisocyanurate: Rigid closed cell polyisocyanurate thermal insulation, fabricated into shapes required to insulate pipes, valves, fittings, vessels, and/or special shapes as required.
   1. Density: 2 lb/cf
   2. Permeance: Less than or equal to 3 perm-inch
   3. Provide with a vapor retardant cross laminated high density polyvinylidene chloride polymer film.
   4. Material shall not contain or be produced with any of the U.S. EPA regulated CFC compounds listed in the Montreal Protocol of the United Nations Environmental Program.

1.5 APPLICATIONS

A. Exposed Interior Piping Systems
   1. Hydronic heating water
   2. Hydronic chilled water
   3. Hydronic heat pump condenser loop water
   4. Condensate drain
   5. Refrigerant suction and hot gas bypass

B. Concealed Interior Piping Systems
   1. Hydronic heating water
   2. Hydronic chilled water
   3. Hydronic heat pump condenser loop water
   4. Condensate drain
   5. Refrigerant suction and hot gas bypass

C. Exposed Exterior Piping Systems
   1. Refrigerant suction and hot gas bypass
   2. Hydronic chilled water
   3. Hydronic heating water

D. Concealed Exterior Piping Systems
   1. Refrigerant suction and hot gas bypass
   2. Hydronic chilled water
   3. Hydronic heating water

E. Concealed Piping Systems in Crawl Spaces or Other Moist Environments:
   1. Polyisocyanurate insulation required for cold services (chilled water) where 25/50 smoke/flame rating is not required, unless specific product is rated for such.

F. Indoor Equipment
   1. Chilled water equipment, tanks, pumps, and heat exchangers.
   2. Following items are not insulated:
      a. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
      b. Flexible connectors.
      c. Vibration control devices.
      d. Testing laboratory labels and stamps.
      e. Nameplates and data plates.
      f. Access panels and doors in air distribution systems.
      g. Factory insulated equipment such as boilers.

G. Ductwork Systems
   1. Interior concealed supply, return, and outside air ductwork.
   2. Interior exposed supply, return, and outside air ductwork.
   3. Exterior exposed supply and return ductwork.
   4. Kitchen range hood supply air ductwork.
   5. Items not insulated as a part of the Specification Section
      a. Metal ducts with duct liner.
      b. Factory-insulated flexible ducts.
      c. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
      d. Flexible connectors.
      e. Vibration control devices.
      f. Testing laboratory labels and stamps.
      g. Nameplates and data plates.
      h. Access panels and doors in air distribution systems.

H. Insulation Jacketing Systems
   1. Provide protective jacketing for all exposed pipe systems located in mechanical rooms, boiler rooms, and storage rooms.
   2. Provide protective jacketing for all exterior pipe systems.
   3. Provide protective jacketing for all exposed ductwork installations.

1.6 EXAMINATION AND PREPARATION

A. Leak test piping and ductwork system before installing insulation systems.

1.7 INSTALLATION

A. Install material in accordance with manufacturer's recommendations and in conformance with building codes and industry standards.

B. A continuous vapor barrier is required.

C. Provide proper support at piping hanger systems.

D. Insulate valves and fittings in cold water systems.

E. Ductwork insulation shall be wrapped in lieu of liner for all applications except for specific sound attenuation means.

F. All insulation shall be applied so that there is no fiberglass exposed to the air stream without filters downstream. All fiberglass insulation, including all exposed edges, shall be coated, or mylar or other suitable material shall be provided between fiberglass and the air stream. ***Elastomeric duct liner does not require coating or mylar.***

END OF SECTION

SECTION 230923

HVAC DIRECT DIGITAL CONTROLS

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for control equipment for HVAC systems and components, software requirements, and installation requirements for a complete HVAC direct digital control (DDC) electronic temperature control system.

1.2 SUBMITTALS

A. Submittals are required and shall include product descriptive literature demonstrating compliance with written specification and, at a minimum, shall include the following:
   1. Equipment and component specifications.
   2. Software capabilities and operation.
   3. Graphics capabilities and proposed solutions.

1.3 QUALITY ASSURANCE

A. Electric components shall be UL Listed.

B. Damper components shall comply with AMCA 500.

C. Energy management components shall comply with NEMA EMCI.

D. Enclosures shall comply with NEMA 250.

E. Electrical requirements shall meet NFPA 70.

F. Installation as a part of the HVAC system shall comply with NFPA 90A.

G. System installation shall allow ***for application*** of the “BACnet” protocol to meet requirements of ASHRAE 135 or “Lonworks” protocol.

H. Control systems shall meet the requirements of ASHRAE Standard 90.1.

1.4 DAMPERS

A. Dampers shall be low-leakage type, as required to meet the requirements of ASHRAE Standard 90.1., not less than 22 gauge galvanized steel frames.

B. Modulating dampers shall be opposed blade type.

C. Dampers shall be sized for 1000 to 1500 FPM air velocity.

1.5 VALVES

A. Factory fabricated of type, body material, pressure class, and at a maximum 5 psi pressure drop.
   1. 2-way valves shall have equal percentage characteristics.
   2. 3-way valves shall have linear characteristics

B. Globe Valves
   1. Up to 2 inches: Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with back seating capacity repackable under pressure.
   2. Over 2 inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.
   3. Service at 125 psi WSP and 250 deg F.
   4. Internal construction shall be replaceable plugs and seats of stainless steel or brass.

C. Butterfly Valves
   1. Iron body, bronze, aluminum-bronze or stainless steel disc, resilient, replaceable seat for service to 200 deg F., lug ends, and extended neck.
   2. Service at 125 psi WSP and 250 deg F.

D. Terminal Unit Control Valves
   1. Bronze body, bronze trim, 2 or 3 port as indicated, replaceable plugs and seats, union and threaded ends.
   2. Service at 125 psi WSP and 250 deg F.

1.6 VALVE AND DAMPERS ACTUATORS

A. Damper actuators shall be electronic, low voltage. Actuator response shall be linear in response to sensed load.
   1. Dampers on outside air intakes/exhaust shall be spring return closed.

B. Valve operators shall be electronic, low voltage and properly selected for the valve body and service.
   1. Actuators shall be fully proportioning unless otherwise indicated.
   2. Heating water valve actuators in the path of outside air shall be spring return open.
   3. Cabinet heater and radiant ceiling panel valves shall be 2-position.

1.7 RELAYS

A. Relays shall be UL Listed and sized for not less than 140 percent of the connected amperage load.

1.8 SENSING DEVICES

A. Electronic Temperature Sensors.

B. Electronic Room Temperature Sensors.

C. Electronic Duct Temperature Sensors.

D. Electric Thermostats.

E. Sensor Guards.

F. Safety Low Limit Thermostats.

G. Electronic Pressure Sensors.

H. Humidity Sensors.

I. Current Sensing Status Switch.

J. Photo Sensitive Resistor.

K. Carbon Dioxide Sensors.

1.9 CONTROL CABINET/ENCLOSURES

A. Shall be constructed of extruded aluminum, galvanized steel, or factory-hardened plastic.

B. Enclosures for electrical devices shall be constructed of code gauge steel with a UL Label.

C. Panels shall be labeled with nameplates and legends as required.

D. Each major control cabinet/enclosure (minimum one per mechanical room) shall be equipped with a fold-out laptop shelf at an appropriate height. Provide a DDC connection port at each.

1.10 BUILDING AUTOMATION SYSTEM

A. The entire system shall utilize electric/electronic DDC technology and actuation. Pneumatics is not permitted.

B. Personal operator workstation complete with color monitor, internal modem, keyboard, and printer.

C. Host Computer Software
1. Energy management report generation.
2. Trend logs setup and storage.
3. Alarm generation, status, and prioritization.
4. User interface with English language applications.
5. Dynamic graphics applications.

1.11 BUILDING AUTOMATION EQUIPMENT

A. Global Control Panel
1. Central, microprocessor host controller

B. Software functions
   1. English language terminal mode interface
   2. Customized report generation
   3. Time and event based trending
   4. Maximum predictive algorithms
   5. Central system optimization
   6. Functional library of operations and applications

C. On-board modem of the latest Kbaud rate for external monitoring and serial connection.

D. AHU Controllers

E. Boiler Plant Unitary Controllers

F. VAV Terminal Controllers

G. Packaged Terminal Equipment Controllers

1.12 TEMPERATURE CONTROL WIRING

A. Where control wiring is installed in conduit, conduit shall be 2 inch minimum size.

B. Wiring in air plenums shall be open wired UL Listed plenum cable or it shall be installed in conduit.

C. Open wiring shall be secured with plastic tie wraps to permanent building structure.

D. Final wiring terminations shall be made by the Temperature Control Contractor.

1.13 INSTALLATION

A. Install in accordance with manufacturers requirements.

1.14 SEQUENCE OF OPERATION

A. Refer to Specification Section 230993 for all equipment sequences.

1.15 DAY/NIGHT ZONE CONTROL

A. Building zone control shall be through the DDC computer.

B. General exhaust fans shall be operated through zone control.

1.16 WARRANTY

A. All equipment shall be warranted for a period of ***two (2)*** years after issuance of Substantial Completion.

B. Temperature Control Contractor shall provide support for operation of the system and improvements to energy usage to the Owner throughout the first ***fifteen months*** of operation.

1.17 TRAINING

A. The system manufacturer shall provide on-site training on the operation of the complete DDC system.

B. All training shall be video-taped by the HVAC contractor. Two copies shall be turned over to the Owner's maintenance staff.

1.18 FINAL CHECK-TEST-START OF SYSTEM

A. Check and/or oil all electric motors furnished under control system.

B. Lubricate all damper bearings.

C. Check damper travel, adjust and tighten all set screws.

D. Lubricate valve stems, check packing.

E. Calibrate all instruments.

F. Check and verify all circuitry.

G. Calibrate and check all controllers, fusing, and electrical connections.

H. Run software through program diagnostics and debug as required.

I. Startup and test operation of variable frequency drive with factory authorized personnel.

END OF SECTION

SECTION 230993

SEQUENCE OF OPERATION FOR HVAC

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for the Sequences of Operation for HVAC systems and terminal units.

1.2 SUBMITTALS

A. Submittals are required and shall include detailed descriptions of the proposed sequence of operations for all systems specific to the project.

B. The following information shall be submitted as a very minimum to the Engineer:
1. System diagrams denoting the operation of each individual system, folded to an equivalent 8-1/2 inch by 11 inch bound packet.
2. DDC logic diagrams.
3. Written sequences of operation with each specific diagram.

1.3 SYSTEM DESCRIPTION

A. Specific system sequences of operation shall be denoted as subsections to this section.

B. Sequences of operation shall meet the requirements of ASHRAE Standard 90.1.

1.4 The following control sequences are examples only. It is the responsibility of the design professional to provide the appropriate custom control sequences for each individual project. Any setpoints listed in these sequences are arbitrary and do not reflect specific requirements of OSFC.

A. Two Boiler System
1. Boiler System - Run Conditions:
a. The boiler system shall be enabled to run whenever outside air temperature is less than ***the unoccupied/occupied reset schedule.***
b. To prevent short cycling, each boiler shall run for and be off for minimum adjustable times (both user definable), unless shutdown on safeties or outside air conditions.
c. Each boiler shall run subject to its own internal safeties and controls.
d. The boiler system shall also run for freeze protection whenever the outside air temperature is less than 38°F (adj.).
2. Boiler 1 Safeties:
a. The following safeties shall be monitored:
1) Boiler alarm.
2) Low water level.
b. Alarms shall be provided as follows:
1) Boiler alarm.
2) Low water level alarm.
3. Boiler 2 Safeties:
a. The following safeties shall be monitored:
1) Boiler alarm.
2) Low water level.

b. Alarms shall be provided as follows:
   1) Boiler alarm.
   2) Low water level.

4. ***Primary*** Hot Water Pump Lead/Standby Operation:
   a. The two ***primary*** hot water pumps shall operate in a lead/standby fashion.
      1) The lead ***primary*** pump shall run first.
      2) On failure of the lead ***primary*** pump, the standby ***primary*** pump shall run and the lead ***primary*** pump shall turn off.
   b. The designated lead ***primary*** pump shall rotate upon one of the following conditions (user selectable):
      1) manually through a software switch
      2) weekly
      3) monthly
   c. Alarms shall be provided as follows:
      1) ***Primary*** Hot Water Pump 1
         a. Failure: Commanded on, but the status is off.
         b. Running in Hand: Commanded off, but the status is on.
      2) ***Primary*** Hot Water Pump 2
         a. Failure: Commanded on, but the status is off.
         b. Running in Hand: Commanded off, but the status is on.
5. ***Boiler*** Circulation Pump 1:
   a. ***Boiler*** Circulation Pump 1 shall run anytime Boiler 1 is called to run and shall have a user definable delay (adj.) on stop.
   b. Alarms shall be provided as follows:
      1) ***Boiler*** Circulation Pump 1 Failure: Commanded on, but the status is off.
      2) ***Boiler*** Circulation Pump 1 Running in Hand: Commanded off, but the status is on.
6. ***Boiler*** Circulation Pump 2:
   a. ***Boiler*** Circulation Pump 2 shall run anytime Boiler 2 is called to run and shall have a user definable delay (adj.) on stop.
   b. Alarms shall be provided as follows:
      1) ***Boiler*** Circulation Pump 2 Failure: Commanded on, but the status is off.
      2) ***Boiler*** Circulation Pump 2 Running in Hand: Commanded off, but the status is on.
7. Boiler Lead/Standby Operation:
   a. The two boilers shall operate in a lead/standby fashion when called to run and flow is proven.
      1) The lead boiler shall run first.
      2) On failure of the lead boiler, the standby boiler shall run and the lead boiler shall turn off.
   b. The designated lead boiler shall rotate upon one of the following conditions: (user selectable):
      1) manually through a software switch
      2) weekly
      3) monthly

c. Alarms shall be provided as follows:
   1) Boiler 1
      a. Failure: Commanded on but the status is off.
      b. Running in Hand: Commanded off but the status is on.
   2) Boiler 2
      a. Failure: Commanded on but the status is off.
      b. Running in Hand: Commanded off but the status is on.
      c. Lead Boiler Failure: The lead boiler is in failure and the standby boiler is on.

8. Hot Water Supply Temperature Setpoint Reset:
   a. The hot water supply temperature setpoint shall reset only after the variable flow secondary hot water pumps are operating at minimum speed. Hot water supply temperature reset shall be a continuation of the control loop for the pump speed. Hot water supply and return temperatures shall be maintained above minimums per boiler manufacturer's recommendations. Further consideration should be given to high efficiency boiler systems to optimize system efficiency (reset water temp starting at higher pump speed to allow boiler to operate at optimum efficiency).
9. Primary Hot Water Temperature Monitoring:
   a. The following temperatures shall be monitored:
      1) Primary hot water supply.
      2) Primary hot water return.
   b. Alarms shall be provided as follows:
      1) High Primary Hot Water Supply Temp: If greater than 200°F (adj.).
      2) Low Primary Hot Water Supply Temp: If less than 100°F (adj.).
10. Boiler 1 Hot Water Temperature Monitoring:
   a. The following temperatures shall be monitored:
      1) Boiler 1 hot water supply.
      2) Boiler 1 hot water return.
   b. Alarms shall be provided as follows:
      1) High Hot Water Supply Temp: If greater than 200°F (adj.).
      2) Low Hot Water Supply Temp: If less than 100°F (adj.).
11. Boiler 2 Hot Water Temperature Monitoring:
   a. The following temperatures shall be monitored:
      1) Boiler 2 hot water supply.
      2) Boiler 2 hot water return.
   b. Alarms shall be provided as follows:
      1) High Hot Water Supply Temp: If greater than 200°F (adj.).
      2) Low Hot Water Supply Temp: If less than 100°F (adj.).

B. Secondary Hot Water Pumps
1. Secondary Hot Water Pump Run Conditions:
   a. The secondary hot water pumps shall be enabled whenever outside air temperature is less than ***the unoccupied/occupied reset schedule.***
   b. The secondary pumps shall run for freeze protection anytime outside air temperature is less than 38°F (adj.).

c. To prevent short cycling, the secondary pumps shall run for and be off for minimum adjustable times (both user definable).

2. Secondary Hot Water Pump Lead/Standby Operation:
   a. The two secondary hot water pumps shall operate in a lead/standby fashion.
      1) The lead secondary pump shall run first.
      2) On failure of the lead secondary pump, the standby secondary pump shall run and the lead pump shall turn off.
   b. The designated lead secondary pump shall rotate upon one of the following conditions (user selectable):
      1) manually through a software switch
      2) weekly
      3) monthly
   c. Alarms shall be provided as follows:
      1) Secondary Hot Water Pump 1
         a) Failure: Commanded on, but the status is off.
         b) Running in Hand: Commanded off, but the status is on.
      2) Secondary Hot Water Pump 2
         a) Failure: Commanded on, but the status is off.
         b) Running in Hand: Commanded off, but the status is on.
3. Secondary Hot Water Pump Volume Control:
   a. A differential pressure sensor installed near the most remote heat exchanger shall monitor hot water system differential pressure.
   b. The hot water system differential pressure shall be reset based on heating valve position.
   c. The secondary hot water pump variable frequency drives shall be modulated to maintain hot water system differential pressure.

C. Single Air Cooled Chiller System
1. Chiller - Run Conditions:
   a. The chiller shall be enabled to run whenever the outside air temperature is greater than ***the unoccupied/occupied reset schedule.***
   b. To prevent short cycling, the chiller shall run for and be off for minimum adjustable times (both user definable), unless shutdown on safeties or outside air conditions.
   c. The chiller shall run subject to its own internal safeties and controls.
2. Chilled Water Pump:
   a. The chilled water pump shall run anytime the chiller is called to run. The chilled water pump shall also run for freeze protection whenever the outside air temperature is less than a user definable setpoint (adj.).
   b. The chilled water pump shall start prior to the chiller being enabled and shall stop only after the chiller is disabled. The chilled water pump shall therefore have:
      1) A user adjustable delay on start.
      2) AND a user adjustable delay on stop.
   c. The delay times shall be set appropriately to allow for orderly chilled water system start-up, shutdown and sequencing.

d. Alarms shall be provided as follows:
   1) Chilled Water Pump Failure: Commanded on, but the status is off.
   2) Chilled Water Pump Running in Hand: Commanded off, but the status is on.

3. Chiller:
   a. The chiller shall be enabled a ***after a*** user-adjustable time after pump statuses are proven on. The chiller shall therefore have a user adjustable delay on start.
   b. The delay time shall be set appropriately to allow for orderly chilled water system start-up, shutdown and sequencing.
   c. The chiller shall run subject to its own internal safeties and controls.
   d. Alarms shall be provided as follows:
      1) Chiller Failure: Commanded on, but the status is off.
      2) Chiller Running in Hand: Commanded off, but the status is on.
4. Chiller Chilled Water Supply Setpoint:
   a. The chiller shall maintain a chilled water supply temperature setpoint as determined by its own internal controls (provided by others).
5. Chilled Water Temperature Monitoring:
   a. The following temperatures shall be monitored:
      1) Chilled water supply.
      2) Chilled water return.
   b. Alarms shall be provided as follows:
      1) High Chilled Water Supply Temp: If the chilled water supply temperature is greater than 55°F (adj.).
      2) Low Chilled Water Supply Temp: If the chilled water supply temperature is less than 38°F (adj.).

D. Single Water Cooled Chiller System
1. Chiller - Run Conditions:
   a. The chiller shall be enabled to run whenever the outside air temperature is greater than the unoccupied/occupied reset schedule.
   b. To prevent short cycling, the chiller shall run for and be off for minimum adjustable times (both user definable), unless shutdown on safeties or outside air conditions.
   c. The chiller shall run subject to its own internal safeties and controls.
2. Refrigerant Detection:
   a. The chiller shall shut down and an alarm generated upon receiving a refrigerant leak detection status.
3. Chilled Water Pump:
   a. The chilled water pump shall run anytime the chiller is called to run. The chilled water pump shall also run for freeze protection whenever the outside air temperature is less than a user definable setpoint (adj.).
   b. The chilled water pump shall start prior to the chiller being enabled and shall stop only after the chiller is disabled. The chilled water pump shall therefore have:
      1) A user adjustable delay on start.
      2) AND a user adjustable delay on stop.
   c. The delay times shall be set appropriately to allow for orderly chilled water system start-up, shutdown and sequencing.

d. Alarms shall be provided as follows:
   1) Chilled Water Pump Failure: Commanded on, but the status is off.
   2) Chilled Water Pump Running in Hand: Commanded off, but the status is on.

4. Condenser Water Pump:
   a. The condenser water pump shall run anytime the chiller is called to run.
   b. The condenser water pump shall start prior to the chiller being enabled and shall stop only after the chiller is disabled. The condenser water pump shall therefore have:
      1) A user adjustable delay on start.
      2) AND a user adjustable delay on stop.
   c. The delay times shall be set appropriately to allow for orderly chilled water system start-up, shutdown and sequencing.
   d. Alarms shall be provided as follows:
      1) Condenser Water Pump Failure: Commanded on, but the status is off.
      2) Condenser Water Pump Running in Hand: Commanded off, but the status is on.

5. Chiller:
   a. The chiller shall be enabled a user adjustable time after pump statuses are proven on. The chiller shall therefore have a user adjustable delay on start.
   b. The delay time shall be set appropriately to allow for orderly chilled water system start-up, shutdown and sequencing.
   c. The chiller shall run subject to its own internal safeties and controls.
   d. Alarms shall be provided as follows:
      1) Chiller Failure: Commanded on, but the status is off.
      2) Chiller Running in Hand: Commanded off, but the status is on.

6. Chiller Chilled Water Supply Setpoint:
   a. The chiller shall maintain a chilled water supply temperature setpoint as determined by its own internal controls (provided by others).

7. Cooling Tower VFD Fan - Condenser Water Temperature Control:
   a. The controller shall measure the cooling tower condenser water supply (basin) temperature and modulate the bypass valve and fan VFD in sequence to maintain setpoints.
   b. The following setpoints are recommended values. All setpoints shall be field adjusted during the commissioning period to meet the requirements of actual field conditions.
   c. On rising supply temperature, the controller shall modulate the bypass valve to maintain setpoint of 78°F (adj.) and the fan VFD to maintain setpoint of 82°F (adj.).
   d. Alarms shall be provided as follows:
      1) Fan
         a) Failure: Commanded on, but the status is off.
         b) Running in Hand: Commanded off, but the status is on.
         c) VFD fault.
      2) High Cooling Tower Supply (Basin) Temp: If greater than 86°F (adj.).
      3) Low Cooling Tower Supply (Basin) Temp: If less than 38°F (adj.).

8. Chilled Water Temperature Monitoring:
   a. The following temperatures shall be monitored:
      1) Chilled water supply.
      2) Chilled water return.
   b. Alarms shall be provided as follows:
      1) High Chilled Water Supply Temp: If the chilled water supply temperature is greater than 55°F (adj.).
      2) Low Chilled Water Supply Temp: If the chilled water supply temperature is less than 38°F (adj.).
9. Condenser Water Temperature Monitoring:
   a. The following temperatures shall be monitored:
      1) Condenser water supply temperature.
      2) Condenser water return temperature.
   b. Alarms shall be provided as follows:
      1) High Condenser Water Supply Temp: If the condenser water supply temperature is greater than 86°F (adj.).
      2) Low Condenser Water Supply Temp: If the condenser water supply temperature is less than 65°F (adj.).
      3) High Condenser Water Return Temp: If the condenser water return temperature is greater than 100°F (adj.).
      4) Low Condenser Water Return Temp: If the condenser water return temperature is less than 75°F (adj.).

E. Cabinet Heater
1. Run Conditions - Continuous:
   a. The unit shall run continuously and shall maintain a heating setpoint of 70°F (adj.).
   b. Alarms shall be provided as follows:
      1) Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
2. Zone Setpoint Adjust:
   a. The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.
3. Fan:
   a. The fan shall run anytime the zone temperature is below heating setpoint, unless shutdown on safeties.
4. Heating Coil Valve:
   a. The controller shall measure the zone temperature and modulate the heating coil valve to maintain its heating setpoint.
   b. The heating shall be enabled whenever:
      1) Outside air temperature is less than ***the unoccupied/ occupied reset schedule.***
      2) AND the zone temperature is below heating setpoint.
      3) AND the fan is on.

F. Unit Heater
1. Run Conditions - Continuous:
   a. The unit shall run continuously and shall maintain a heating setpoint of 70°F (adj.).
   b. Alarms shall be provided as follows:
      1) Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

2. Zone Setpoint Adjust:
   a. The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.
3. Fan:
   a. The fan shall run anytime the zone temperature drops below heating setpoint, unless shutdown on safeties.
4. Heating Coil Valve:
   a. The controller shall measure the zone temperature and modulate the heating coil valve to maintain its heating setpoint.
   b. The heating shall be enabled whenever:
      1) Outside air temperature is less than ***the unoccupied/ occupied reset schedule.***
      2) AND the zone temperature is below heating setpoint.
      3) AND the fan is on.

G. Convective / Fin Tube Heater
1. Run Conditions - Continuous:
   a. The unit shall run continuously and shall maintain a heating setpoint of 70°F (adj.).
   b. Alarms shall be provided as follows:
      1) Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
2. Heating Coil Valve:
   a. The controller shall measure the zone temperature and modulate the heating coil valve to maintain its heating setpoint.
   b. The heating shall be enabled whenever:
      1) Outside air temperature is less than ***the unoccupied/ occupied reset schedule.***
      2) AND the zone temperature is below heating setpoint.

H. Exhaust Fan - Building Static
1. Run Conditions - Interlocked:
   a. The unit(s) EF --- shall be interlocked to run whenever Air Handling Unit ---- runs unless shutdown on safeties.
2. Control - Building Static Pressure:
   a. The controller shall measure building static pressure and stage the exhaust fan on and off to maintain a building static pressure setpoint of 0.05in H_2O (adj.). The fan shall have a user definable (adj.) minimum runtime.
   b. Alarms shall be provided as follows:
      1) High Building Static Pressure: If the building static pressure is 25% (adj.) greater than setpoint.
      2) Low Building Static Pressure: If the building static pressure is 25% (adj.) less than setpoint.
3. Exhaust Air Damper:
   a. The exhaust air damper shall open anytime the unit runs and shall close anytime the unit stops. The exhaust air damper shall close 30 sec (adj.) after the fan stops.
4. Fan Status:
   a. The controller shall monitor the fan status.
   b. Alarms shall be provided as follows:

1) Fan Failure: Commanded on, but the status is off.
2) Fan in Hand: Commanded off, but the status is on.

I. Variable Air Volume - AHU

1. Run Conditions - Scheduled:
   a. The unit shall run based upon an operator adjustable schedule.
2. Freeze Protection:
   a. The unit shall shut down and generate an alarm upon receiving a freezestat status.
3. High Static Shutdown:
   a. The unit shall shut down and generate an alarm upon receiving an high static shutdown signal.
4. Supply Air Smoke Detection:
   a. The unit shall shut down and generate an alarm upon receiving a supply air smoke detector status.
5. Supply Fan:
   a. The supply fan shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime.
   b. Alarms shall be provided as follows:
      1) Supply Fan Failure: Commanded on, but the status is off.
      2) Supply Fan in Hand: Commanded off, but the status is on.
      3) Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
6. Supply Air Duct Static Pressure Control:
   a. The controller shall measure duct static pressure and shall modulate the supply fan VFD speed to maintain a duct static pressure setpoint of 1.5in H_2O (adj.). The supply fan VFD speed shall not drop below 30% (adj.).
   b. Alarms shall be provided as follows:
      1) High Supply Air Static Pressure: If the supply air static pressure is 25% (adj.) greater than setpoint.
      2) Low Supply Air Static Pressure: If the supply air static pressure is 25% (adj.) less than setpoint.
      3) Supply Fan VFD Fault.
7. Return Fan:
   a. The return fan shall run whenever the supply fan runs.
   b. Alarms shall be provided as follows:
      1) Return Fan Failure: Commanded on, but the status is off.
      2) Return Fan in Hand: Commanded off, but the status is on.
      3) Return Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
      4) Return Fan VFD Fault.
8. Building Static Pressure Control:
   a. The controller shall measure building static pressure and modulate the return fan VFD speed to maintain a building static pressure setpoint of 0.05in H_2O (adj.). The return fan VFD speed shall not drop below 20% (adj.).
   b. Alarms shall be provided as follows:
      1) High Building Static Pressure: If the building air static pressure is 25% (adj.) greater than setpoint.

2) Low Building Static Pressure: If the building air static pressure is 25% (adj.) less than setpoint.

9. Heat Recovery Wheel - Constant Speed:
   a. The controller shall run the heat recovery wheel for energy recovery as follows.
      1) Cooling Recovery Mode: The controller shall measure the heat wheel discharge air temperature and run the heat wheel to maintain a setpoint 2°F (adj.) less than the unit supply air temperature setpoint. The heat wheel shall run for cool recovery whenever:
         a) The unit return air temperature is 5°F (adj.) or more below the outside air temperature.
         b) AND the unit is in a cooling mode.
         c) AND the economizer (if present) is off.
         d) AND the supply fan is on.
      2) Heating Recovery Mode: The controller shall measure the heat wheel discharge air temperature and run the heat wheel to maintain a setpoint 2°F (adj.) greater than the unit supply air temperature setpoint. The heat wheel shall run for heat recovery whenever:
         a) The unit return air temperature is 5°F (adj.) or more above the outside air temperature.
         b) AND the unit is in a heating mode.
         c) AND the economizer (if present) is off.
         d) AND the supply fan is on.
   b. Periodic Self-Cleaning:
      1) The heat wheel shall run for 10sec (adj.) every 4hr (adj.) the unit runs.
   c. Frost Protection:
      1) The heat wheel shall run for 10sec (adj.) every 600sec (adj.) whenever:
         a) Outside air temperature drops below 15°F (adj.)
         b) OR the exhaust air temperature drops below 20°F (adj.).
   d. The heat wheel bypass dampers will open whenever the heat wheel is disabled.
   e. Alarms shall be provided as follows:
      1) Heat Wheel Rotation Failure: Commanded on, but the status is off.
      2) Heat Wheel in Hand: Commanded off, but the status is on.
      3) Heat Wheel Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).

10. Preheating Coil Valve:
   a. The controller shall measure the mixed air temperature and modulate the preheating coil valve to maintain its setpoint 5°F (adj.) less than the supply air temperature setpoint.
   b. The preheating shall be enabled whenever:
      1) Outside air temperature is less than 60°F (adj.).
      2) AND the economizer (if present) is disabled.
      3) AND the supply fan status is on.

c. The preheating coil valve shall open for freeze protection whenever:
   1) Mixed air temperature drops from 40°F to 35°F (adj.).
   2) OR the freezestat (if present) is on.

11. Supply Air Temperature Setpoint - Optimized:
   a. The controller shall monitor the supply air temperature and shall maintain a supply air temperature setpoint reset based on zone cooling and heating requirements
   b. The supply air temperature setpoint shall be reset for cooling based on zone cooling requirements as follows:
      1) The initial supply air temperature setpoint shall be 55°F (adj.).
      2) As cooling demand increases, the setpoint shall incrementally reset down to a minimum of 53°F (adj.).
      3) As cooling demand decreases, the setpoint shall incrementally reset up to a maximum of 72°F (adj.) .
   c. If more zones need heating than cooling, then the supply air temperature setpoint shall be reset for heating as follows:
      1) The initial supply air temperature setpoint shall be 82°F (adj.).
      2) As heating demand increases, the setpoint shall incrementally reset up to a maximum of 85°F (adj.).
      3) As heating demand decreases, the setpoint shall incrementally reset down to a minimum of 72°F (adj.).

12. Cooling Coil Valve:
   a. The controller shall measure the supply air temperature and modulate the cooling coil valve to maintain its cooling setpoint.
   b. The cooling shall be enabled whenever:
      1) Outside air temperature is greater than ***the unoccupied/ occupied reset schedule.***
      2) AND the economizer (if present) is disabled or fully open.
      3) AND the supply fan status is on.
      4) AND the heating (if present) is not active.
   c. The cooling coil valve shall open to 50% (adj.) whenever the freezestat (if present) is on.
   d. Alarms shall be provided as follows:
      1) High Supply Air Temp: If the supply air temperature is 5°F (adj.) greater than setpoint.

13. Heating Coil Valve:
   a. The controller shall measure the supply air temperature and modulate the heating coil valve to maintain its heating setpoint.
   b. The heating shall be enabled whenever:
      1) Outside air temperature is less than ***the unoccupied/ occupied reset schedule.***
      2) AND the supply fan status is on.
      3) AND the cooling (if present) is not active.
   c. The heating coil valve shall open whenever:
      1) Supply air temperature drops from 40°F to 35°F (adj.).
      2) OR the freezestat (if present) is on.
   d. Alarms shall be provided as follows:
      1) Low Supply Air Temp: If the supply air temperature is 5°F (adj.) less than setpoint.

14. Preheating Coil Pump:
   a. The recirculation pump shall run whenever:

1) The preheating coil valve is enabled.
2) OR the freezestat (if present) is on.

b. Alarms shall be provided as follows:
1) Preheating Coil Pump Failure: Commanded on, but the status is off.
2) Preheating Coil Pump in Hand: Commanded off, but the status is on.
3) Preheating Coil Pump Runtime Exceeded: Status runtime exceeds a user definable limit.

15. Economizer:

a. The controller shall measure the mixed air temperature and modulate the economizer dampers in sequence to maintain a setpoint 2°F (adj.) less than the supply air temperature setpoint. The outside air dampers shall maintain a minimum adjustable position of 20% (adj.) open whenever occupied.

b. The economizer shall be enabled whenever:
1) Outside air temperature is less than 65°F (adj.).
2) AND the outside air enthalpy is less than 22Btu/lb (adj.)
3) AND the outside air temperature is less than the return air temperature.
4) AND the outside air enthalpy is less than the return air enthalpy.
5) AND the supply fan status is on.

c. The economizer shall close whenever:
1) Mixed air temperature drops from 40°F to 35°F (adj.)
2) OR the freezestat (if present) is on.
3) OR on loss of supply fan status.

d. The outside and exhaust air dampers shall close and the return air damper shall open when the unit is off. If Optimal Start Up is available the mixed air damper shall operate as described in the occupied mode except that the outside air damper shall modulate to fully closed.

16. Minimum Outside Air Ventilation:

a. When in the occupied mode, the controller shall measure the outside airflow and modulate the outside air dampers to maintain the proper minimum outside air ventilation, overriding normal damper control. On dropping outside airflow, the controller shall modulate the outside air dampers open to maintain the outside airflow setpoint (adj.).

17. Dehumidification:

a. The controller shall measure the return air humidity and override the cooling sequence to maintain return air humidity at or below 60% rh (adj.). Dehumidification shall be enabled whenever the supply fan status is on.

18. Prefilter Status:

a. The controller shall monitor the prefilter status.

b. Alarms shall be provided as follows:
1) Prefilter Change Required: Prefilter differential pressure exceeds a user definable limit (adj.).

19. Final Filter Status:

a. The controller shall monitor the final filter status.

b. Alarms shall be provided as follows:
   1) Final Filter Change Required: Final filter differential pressure exceeds a user definable limit (adj.).

20. Mixed Air Temperature:
   a. The controller shall monitor the mixed air temperature and use as required for economizer control (if present) or preheating control (if present).
   b. Alarms shall be provided as follows:
      1) High Mixed Air Temp: If the mixed air temperature is greater than 90°F (adj.).
      2) Low Mixed Air Temp: If the mixed air temperature is less than 45°F (adj.).

21. Return Air Humidity:
   a. The controller shall monitor the return air humidity and use as required for economizer control (if present) or humidity control (if present).
   b. Alarms shall be provided as follows:
      1) High Return Air Humidity: If the return air humidity is greater than 70% (adj.).
      2) Low Return Air Humidity: If the return air humidity is less than 35% (adj.).

22. Return Air Temperature:
   a. The controller shall monitor the return air temperature and use as required for setpoint control or economizer control (if present).
   b. Alarms shall be provided as follows:
      1. High Return Air Temp: If the return air temperature is greater than 90°F (adj.).
      2. Low Return Air Temp: If the return air temperature is less than 45°F (adj.).

23. Supply Air Temperature:
   a. The controller shall monitor the supply air temperature.
   b. Alarms shall be provided as follows:
      1) High Supply Air Temp: If the supply air temperature is greater than 120°F (adj.).
      2) Low Supply Air Temp: If the supply air temperature is less than 45°F (adj.).

24. Zone Optimal Start:
   a. The unit shall use an optimal start algorithm for morning startup. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.

J. Variable Air Volume - Terminal Unit

1. Run Conditions - Scheduled:
   a. The unit shall run according to a user definable time schedule in the following modes:
      1) Occupied Mode: The unit shall maintain
         a) A 75°F (adj.) cooling setpoint
         b) A 70°F (adj.) heating setpoint.
      2) Unoccupied Mode (night setback): The unit shall maintain
         a) A 85°F (adj.) cooling setpoint.

b) A 55°F (adj.) heating setpoint.

b. Alarms shall be provided as follows:

1) High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).

2) Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

2. Zone Setpoint Adjust:

a. The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.

3. Zone Unoccupied Override:

a. A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.

4. Reversing Variable Volume Terminal Unit - Flow Control:

a. The unit shall maintain zone setpoints by controlling the airflow through one of the following:

1) Occupied:

a) When zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum occupied airflow (adj.) and the maximum cooling airflow (adj.) until the zone is satisfied.

b) When the zone temperature is between the cooling setpoint and the heating setpoint, the zone damper shall maintain the minimum required zone ventilation (adj.).

c) When zone temperature is less than its heating setpoint, the controller shall enable heating to maintain the zone temperature at its heating setpoint. Additionally, if warm air is available from the AHU, the zone damper shall modulate between the minimum occupied airflow (adj.) and the maximum heating airflow (adj.) until the zone is satisfied.

2) Unoccupied:

a) When the zone is unoccupied the zone damper shall control to its minimum unoccupied airflow (adj.).

b) When the zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum unoccupied airflow (adj.) and the maximum cooling airflow (adj.) until the zone is satisfied.

c) When zone temperature is less than its unoccupied heating setpoint, the controller shall enable heating to maintain the zone temperature at the setpoint. Additionally, if warm air is available from the AHU, the zone damper shall modulate between the minimum unoccupied airflow (adj.) and the auxiliary heating airflow (adj.) until the zone is satisfied.

5. Reheating Coil Valve:

a. The controller shall measure the zone temperature and modulate the reheating coil valve open on dropping temperature to maintain its heating setpoint.

6. Discharge Air Temperature:

a. The controller shall monitor the discharge air temperature.

b. Alarms shall be provided as follows:
   1) High Discharge Air Temp: If the discharge air temperature is greater than 120°F (adj.).
   2) Low Discharge Air Temp: If the discharge air temperature is less than 40°F (adj.).

K. Fan Powered Variable Air Volume - Terminal Unit
1. Run Conditions - Scheduled:
   a. The unit shall run according to a user definable time schedule in the following modes:
      1) Occupied Mode: The unit shall maintain
         a) A 75°F (adj.) cooling setpoint
         b) A 70°F (adj.) heating setpoint.
      2) Unoccupied Mode (night setback): The unit shall maintain
         a) A 85°F (adj.) cooling setpoint.
         b) A 55°F (adj.) heating setpoint.
   b. Alarms shall be provided as follows:
      1) High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
      2) Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
2. Zone Setpoint Adjust:
   a. The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.
3. Zone Unoccupied Override:
   a. A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.
4. Reversing Variable Volume Terminal Unit - Flow Control:
   a. The unit shall maintain zone setpoints by controlling the airflow through one of the following:
      1) Occupied:
         a) When zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum occupied airflow (adj.) and the maximum cooling airflow (adj.) until the zone is satisfied.
         b) When the zone temperature is between the cooling setpoint and the heating setpoint, the zone damper shall maintain the minimum required zone ventilation (adj.).
         c) When zone temperature is less than its heating setpoint, the controller shall enable heating to maintain the zone temperature at its heating setpoint. Additionally, if warm air is available from the AHU, the zone damper shall modulate between the minimum occupied airflow (adj.) and the maximum heating airflow (adj.) until the zone is satisfied.
      2) Unoccupied:
         a) When the zone is unoccupied the zone damper shall control to its minimum unoccupied airflow (adj.).

b) When the zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum unoccupied airflow (adj.) and the maximum cooling airflow (adj.) until the zone is satisfied.

c) When zone temperature is less than its unoccupied heating setpoint, the controller shall enable heating to maintain the zone temperature at the setpoint. Additionally, if warm air is available from the AHU, the zone damper shall modulate between the minimum unoccupied airflow (adj.) and the auxiliary heating airflow (adj.) until the zone is satisfied.

5. Fan Control - Parallel:
   a. The fan shall run whenever the zone controller calls for heat. The fan shall run for a minimum user definable time (adj.).
6. Fan Control – Series:
   a. The fan shall run whenever the system is in the occupied mode.
7. Reheating Coil Valve:
   a. The controller shall measure the zone temperature and modulate the reheating coil valve open on dropping temperature to maintain its heating setpoint.
8. Discharge Air Temperature:
   a. The controller shall monitor the discharge air temperature.
   b. Alarms shall be provided as follows:
      1) High Discharge Air Temp: If the discharge air temperature is greater than 120°F (adj.).
      2) Low Discharge Air Temp: If the discharge air temperature is less than 40°F (adj.).

L. Single Zone Unit
1. Run Conditions - Scheduled:
   a. The unit shall run according to a user definable time schedule in the following modes:
      1) Occupied Mode: The unit shall maintain
         a) A 75°F (adj.) cooling setpoint
         b) A 70°F (adj.) heating setpoint.
      2) Unoccupied Mode (night setback): The unit shall maintain
         a) A 85°F (adj.) cooling setpoint.
         b) A 55°F (adj.) heating setpoint.
   b. Alarms shall be provided as follows:
      1) High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
      2) Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
2. Zone Setpoint Adjust:
   a. The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.
3. Zone Optimal Start:
   a. The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.

4. Zone Unoccupied Override:
   a. A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.
5. Freeze Protection:
   a. The unit shall shut down and generate an alarm upon receiving a freezestat status.
6. Supply Air Smoke Detection:
   a. The unit shall shut down and generate an alarm upon receiving a supply air smoke detector status.
7. Supply Fan:
   a. The supply fan shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime.
   b. Alarms shall be provided as follows:
      1) Supply Fan Failure: Commanded on, but the status is off.
      2) Supply Fan in Hand: Commanded off, but the status is on.
8. Heat Recovery Wheel - Constant Speed:
   a. The controller shall run the heat recovery wheel for energy recovery as follows.
      1) Cooling Recovery Mode: The controller shall measure the zone temperature and run the heat recovery wheel to maintain a setpoint 2°F (adj.) less than the zone cooling setpoint. The heat wheel shall run for cool recovery whenever:
         a) Return air temperature is 5°F (adj.) or more below the outside air temperature.
         b) AND the zone temperature is above cooling setpoint.
         c) AND the economizer (if present) is off.
         d) AND the supply fan is on.
      2) Heating Recovery Mode: The controller shall measure the zone temperature and run the heat recovery wheel to maintain a setpoint 2°F (adj.) greater than the zone heating setpoint. The heat wheel shall run for heat recovery whenever:
         a) Return air temperature is 5°F (adj.) or more above the outside air temperature.
         b) AND the zone temperature is below heating setpoint.
         c) AND the economizer (if present) is off.
         d) AND the supply fan is on.
   b. Periodic Self-Cleaning:
      1) The heat wheel shall run for 10sec (adj.) every 4hr (adj.) the unit runs.
   c. Frost Protection:
      1) The heat wheel shall run for 10sec (adj.) every 600sec (adj.) whenever:
         a) Outside air temperature drops below 15°F (adj.)
         b) OR the exhaust air temperature drops below 20°F (adj.).
   d. The heat wheel bypass dampers will open whenever the heat wheel is disabled.

e. Alarms shall be provided as follows:
   1) Heat Wheel Rotation Failure: Commanded on, but the status is off.
   2) Heat Wheel in Hand: Commanded off, but the status is on.
   3) Heat Wheel Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).

9. Preheating Coil Valve:
   a. The controller shall measure the mixed air temperature and modulate the preheating coil valve to maintain its setpoint 10°F (adj.) less than the zone heating setpoint.
   b. The preheating shall be enabled whenever:
      1) Outside air temperature is less than 55°F (adj.).
      2) AND the economizer (if present) is disabled.
      3) AND the heating is active.
      4) AND cooling is not active.
      5) AND the supply fan status is on.
   c. The preheating coil valve shall open for freeze protection whenever:
      1) Mixed air temperature drops from 40°F to 35°F (adj.).
      2) OR the freezestat (if present) is on.

10. Cooling Coil Valve:
   a. The controller shall measure the zone temperature and modulate the cooling coil valve to maintain its cooling setpoint.
   b. The cooling shall be enabled whenever:
      1) Outside air temperature is greater than ***the unoccupied/ occupied reset schedule.***
      2) AND the economizer (if present) is disabled or fully open.
      3) AND the zone temperature is above cooling setpoint.
      4) AND the supply fan status is on.
      5) AND the heating is not active.
   c. The cooling coil valve shall open to 50% (adj.) whenever the freezestat (if present) is on.

11. Heating Coil Valve:
   a. The controller shall measure the zone temperature and modulate the heating coil valve to maintain its heating setpoint.
   b. The heating shall be enabled whenever:
      1) Outside air temperature is less than ***the unoccupied/ occupied reset schedule.***
      2) AND the zone temperature is below heating setpoint.
      3) AND the supply fan status is on.
      4) AND the cooling is not active.
      c. The heating coil valve shall open whenever the freezestat (if present) is on.

12. Economizer:
   a. The controller shall measure the zone temperature and modulate the economizer dampers in sequence to maintain a setpoint 2°F less than the zone cooling setpoint. The outside air dampers shall maintain a minimum adjustable position of 20Btu/lb (adj.) open whenever occupied.
   b. The economizer shall be enabled whenever:
      1) Outside air temperature is less than 65°F (adj.).
      2) AND the outside air enthalpy is less than 22Btu/lb (adj.).

3) AND the outside air temperature is less than the return air temperature.
4) AND the outside air enthalpy is less than the return air enthalpy.
5) AND the supply fan status is on.

c. The economizer shall close whenever:
1) Mixed air temperature drops from 45°F to 40°F (adj.).
2) OR on loss of supply fan status.
3) OR freezestat (if present) is on.

d. The outside and exhaust air dampers shall close and the return air damper shall open when the unit is off. If Optimal Start Up is available, the mixed air damper shall operate as described in the occupied mode except that the outside air damper shall modulate to fully closed.

13. Minimum Outside Air Ventilation - Fixed Percentage:
a. The outside air dampers shall maintain a minimum position (adj.) during building occupied hours and be closed during unoccupied hours.

14. Dehumidification:
a. The controller shall measure the return air humidity and override the cooling sequence to maintain return air humidity at or below 60% rh (adj.). Dehumidification shall be enabled whenever the supply fan status is on.

15. Prefilter Status:
a. The controller shall monitor the prefilter status.
b. Alarms shall be provided as follows:
1) Prefilter Change Required: Prefilter differential pressure exceeds a user definable limit (adj.).

16. Final Filter Status:
a. The controller shall monitor the final filter status.
b. Alarms shall be provided as follows:
1) Final Filter Change Required: Final filter differential pressure exceeds a user definable limit (adj.).

17. Mixed Air Temperature:
a. The controller shall monitor the mixed air temperature and use as required for economizer control (if present) or preheating control (if present).
b. Alarms shall be provided as follows:
1) High Mixed Air Temp: If the mixed air temperature is greater than 90°F (adj.).
2) Low Mixed Air Temp: If the mixed air temperature is less than 45°F (adj.).

18. Return Air Humidity:
a. The controller shall monitor the return air humidity and use as required for economizer control (if present) or humidity control (if present).
b. Alarms shall be provided as follows:
1) High Return Air Humidity: If the return air humidity is greater than 70% (adj.).
2) Low Return Air Humidity: If the return air humidity is less than 35% (adj.).

19. Return Air Temperature:
    a. The controller shall monitor the return air temperature and use as required for economizer control (if present).
    b. Alarms shall be provided as follows:
        1) High Return Air Temp: If the return air temperature is greater than 90°F (adj.).
        2) Low Return Air Temp: If the return air temperature is less than 45°F (adj.).
20. Supply Air Temperature:
    a. The controller shall monitor the supply air temperature.
    b. Alarms shall be provided as follows:
        1) High Supply Air Temp: If the supply air temperature is greater than 120°F (adj.).
        2) Low Supply Air Temp: If the supply air temperature is less than 45°F (adj.).

M. Makeup Air Unit - Supply Air Temp
1. Run Conditions - Interlocked:
    a. The unit MAU --- shall be interlocked to run whenever Air Handling Unit ---- runs unless shutdown on safeties.
2. Freeze Protection:
    a. The unit shall shut down and generate an alarm upon receiving a freezestat status.
3. Outside Air Damper:
    a. The outside air damper shall open anytime the unit runs and shall close anytime the unit stops. The supply fan shall start only after the damper status has proven the damper is open. The outside air damper shall close 4sec (adj.) after the supply fan stops.
    b. Alarms shall be provided as follows:
        1) Outside Air Damper Failure: Commanded open, but the status is closed.
        2) Outside Air Damper in Hand: Commanded closed, but the status is open.
4. Supply Fan:
    a. The supply fan shall run anytime the unit is commanded to run. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime, unless shutdown on safeties.
    b. Alarms shall be provided as follows:
        1) Supply Fan Failure: Commanded on, but the status is off.
        2) Supply Fan in Hand: Commanded off, but the status is on.
5. Exhaust Fan:
    a. The exhaust fan shall run whenever the supply fan runs, unless shutdown on safeties.
    b. Alarms shall be provided as follows:
        1) Exhaust Fan Failure: Commanded on, but the status is off.
        2) Exhaust Fan in Hand: Commanded off, but the status is on.
6. Supply Air Temperature Setpoint - Fixed:
    a. The controller shall monitor the supply air temperature and shall maintain a supply air temperature setpoint ***based on a reset schedule.***
7. Cooling Coil Valve:
    a. The controller shall measure the supply air temperature and

modulate the cooling coil valve to maintain its cooling setpoint.

b. The cooling shall be enabled whenever:
   1) Outside air temperature is greater than ***the unoccupied/ occupied reset schedule.***
   2) AND the supply air temperature is above cooling setpoint.
   3) AND the fan status is on.

c. The cooling coil valve shall open to 50% (adj.) whenever the freezestat is on.

8. Heating Coil Valve:
   a. The controller shall measure the supply air temperature and modulate the heating coil valve to maintain its heating setpoint.
   b. The heating shall be enabled whenever:
      1) Outside air temperature is less than ***the unoccupied/ occupied reset schedule.***
      2) AND the supply air temperature is below heating setpoint.
      3) AND the fan status is on.
   c. The heating coil valve shall open to 100% (adj.) whenever the freezestat is on.
9. Prefilter Status:
   a. The controller shall monitor the prefilter status.
   b. Alarms shall be provided as follows:
      1) Prefilter Change Required: Prefilter differential pressure exceeds a user definable limit (adj.).
10. Supply Air Temperature:
   a. The controller shall monitor the supply air temperature.
   b. Alarms shall be provided as follows:
      1) High Supply Air Temp: If the supply air temperature is greater than 120°F (adj.).
      2) Low Supply Air Temp: If the supply air temperature is less than 45°F (adj.).

N. Water Source Heat Pump (typical of 1)
1. Run Conditions - Scheduled:
   a. The unit shall run according to a user definable time schedule in the following modes:
      1) Occupied Mode: The unit shall maintain
         a) A 75°F (adj.) cooling setpoint
         b) A 72°F (adj.) heating setpoint
      2) Unoccupied Mode (night setback): The unit shall maintain
         a) A 85°F (adj.) cooling setpoint.
         b) A 55°F (adj.) heating setpoint.
         c) 60 – 65% RH zone space humidity
   b. Alarms shall be provided as follows:
      1) High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
      2) Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
2. Freeze Protection:
   a. The unit shall shut down and generate an alarm upon receiving a freezestat status.

3. Smoke Detection:
   a. The unit shall shut down and generate an alarm upon receiving a smoke detector status.
4. Zone Setpoint Adjust:
   a. The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.
5. Zone Optimal Start:
   a. The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.
6. Zone Unoccupied Override:
   a. A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.
7. Fan:
   a. The fan shall run anytime the unit is commanded to run, unless shutdown on safeties.
8. Heating and Cooling - 1 Compressor Stage:
   a. The controller shall receive a signal from the loop water source monitor indicating that there is water flow and that the water temperature is within acceptable limits.
   b. The controller shall measure the zone temperature and cycle the compressor to maintain its setpoint. To prevent short cycling, the stage shall have a user definable (adj.) minimum runtime. The compressor shall run subject to its own internal safeties and controls.
   c. The heating shall be enabled whenever:
      1) Outside air temperature is less than ***the unoccupied/ occupied reset schedule.***
      2) AND the fan is on.
      3) AND the reversing valve is in heat mode.
   d. The cooling shall be enabled whenever:
      1) Outside air temperature is greater than ***the unoccupied/ occupied reset schedule.***
      2) the fan is on.
      3) AND the reversing valve is in cool mode.
   e. The compressor shall be disabled and remain off for 30sec (adj.) after the reversing valve has changed position.
   f. Alarms shall be provided as follows:
      1) Compressor Runtime Exceeded: The compressor runtime exceeds a user definable limit (adj.).
9. Outside Air Dampers:
   a. The outside air damper shall open to provide a fixed percentage outside air ventilation anytime the unit runs and shall close anytime the unit stops. The damper open position shall be set during testing and balancing. The outside air damper shall close 1sec (adj.) after the fan stops.
   b. If Optimal Start Up is available the outside air damper shall close and the return air damper shall open.
10. Filter Status:
   a. The controller shall monitor the filter status.

b. Alarms shall be provided as follows:
   1) Filter Change Required: Filter differential pressure exceeds a user definable limit (adj.).

11. Discharge Air Temperature:
   a. The controller shall monitor the discharge air temperature.
   Alarms shall be provided as follows:
   1) High Discharge Air Temp: If the discharge air temperature is greater than 120°F (adj.).
   2) Low Discharge Air Temp: If the discharge air temperature is less than 40°F (adj.).

12. Fan Status:
   a. The controller shall monitor the fan status.
   b. Alarms shall be provided as follows:
   1) Fan Failure: Commanded on, but the status is off.
   2) Fan in Hand: Commanded off, but the status is on.

O. Loop Monitor and Pumps (typical of 1)

1. Water Source Heat Pump Loop Monitor - Run Conditions:
   a. The loop monitor shall run whenever:
   1) Any zone is occupied.
   2) OR a definable number of unoccupied zones need heating or cooling.
   b. The following loop water conditions shall be monitored:
   1) Flow status.
   2) Supply temperature.
   3) Return temperature.
   c. Alarms and a heat pump shutdown signal shall be generated upon any of the following loop water conditions:
   1) No Loop Flow.
   2) High Loop Water Supply Temp Shutdown: If the loop water supply temperature is greater than 92°F (adj.).
   3) Low Loop Water Supply Temp Shutdown: If the loop water supply temperature is less than 58°F (adj.).
   d. Alarms shall be provided as follows:
   1) High Loop Water Supply Temp: If the loop water supply temperature is greater than 90°F (adj.).
   2) Low Loop Water Supply Temp: If the loop water supply temperature is less than 60°F (adj.).

2. Loop Water Pump Lead/Standby Operation:
   a. The two loop water pumps shall operate in a lead/standby fashion.
   1) The lead pump shall run first.
   2) On failure of the lead pump, the standby pump shall run and the lead pump shall turn off.
   b. The designated lead pump shall rotate upon one of the following conditions (user selectable):
   1) manually through a software switch
   2) weekly
   c. Alarms shall be provided as follows:
   1) Loop Water Pump 1
   a) Failure: Commanded on, but the status is off.
   b) Running in Hand: Commanded off, but the status is on.

2) Loop Water Pump 2
   a) Failure: Commanded on, but the status is off.
   b) Running in Hand: Commanded off, but the status is on.

P. Loop Cooling (typical of 1)
1. Water Source Heat Pump Cooling Tower System - Run Conditions:
   a. The cooling tower system shall be enabled to run whenever:
      1) The loop control is enabled by zone requirements.
2. Closed System Cooling Tower Loop Water Temperature Control:
   a. The controller shall measure the loop water supply temperature and stage the damper, spray pump and fans on in sequence to maintain setpoints. The following setpoints are recommended values. All setpoints shall be field adjusted during the commissioning period to meet the requirements of actual field conditions.
   b. On rising loop water supply temperature, the damper, pump and fan speeds shall stage on at the setpoints given below. When the loop water supply temperature drops back below the setpoints by the differentials listed, the fan speeds, pump and damper shall stage off. To prevent short cycling and back-emf in the fan motors, there shall be a minimum delay (adj.) between each stage.

	Tower Damper	Spray Pump	Low Speed Fan	High Speed Fan
Stage ON: If loop temp rises above setpoint of:	80°F	83°F	85°F	88°F
Stage OFF: If loop temp drops below setpoint by:	4°F	5°F	5°F	5°F

   c. Alarms shall be provided as follows:
      1) Damper
         a) Failure: Commanded open, but the status indicates closed.
         b) Open in Hand: Commanded closed, but the status indicates open.
      2) Spray Pump
         a) Failure: Commanded on, but the status is off.
         b) Running in Hand: Commanded off, but the status is on.
      3) Fan Low Speed
         a) Failure: Commanded on, but the status is off.
         b) in Hand: Commanded off, but the status is on.
      4) Fan High Speed
         a) Failure: Commanded on, but the status is off.
         b) in Hand: Commanded off, but the status is on
      5) High Condenser Water Supply Temp: If the condenser water supply temperature is greater than 90°F (adj.).

Q. Loop Heating (typical of 1)
1. Water Source Heat Pump Boiler System - Run Conditions:
   a. The boiler system shall run subject to its own internal safeties and controls. The boiler system shall be enabled to run whenever:
      1. The loop control is enabled by zone requirements.
      2. AND outside air temperature is less than ***the unoccupied/ occupied reset schedule.***

b. The boiler system shall also run for freeze protection whenever outside air temperature is less than 38°F (adj.).

2. Two Stage Boiler Loop Water Temperature Control:
   a. The controller shall measure the loop water supply temperature and stage the boiler, its circulation pump and heating stages on in sequence to maintain setpoints. The boiler system shall run subject to its own internal safeties and controls.
   b. On dropping loop water supply temperature, the boiler and its circulation pump shall stage on at the setpoints given below. When the loop water supply temperature rises back above the setpoints by the differentials listed, the boiler shall then stage off. To prevent short cycling, there shall be a user definable (adj.) delay between stages, and each stage shall have a user definable (adj.) minimum runtime.
   c. The following setpoints are recommended values. All setpoints shall be field adjusted during the commissioning period to meet the requirements of actual field conditions.
   d. The boiler and circulation pump shall stage to maintain setpoints as follows:

	Boiler & Pump	Stage 1	Stage 2
Stage ON: If loop temp drops below setpoint of:	70°F	68°F	66°F
Stage OFF: If loop temp rises above setpoint by:	4°F	4°F	4°F

   e. Alarms shall be provided as follows:
      1) Boiler
         a) Failure: Commanded on, but the status is off.
         b) Running in Hand: Commanded off, but the status is on.
      2) Low Boiler Supply Temp: If the boiler supply temperature is less than 120°F (adj.).

R. Makeup Air Unit - Supply Air Temp (typical of 1)
   1. Run Conditions - Interlocked:
      a. The unit MAU --- shall be interlocked to run whenever Air Handling Unit ---- runs unless shutdown on safeties.
   2. Freeze Protection:
      a. The unit shall shut down and generate an alarm upon receiving a freezestat status.
   3. Outside Air Damper:
      a. The outside air damper shall open anytime the unit runs and shall close anytime the unit stops. The supply fan shall start only after the damper status has proven the damper is open. The outside air damper shall close 4sec (adj.) after the supply fan stops.
      b. Alarms shall be provided as follows:
         1) Outside Air Damper Failure: Commanded open, but the status is closed.
         2) Outside Air Damper in Hand: Commanded closed, but the status is open.

4. Heat Recovery Wheel - Constant Speed:
   a. The controller shall run the heat wheel for energy recovery as follows.
      1) Cooling Recovery Mode: The controller shall measure the heat wheel discharge air temperature and run the heat wheel to maintain a setpoint 2°F (adj.) less than the unit supply air temperature setpoint. The heat wheel shall run for cool recovery whenever:
         a) The unit return air temperature is 5°F (adj.) or more below the outside air temperature.
         b) AND the unit is in a cooling mode.
         c) AND the supply fan is on.
      2) Heating Recovery Mode: The controller shall measure the heat wheel discharge air temperature and run the wheel to maintain a setpoint 2°F (adj.) greater than the unit supply air temperature setpoint. The heat wheel shall run for heat recovery whenever:
         a) Unit return air temperature is 5°F (adj.) or more above the outside air temperature.
         b) AND the unit is in a heating mode.
         c) AND the supply fan is on.
   b. Periodic Self-Cleaning:
      1) The heat wheel shall run for 10sec (adj.) every 4hrs (adj.) the unit runs.
   c. Frost Protection:
      1) The heat wheel shall run for 10sec (adj.) every 600sec (adj.) whenever:
         a) Outside air temperature drops below 15°F (adj.)
         b) OR whenever exhaust air temperature drops below 20°F (adj.).
   d. The bypass dampers will open whenever the heat wheel is disabled.
   e. Alarms shall be provided as follows:
      1) Heat Wheel Rotation Failure: Commanded on, but the status is off.
      2) Heat Wheel in Hand: Commanded off, but the status is on.
5. Supply Fan:
   a. The supply fan shall run anytime the unit is commanded to run. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime, unless shutdown on safeties.
   b. Alarms shall be provided as follows:
      1) Supply Fan Failure: Commanded on, but the status is off.
      2) Supply Fan in Hand: Commanded off, but the status is on.
6. Supply Air Temperature Setpoint - Fixed:
   a. The controller shall monitor the supply air temperature and shall maintain a fixed supply air temperature setpoint of 55°F (adj.) cooling, 70 °F (adj.) heating.
7. Cooling Coil Valve:
   a. The controller shall measure the supply air temperature and modulate the cooling coil valve to maintain its cooling setpoint.
   b. The cooling shall be enabled whenever:

1) Outside air temperature is greater than ***the unoccupied/ occupied reset schedule.***
2) AND the supply air temperature is above cooling setpoint.
3) AND the fan status is on.

c. The cooling coil valve shall open to 50% (adj.) whenever the freezestat is on.

8. Heating Coil Valve:
   a. The controller shall measure the supply air temperature and modulate the heating coil valve to maintain its heating setpoint.
   b. The heating shall be enabled whenever:
      1) Outside air temperature is less than ***the unoccupied/ occupied reset schedule.***
      2) AND the supply air temperature is below heating setpoint.
      3) AND the fan status is on.
   c. The heating coil valve shall open to 100% (adj.) whenever the freezestat is on.
9. Prefilter Status:
   a. The controller shall monitor the prefilter status.
   b. Alarms shall be provided as follows:
      1) Prefilter Change Required: Prefilter differential pressure exceeds a user definable limit (adj.).
10. Final Filter Status:
   a. The controller shall monitor the final filter status.
   b. Alarms shall be provided as follows:
      1) Final Filter Change Required: Final filter differential pressure exceeds a user definable limit (adj.).
11. Supply Air Temperature:
   a. The controller shall monitor the supply air temperature.
   b. Alarms shall be provided as follows:
      1) High Supply Air Temp: If the supply air temperature is greater than 120°F (adj.).
      2) Low Supply Air Temp: If the supply air temperature is less than 45°F (adj.).

END OF SECTION

SECTION 231101

LIQUID PETROLEUM GAS PIPING

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for interior LP gas piping, exterior LP gas piping, gas valves, gas regulators, LP gas tanks, and vaporizers.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, performance ratings, and installation instructions.

1.3 QUALITY ASSURANCE

A. Material and installation requirements shall follow NFPA 58, state and local gas company codes.

B. Material and installation requirements shall follow OBC-Plumbing Code 4101:2-67 and 4101:8-1 thru 19 of the Ohio Pressure Piping Systems Rules.

C. Conformance to National Fuel Gas Code.

1.4 GAS PIPING

A. Interior gas piping shall be schedule 40 black steel piping.

B. Exterior gas piping shall be schedule 40 black steel piping with bituminous coating. Provide grounding anode(s). Review type of piping and depth of bury with local L.P. tank company.

C. Option to 2.01,A: Gas piping for ½ to 2 inch shall be corrugated stainless steel tubing. Covering must meet ASTM 84 (25/50) requirements and ANSI/AGA LCI B2005.

D. Copper tubing must meet ASTM B88 and NFPA 58.

E. Copper press fittings may be used as an option to wrought copper fittings. Fitting must be specifically made for natural gas and LP gas.

1.5 GAS VALVES

A. Gas valves 2 inches and smaller shall be full port all brass screwed gas service stops with lever handles and check.

B. Gas valves 2-1/2 inches and larger shall be semi-steel, straightway flanged, 125 lbs. swp, square head wrench operated, lubricated plug valve.

C. Kitchen Hood – Spring loaded (N.C.) gas valve.

D. In the science and art rooms, provide the following:
   1. A manual reset, solenoid operated shut-off valve with 120v operation with remote push button operation and fire alarm system activation.

1.6 GAS REGULATORS

A. Gas regulators shall limit the pressure of gas from the inlet to the outlet feeding a gas appliance.

1.7 LP GAS TANK

A. Tank shall be supplied by the local LP gas company, sized to match the gas usage of the school.

1.8 LP GAS VAPORIZER

A. Provide vaporizer for delivery of gas to the building if a liquid LP source is used, sized for the total building load.

1.9 INSTALLATION

A. Unions and valves are not permitted in the gas piping in a return air plenum.

B. Piping 1-1/2 inch and smaller shall have threaded joints.

C. Piping 2 inches and larger shall have welded joints.

D. All regulators shall be separately vented full size to the exterior, with a turndown elbow and insect screen. Vent outlet shall not terminate next to a combustion or fresh air intake.

E. Provide a valve, union and dirt leg at each appliance. Lubricate all valves before putting the valves into service.

F. Provide 1/2 inch elastomeric insulation around all piping through walls and floors.

G. Test all piping for 24 hours at 100 psi.

H. All interior piping shall be exposed. Exposed piping shall not be located where students could hang from the piping.

I. All exterior gas piping shall be buried a minimum of 30 inches.

J. Provide 6 foot high fence around tank(s).

K. Provide regulator on exterior wall of building, connected to the interior piping. Provide inlet and outlet shutoff valve.

L. Provide vaporizer within LP tank fence.

M. Science room auto shut-off valves can be located in teacher's demo unit, under sink, or exposed in storage room.

END OF SECTION

SECTION 232113

HVAC PIPING SPECIALITIES

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for piping expansion joints and piping guides, pressure reducing valves, ASME safety relief valves, manual and automatic air vents, ASME compression and expansion tanks, air separators with automatic air vent, and strainers.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. Pressure piping shall meet ASME B31.9 Code.

B. Safety relief valve requirements shall meet ASME Boiler and Pressure Vessel Code.

1.4 COMPONENTS

A. Expansion Joint: Housed stainless steel bellows type. Provide with piping expansion guides.

B. Pressure-Reducing Valves. Bronze or cast iron body with inlet strainer and noncorrosive valve seat and stem. Preset at 12 psig (adjustable).

C. ASME Safety-Relief Valves: Brass or bronze body with brass and rubber wetted internal working parts. Size for the pressure and capacity of the system.

D. Manual Air Vents: Provide 1/2 inch diameter piping loop with ball valve and standard hose end connection.

E. Automatic Air Vents: High capacity with float operation. Constructed of cast iron body with stainless steel, brass and EPDM internal parts. Rated for 250 degrees F at 150 psig. Unit shall be designed not to allow air into the vent in ***case*** of system pressure dropping below atmospheric pressure. Use for relieving air from the system at the air separator only.

F. ASME expansion tanks with air-control tanks fittings, gauge glass and tank drain fittings.

G. ASME diaphragm-type compression tanks.

H. Air separators with high capacity automatic air vent.

I. Y-Pattern Strainers: 125 psig working pressure cast iron or bronze body ASTM A126 Class B.

J. Duplex basket strainers for open condenser water systems. Cast iron body with stainless steel basket strainer. Provide with isolation valves for cleaning each strainer while remaining in service.

K. Corrosion coupons with associated holders in piping.

1.5 INSTALLATION

A. Provide piping expansion joints with piping control guides to control the expansion of the heating water piping systems where piping expansion loops cannot be used because of space restrictions.

B. Provide pressure reducing valves at the domestic cold water make-up connection to the closed loop heating water, chilled water piping systems, and heat pump.

C. Provide ASME safety relief valve in all closed hydronic loop systems. Relief valves shall be sized for the proper relief capacity to protect each system.

D. Provide manual air vent valves at all coils and at the high points of each system.

E. Provide automatic air vent valves on the air separator for each system. Pipe this air relief discharge to the nearest floor drain.

F. Provide either an ASME compression tank or an ASME bladder type expansion tank for each closed loop system.

G. Provide a full size (same size as the main piping system) centrifugal air separator on the suction side of the closed loop pumping system. The capacity shall meet or exceed the flow requirements of the system.

H. Provide basket strainer for all open loop condenser water systems.

I. Provide corrosion coupons and holders for all open loop condenser water systems.

J. Provide Y-pattern strainer at all coils including VAV reheat coils at inlet side of control valve and automatic flow controller.

END OF SECTION

SECTION 232117

GLYCOL HEAT TRANSFER FLUID

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for pre-mixed [ethylene] [propylene] glycol solution for the closed loop heating water systems and chilled water systems.

1.2 SUBMITTALS

A. Submittals are required and shall include product data, system capacity adjustments, MSDS sheets, and requirements for installation.

1.3 QUALITY ASSURANCE

A. Chemical shall meet all state and local pollution control regulations.

B. Heat transfer solution shall be inhibited and specifically for use in commercial HVAC systems.

C. System shall have a minimum 8 inch by 10 inch metal system nameplate denoting the following:

1. Date of original HTF charge.
2. Description of heat transfer fluid.
3. Manufacturer's name, address, and telephone.
4. Percent ***glycol.***
5. Freeze point and burst point.
6. Total system gallons.
7. Reference to material safety sheet.
8. Instruction for sampling of fluid.
9. Month for annual sampling.
10. Mailing instructions.

1.4 ETHYLENE GLYCOL-BASED PRODUCT

A. Inhibited ethylene glycol containing inhibitors, buffers, and anti-foaming agents.

B. Minimum 25 percent solution of heat transfer fluid and deionized water.

1.5 PROPYLENE GLYCOL-BASED PRODUCT

A. Inhibited propylene glycol containing inhibitors, buffers, and anti-foaming agents.

B. Minimum 30 percent solution of heat transfer fluid and deionized water. A 20 percent solution shall be acceptable in geothermal, ground-coupled systems where required for protection of equipment - not for freeze (burst) protection for exterior piping.

1.6 INSTALLATION

A. Install fluid on suction side of system pump.

1.7 HYDRONIC SYSTEMS FLUSHING

A. Hydronic systems shall be throughly flushed with approved pre-cleaning agent prior to being placed into service.

END OF SECTION

SECTION 232119

HVAC FLOW CONTROL

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for calibrated plug valves for manual system flow balancing and automatic flow balancing valves.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, and dimensions.

1.3 COMPONENTS

A. Calibrated plug valves
1. 125 psig maximum working pressure 250 degrees Fahrenheit maximum operating temperature, bronze construction with calibrated orifice. Provide with pressure temperature taps. Two inches diameter and smaller shall have threaded connections. Two and one-half inches diameter and larger shall be flanged connections.

B. Automatic flow balancing valves:
1. 150 psig maximum working pressure, 250 degrees F maximum operating temperature. Brass or bronze housing for one and one-half inches diameter piping size and smaller and cast iron for two inches diameter and larger piping size with all stainless steel operating parts. Flow shall be controlled to plus or minus 5 percent of the required flow. Provide with threaded connections for two inches diameter and smaller. Provide flanged or grooved connections for two inches diameter and larger. Provide with pressure temperature taps on each side of the flow control cartridge. Provide the proper pressure control range for the system.

1.4 INSTALLATION

A. Provide (calibrated manual) (automatic) flow control valves at each coil, heat pump, boiler or each chiller of a multiple chiller installation to properly balance the flow to each device.

END OF SECTION

SECTION 232123

HVAC HYDRONIC PUMPS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for in-line circulators, vertical in-line pumps, base-mount end-suction pumps, close-coupled end-suction pumps, coil circulating pumps, and double-suction, vertical split-case pumps.

1.2 SYSTEM DESCRIPTION

A. Impellers shall be sized for a maximum diameter not to exceed 85 percent of the selected pump's largest diameter.

B. Each pump shall be selected for non-overloading operation throughout its curve.

C. Each pump shall be provided with high efficiency motors.

D. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

1.3 SUBMITTALS

A. Submittals are required and shall include pump performance curves.

1.4 HORIZONTAL IN-LINE CIRCULATORS

A. Each pump will be horizontal, centrifugal, single stage, design with cast iron casings and bronze impellers.

B. Mechanical seals.

C. Resiliently mounted motor.

1.5 VERTICAL IN-LINE PUMPS

A. Each pump will be vertical, centrifugal, single stage, design with cast iron casings and bronze impellers.

B. Mechanical seals.

C. Direct-mounted motor with lifting and supporting lugs.

1.6 BASE-MOUNT END-SUCTION PUMPS

A. Each pump will be single stage, base-mounted, end-suction design with cast iron casing, cast-bronze impeller, and bronze fitted construction.

B. Mechanical seals.

C. The pump and motor shall be mounted on a common baseplate of heavy structural steel.

1.7 CLOSE-COUPLED END SUCTION PUMPS

A. Each pump shall be closed-coupled, single-stage, end suction design with cast iron casing, cast-bronze impeller, and bronze-fitted construction.

B. Mechanical seals.

C. Direct-mounted motor.

1.8 COIL CIRCULATING PUMPS

A. Each pump will be horizontal, centrifugal, single stage, design with cast iron casings and nonmetallic impellers.

B. Mechanical seals.

C. Resiliently mounted motor.

1.9 DOUBLE-SUCTION, VERTICAL SPLIT-CASE PUMPS

A. Each pump will be single stage, double-suction, vertical split case design with cast iron casing, bronze impeller, and bronze fitted construction.

B. Mechanical seals.

C. The pump and motor shall be mounted on a common baseplate of heavy structural steel.

1.10 INSTALLATION

A. Install all pumps in accordance with manufacturer's requirements.

B. Base mounted pumps shall be mounted on a concrete housekeeping pad. In-line pumps shall be supported from the structure or floor. Pumps may be provided as part of a packaged pumping system. Base mounted pumps shall be set on concrete inertia base when provided as part of packaged pumping systems.

END OF SECTION

SECTION 232300

REFRIGERANT PIPING

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for refrigerant piping and accessories.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. ASME B31.5 Refrigeration Piping latest edition.

B. UL 207 Refrigerant Containing Components and Accessories.

1.4 COMPONENTS

A. Piping: Type ACR hard copper tubing with wrought copper fittings and brazed joints.

B. Valves
1. Packed angle valve.
2. Solenoid valve.
3. Refrigerant check valve.
4. Thermal expansion valve.
5. Pressure relief valve.
6. Pressure regulating valve.
7. Hot gas bypass valve.
8. Suction accumulator.

C. Moisture indicators.

D. Replaceable type filter/dryer assemblies with three valve by-pass.

E. Flexible piping connectors.

1.5 INSTALLATION

A. Provide filter/dryer assemblies, moisture indicators, thermal expansion valve and solenoid valves for each refrigeration circuit.

B. Pressure test refrigerant piping system at 300 psi for high side and 150 psi for low side. Maintain pressure for a minimum of 24 hours.

C. Leak test piping and joints with an electronic or halide leak detector.

D. Evacuate entire system with an approved high vacuum pump system to 500 microns.

END OF SECTION

SECTION 232500

HVAC WATER TREATMENT

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for closed water treatment system for heating hot water, chilled water, geothermal, and heat pump condenser water systems.

B. Qualitative requirements for open water treatment system for cooling tower condenser water systems.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting catalog data, specification data, dimensional and operational data, wiring requirements with diagram, chemical specification data, and warranty data.

1.3 QUALITY ASSURANCE

A. Chemical shall meet all state and local pollution control regulations.

B. Water chemistry and makeup must meet the installed equipment's operational and warranty requirements.

1.4 WARRANTY

A. Provide a 1 year ***service program including testing and required materials and maintenance.***

1. Chemical feed systems shall include all chemicals and additives.

B. Filter media is to be provided as necessary to maintain the required water quality over the installation, start-up, and ***warranty*** periods.

1.5 Applicable System Types

A. Closed Water Treatment Systems

1. Manual bypass chemical feeder.

2. Automatic glycol feeder pump.

B. Open Water Treatment Systems

1. Automatic chemical injection system.

2. Chemical-free Magnetic Field with alternating and reversing polarity field orientation.

3. Chemical-free Pulsed Electric Field.

4. Chemical-free Hydrodynamic Cavitation.

C. Open systems employing a chemical-free water treatment system shall also include a side stream filter and manual bypass chemical feeder for use with initial flushing, cleaning and cooling tower passivation. Bypass feeder shall also be utilized for additional biocide treatment if required by evidence of sampling and testing.

1.6 Performance Requirements

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

B. Closed Hydronic Systems shall maintain the following water qualities:

1. ***pH: Maintain a value within 9.0 to 10.5 .***
2. ***"P" Alkalinity: Maintain a value within 100 to 500 ppm.***
3. ***Conductivity: Maintain a value within 300 to 5,000 S/cm.***
4. ***TDS: Maintain a maximum value of 10 ppm.***
5. ***Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.***
6. ***Microbiological Limits:***
   a. ***Total Aerobic Plate Count: Maintain a maximum value of 1000 CFU's/ml.***
   b. ***Total Anaerobic Plate Count: Maintain a maximum value of 100 CFU's/ml.***
   c. ***Iron Bacteria: Maintain a maximum value of 0 CFU's/ml.***

C. Open Hydronic Systems shall maintain the following water qualities:

1. ***pH: Maintain a value within 7.2 to 9.4 .***
2. ***"P" Alkalinity: Maintain a maximum value of 100 ppm.***
3. ***Conductivity: Maintain a value within 300 to 5,000 S/cm.***
4. ***Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.***
5. ***TDS: Maintain a maximum value of 10 ppm.***
6. ***Free "OH" Alkalinity: Maintain a maximum value of 0 ppm***
7. ***Microbiological Limits:***
   a. ***Total Aerobic Plate Count: Maintain a maximum value of 10,000 CFU's/ml.***
   b. ***Total Anaerobic Plate Count: Maintain a maximum value of 1000 CFU's/ml.***
   c. ***Iron Bacteria: Maintain a maximum value of 0 CFU's/ml.***
8. ***Polymer Testable: Maintain a minimum value within 10 to 40.***

D. Passivation for Galvanized Steel: For the first 60 days of operation.

1. ***pH: Maintain a value within 7 to 8 .***
2. ***Calcium Carbonate Hardness: Maintain a value within 100 to 300 ppm.***
3. ***Calcium Carbonate Alkalinity: Maintain a value within 100 to 300 ppm.***

1.7 SYSTEM COMPONENTS

A. Side Stream Filters and Chemical Feeder: Cast iron or steel, [2 gallon][5 gallon][10 gallon] capacity, 300 psi at 200 degrees F, support legs, 20 micron filter, epoxy-coated, drain valve, spare filter, and spare lid gasket.

B. Conductivity Probe: Provide complete with probe and flow switch and dual flat switch surface carbon elements. Maximum pressure shall not exceed 150 psi and maximum temperature shall not exceed 140 degrees F.

C. Positive-displacement [diaphragm] [piston] pumps: Provide with ball type check valves, foot valves, and injection fittings.

D. Chemical Solution Tanks: [30 gallon] [50 gallon].

E. Packaged conductivity controller: Electronic operation with bleed and feed relays, feed timer, and digital display for control setting and adjustments.

F. Cold-water meter: Provide complete with contacting register sized to meter twice the volume of maximum makeup water rate for system.

G. Solenoid valves: Provide and wire as required.

H. Electronic timers: Provide a biocide control timer and lockout control timer.

I. Condenser water treatment control panel: Provide enclosed in a NEMA 4X, IP-65 rated enclosure with hinged lockable cover.

J. ***Water*** treatment test equipment
   1. Water test kit with spare reagents.
   2. Conductivity meter that compensates for differences in temperatures and analog meter.
   3. Corrosion test coupon assembly (open systems)

K. Chemicals
   1. Provide a minimum of 1 years supply.
   2. Include all MSDS sheets for chemicals provided.

L. Pre-cleaning and flushing materials: Provide chemicals produced specifically for use in cleaning piping systems after installation and prior to being placed into operation.

1.8 INSTALLATION

A. Install side stream filter and chemical feeder with 2 valve bypass and drain.

B. Install make-up water meter with 3-valve bypass, strainer, and unions.

C. Mount conductivity monitor, chemical feed pumps, and biocide timer on 304 stainless steel shelf.

D. Hydronic systems shall not be operated for any reason prior to complete flushing and charging with appropriate chemicals.

1.9 HYDRONIC SYSTEMS FLUSHING AND PRE-CLEANING

A. The following procedures is for flushing and pre-cleaning
   1. Determine the metallurgy of the system
   2. By-pass all HVAC equipment
   3. Determine the exact system volume. This may be accomplished by filling the system through a water meter or salt test.
   4. With all areas open to flow, add system cleaner through the By-Pass Filter Feeder or pump per manufacturer's recommendations.
   5. Cleaning and flush rates must be at a minimum of 6 ft/sec through the piping or maximum flow rate of the system.
   6. First flush the system to remove as much suspended material as possible with clear water.
   7. Second, cleaning shall maintain total alkalinity of 3000 ppm for twenty-four (24)

to thirty-six (36) hours.

8. Third, flush system until pH and Alkalinity return to make-up water levels and drain.
9. Fourth, fill system with OSDM-compliant clean water with a water chemistry (pH, alkalinity, etc.) and make-up that meets equipment water quality requirements.
   a. If the system is drained of water and a heat transfer solution added, a quality corrosion inhibitor shall be added to the system to protect against flash rust while the system is drained. Please consult your water treatment professional for recommendations.

10. Simply draining the loop and refilling with fresh water is not permitted. The loop needs to be flushed by adding fresh water and draining dirty water continuously. This procedure will help prevent foulants from dropping out on the pipe surfaces.

B. ADDITIONAL PROCEDURE FOR GEOTHERMAL SYSTEM FLUSHING AND CLEANING

1. It is imperative that the geothermal piping is sealed and capped during installation to keep debris out. Geothermal systems must be flushed after each stage of the installation.

2. Vertical well piping shall be flushed with high pressure water once they are installed and grouted to remove any debris in the pipe. Piping shall be recapped to prevent sand and dirt from entering the piping before they are connected to the header.

3. Main horizontal header shall be flushed with high pressure water once they are installed to remove any debris in the piping. Piping shall be recapped to prevent sand and dirt from entering the piping until they are connected to the vertical well piping.

4. The entire geothermal piping system shall be cleaned and flushed as indicated above in item A.

5. Architect, Engineer or CM shall signoff on pipe cleaning before system can be started.

1.10 WATER SERVICE PROGRAM

A. The ***water*** treatment contractor shall provide ***maintenance*** and consulting services for 1 year from date of acceptance of system by the Owner. Minimum service requirements shall include:

1. ***Monthly*** sample and testing
2. Additional chemical if needed
3. Side stream filter change
4. Testing of: PH, alkalinity, conductance, inhibitor, microbiological dip slide, and % glycol
5. Visual check of system
6. Written report documenting all of the items above.

1.11 TRAINING

A. Provide training for Owner's maintenance staff on testing of water samples.

END OF SECTION

SECTION 233113

LOW-PRESSURE DUCTWORK

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for low pressure supply (2-inch wg pressure class) sheetmetal ductwork; and low pressure return, relief and exhaust (2-inch wg pressure class negative) sheetmetal ductwork.

C. Qualitative requirements for duct insulation liner. Application shall be limited; external wrapped insulation is preferred.

1.2 SUBMITTALS

A. Submittals are required and shall include 1/4 inch scale layout shop drawings showing duct location sizes, elevations and air flow quantities for each air terminal device. Electronic drawing files of floor plans and structural plans are available from the Architect/Engineer upon request.

1.3 QUALITY ASSURANCE

A. SMACNA HVAC Duct Construction Standards-Metal and Flexible.

B. UL181.

C. NAIMA AH124-94: Fibrous Glass Duct Liner Standard.

D. NFPA 90A and 90B.

E. ASHRAE Handbook, HVAC Systems and Equipment.

F. Ductwork shall be sealed and leak tested as required by ASHRAE Standard 90.1.

1.4 COMPONENTS

A. Supply air, return air, relief air and exhaust air (except shower rooms, kitchen exhaust hoods, dishwasher exhaust and fume hood exhaust) shall be galvanized steel lock-forming quality ASTM A 653/A 653/M, G90 (Z275) coating designation; milli-phosphatized finish for surfaces of ducts exposed to view. Gauges shall be per the latest issue of SMACNA for listed pressure requirements.

1. Provide Class B seals for all joints.
2. Bolted-flange style duct connections shall be acceptable.

B. Fume hood exhaust shall be Type 304 stainless steel or PVC -coated galvanized steel lock forming quality meeting UL 181, ASTM A 653/A 653/M, G90 (Z275) coating designation. Provide 4-mil PVC coating on the interior of the duct and fittings. Gauges shall be per the latest issue of SMACNA for listed pressure requirements.

1. Provide Class A seals for all joints.

C. Shower exhaust ductwork shall be aluminum construction conforming to ASTM B 209 Alloy 3003, Temper H14, Gauges shall be per the latest issue of SMACNA for listed pressure requirements. Seal all joints liquid-tight. Pitch ductwork back toward grille.

D. Kitchen exhaust hood exhaust ductwork shall be 16 gauge steel with weld joints as required by the Ohio Basic Mechanical Code. All joints shall be welded liquid tight.

E. Dishwasher exhaust ductwork shall be 16 gauge type 304 stainless steel with liquid tight welded joints all the way to the fan. Pitch ductwork back toward dishwasher.

F. Flexible duct liner shall be a minimum of 1 inch thick and shall be applied in accordance with the latest addition of the SMACNA's Duct Liner Application Standard. All dimension shown on the plans are inside duct dimension and do not include the dimension of the duct liner.

END OF SECTION

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK.

SECTION 233115

MEDIUM-PRESSURE DUCTWORK

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for medium-pressure round or flat oval supply (3 inch wg pressure class) sheetmetal ductwork.

1.2 SUBMITTALS

A. Submittals are required and shall include 1/4 inch scale layout shop drawings showing duct location sizes, elevations and air flow quantities for each air terminal device. Electronic drawing files of floor plans and structural plans are available from the Architect/Engineer upon request.

1.3 QUALITY ASSURANCE

A. SMACNA HVAC Duct Construction Standards-Metal and Flexible.

B. UL181.

C. NFPA 90A and 90B.

D. ASHRAE Handbook, HVAC Systems and Equipment.

E. Ductwork shall be sealed and leak tested as required by ASHRAE Standard 90.1.

1.4 COMPONENTS

A. Supply air shall be spiral seam round or flat oval duct work constructed of galvanized steel lock-forming quality ASTM A 653/A 653/M, G90 (Z275) coating designation; milli-phosphatized finish for surfaces of ducts exposed to view. Gauges shall be per the latest issue of SMACNA for listed pressure requirements.

B. Minimum round duct sheet metal gauge shall be as follows:

Duct Diameter	Spiral Seam Gauge	Longitudinal Seam Gauge
3 through 14 inches	26	24
15 through 26 inches	24	22
27 through 36 inches	22	20
37 through 50 inches	20	20
51 through 60 inches	18	18
61 through 84 inches	18	16

C. Minimum flat oval duct gauges shall be as follows:

Major Dimension Duct Width	Spiral Seam Gauge	Longitudinal Seam Gauge
Up through 24 inches	24	20
25 through 36 inches	22	20
37 through 48 inches	22	18
49 through 60 inches	20	18
61 through 70 inches	20	16
70 inches and up	18	16

D. Fittings for duct construction shall be of sheet metal gauges as follows:

Duct Diameter/ Major Dimension	Round Fittings	Flat Oval Fittings
3 through 14 inches	24	20
15 through 26 inches	22	20
27 through 36 inches	20	20
37 through 50 inches	20	18
51 through 60 inches	18	18
61 through 84 inches	16	16

E. Provide with Class A seals for all duct joints.

END OF SECTION

SECTION 233117

FLEXIBLE DUCTWORK

GENERAL GUIDELINES

1.1 SECTION INCLUDES
- A. Qualitative requirements for flexible insulated HVAC ductwork and flexible ductwork joint connections.

1.2 SUBMITTALS
- A. Submittals are required and shall include material pressure ratings and dimensions.

1.3 QUALITY ASSURANCE
- A. SMACNA HVAC Duct Construction Standards-Metal and Flexible.
- B. UL181 .
- C. NFPA 90A and 90B.
- D. ASHRAE Handbook, HVAC Systems and Equipment.
- E. UL 191.
- F. Ductwork shall be sealed and leak tested as required by ASHRAE Standard 90.1.

1.4 COMPONENTS
- A. Low Pressure Flexible Duct
  1. Inner Core: Reinforced 3-ply aluminum foil with mechanically lock helix.
  2. Outer Covering: 1 inch thick, 3/4 pound density fiberglass with fire retardant jacket.
  3. Pressure Rating: 5 inches positive or negative.
- B. High Pressure Flexible Duct
  1. Inner Core: All metal, bend 3-ply laminated aluminum.
  2. Outer Covering: 1 inch thick, 3/4 pound density fiberglass with fire retardant jacket.
  3. Pressure Rating: 10 inch positive.
- C. Flexible Joints
  1. Minimum 30 ounce neoprene coated fabric secured by bolted angles or band iron.
  2. Metal to metal contact shall not be permitted.

1.5 INSTALLATION
- A. Provide the flexible connections at ductwork connections to vibrating or rotating equipment, including fans.

END OF SECTION

SECTION 233300

DUCTWORK ACCESSORIES

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for backdraft dampers, manual volume dampers, fire dampers, smoke dampers, duct silencers, turning vanes and duct access doors.

1.2 SUBMITTALS

A. Submittals are required and shall include material, sizes, quantities, and dimensions.

1.3 QUALITY ASSURANCE

A. SMACNA HVAC Duct Construction Standards-Metal and Flexible.

B. UL181 .

C. NFPA 90A and 90B.

D. ASHRAE Handbook, HVAC Systems and Equipment.

E. Dampers shall meet the requirements of ASHRAE Standard 90.1.

1.4 COMPONENTS

A. Backdraft Dampers
1. Frames: Galvanized steel.
2. Blades: Extruded aluminum.
3. Blade Seals: Neoprene.
4. Blade Axles: Galvanized steel.
5. Tie Bars and Brackets: Aluminum.
6. Return Spring: Adjustable tension for motor operated dampers only.
7. Dampers: Counter-balanced for building pressure activation.

B. Manual Volume Dampers
1. Frames: Galvanized steel.
2. Blades: Galvanized steel or Extruded aluminum.
3. Tie Bars and Brackets: Galvanized steel.
4. Blade Seals: Neoprene.
5. Dampers: Multiple, opposed blade design with linkage outside airstream.

C. Fire Dampers
1. UL listed and labeled for 1-1/2 hour or 3 hour.
2. Frame: Galvanized steel.
3. Blades: Mounted out of airstream.
4. Fusible Link: Replaceable 165 degrees F.

D. Smoke Dampers
   1. Actuators: Two-position with spring-return motors.

E. Duct Silencers: Factory-fabricated and -tested, 25/50 flame-spread/smoke-developed rating, with performance ratings determined by ASTM E 477.
   1. Fill Material: fiberglass.

F. Turning Vanes
   1. Installer fabricated or manufactured.

G. Duct-Mounted Access Panels and Doors
   1. Frame: Galvanized steel
   2. Door: Double wall galvanized steel with 1 inch insulation fill and neoprene seal.
   3. Access panels shall be rated to seal at air pressure of associated duct.

1.5 INSTALLATION

A. Provide backdraft dampers on all relief air and exhaust air outlets (except kitchen exhaust and fume hood exhaust).

B. Provide manual volume dampers at each supply air outlet, exhaust air inlet, ducted relief air, and return air inlet.

C. Provide fire dampers in all ducted and non-ducted openings in fire rated assemblies as required by the Ohio Basic Building.

D. Provide smoke dampers in smoke barriers where required by the Ohio Basic Building Code.

E. Provide duct silencers to control the air handling system discharge sound pressure level to acceptable levels.

F. Provide turning vanes in all mitered ductwork 90 degree elbows.

G. Provide duct mounted access doors and panels to all fire dampers, control damper, plenum housings.

END OF SECTION

SECTION 233313

EXTERIOR WALL LOUVERS

GENERAL GUIDELINES

1.1 SECTION INCLUDES
- A. Qualitative requirements for exterior wall louvers and soffit louvers.

1.2 SUBMITTALS
- A. Submittals are required and shall include scheduled material, sizes, quantities, and finish.

1.3 QUALITY ASSURANCE
- A. AMCA Standard 511.

1.4 COMPONENTS
- A. Rectangular Drainable Wall Louvers
  1. Stormproof, aluminum construction.
  2. Aluminum bird screen suitably braced to prevent sagging.
  3. Frame shall be constructed of 6063T5 extruded aluminum.
  4. Blades shall be constructed of 6063T5 extruded aluminum. Blades shall be the drainable type, positioned at a minimum 35 degree angle.
  5. Finish shall be factory applied baked enamel.

- B. Specialty Louvers-Polygon
  1. Stormproof, aluminum construction.
  2. Aluminum bird screen suitably braced to prevent sagging.
  3. Frame shall be constructed of 6063T5 extruded aluminum.
  4. Blades shall be constructed of 6063T5 extruded aluminum. Blades shall be the drainable type, positioned at a minimum 35 degree angle.
  5. Finish shall be factory applied baked enamel.

- C. Specialty Louvers Semi-Round or Round
  1. Stormproof, aluminum construction.
  2. Aluminum bird screen suitably braced to prevent sagging.
  3. Frame shall be constructed of 6063T5 extruded aluminum.
  4. Blades shall be constructed of 6063T5 extruded aluminum. Blades shall be the drainable type, positioned at a minimum 35 degree angle.
  5. Finish shall be factory applied baked enamel.

- D. Horizontal Soffit Louvers
  1. Horizontal soffit louvers shall be of aluminum construction.
  2. Frame to be of 6063T5 extruded aluminum.
  3. Blades to be of 6063T5 extruded aluminum.
  4. Aluminum bird screen suitably braced to prevent sagging.
  5. Finish shall be factory applied baked enamel.

1.5 INSTALLATION
- A. Install wall louvers of the sizes and quantities as required.

END OF SECTION

SECTION 233400

HVAC FANS

GENERAL GUIDELINES

1.1 SECTION INCLUDES
- A. Qualitative requirements for roof exhaust fans, in-line exhaust fans, utility fan sets, and ceiling exhaust fans.

1.2 SUBMITTALS
- A. Submittals are required and shall include material capacities, quantities, and accessories.

1.3 QUALITY ASSURANCE
- A. Sound Power Level Rating: AMCA 301.
- B. Performance Requirements: AMCA 210.
- C. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

1.4 COMPONENTS
- A. Utility Set Fans
  1. Drive: Belt driven.
  2. Housing: Steel, adjustable.
  3. Fan Wheel: Centrifugal, single inlet, steel [backward inclined] [forward curved].
  4. Fan Shaft: Steel.
  5. Shaft Bearings: Prelubricated, self-aligning, pillow block type ball bearings with 200,000 hour rated life.
  6. Belt Drives: Factory mounted, 1.4 service factor, adjustable pitch motor pulleys, oil-resistant non-sparking belts, and belt guards.
  7. Motors: Heavy duty, ball bearing type with overload protection.
  8. Accessories: [Gravity-actuated backdraft dampers] [Access doors] [Scroll dampers] [Spark-resistant construction] [Inlet screens] [Drain connection] [Weathershield hoods].
- B. Centrifugal Roof Ventilators
  1. Drive: [Belt] [Direct].
  2. Housing: Spun aluminum.
  3. Fan Wheel: Aluminum hub and wheel, backward-inclined blades.
  4. Belt Drive Assembly: Steel shaft, permanently lubricated ball bearings, cast iron adjustable pitch pulley, and fan motor isolated from airstream.
  5. Motor: Heavy duty, ball bearing type with overload protection.
  6. Accessories: [Variable speed controller] [Disconnect switch] [Bird screens] [Backdraft dampers].
  7. Roof Curb Configuration: [Self-flashing without cant strip and with mounting flange] [Built-in cant and mounting flange] [Built-in raised cant and mounting flange].
  8. Roof Curb Height: 12 inches standard above finished roof.

C. Upblast Centrifugal Roof Exhaust Fans

Spec Writer Note: Accessories not to be used on greese duct exhaust system.

1. Drive: Belt driven.
2. Wind Band, Fan Housing, and Base: Reinforced and braced aluminum.
3. Housing: Spun aluminum.
4. Fan Wheel: Aluminum construction, backward inclined centrifugal.
5. Belt Drive Assembly: Steel shaft, permanently lubricated ball bearings, cast iron adjustable pitch pulley with motor mounted outside the airstream.
6. Motor: Heavy duty, ball bearing type with overload protection.
7. ***Accessories: [Variable speed controller][Disconnect switch][Bird screen][Back draft dampers]***
8. Roof Curb Configuration: [Self-flashing without cant strip and with mounting flange] [Built-in cant and mounting flange] [Built-in raised cant and mounting flange].
9. Roof Curb Height: 18 inches.

D. Propeller Wall Ventilators

1. Drive: [Belt] [Direct].
2. Housing: [Spun aluminum] [Painted steel].
3. Fan Blade: Steel hub with steel propeller blades.
4. Belt Drive Assembly: Steel shaft, permanently lubricated ball bearings, cast iron adjustable pitch pulley, and fan motor isolated from airstream.
5. Motors: Shall be permanently lubricated, heavy duty type with overload protection.
6. Accessories: [Variable speed controller] [Disconnect switch] [Bird screens] [Backdraft dampers].

E. Ceiling Mounted Exhaust Fans

1. Drive: Direct.
2. Housing: Galvanized steel.
3. Fan Wheel: Centrifugal.
4. Grilles: Plastic, louvered.
5. Roof jack or wall cap and transition fittings.
6. Provide with backdraft dampers.
7. Provide with integral disconnect switch.

F. In-Line Centrifugal Fans.

1. Drive: [Direct] [Belt].
2. Housing: Galvanized sheet metal.
3. Fan Wheel: Centrifugal, aluminum.
4. Belt Drive Assembly: Steel shaft, permanently lubricated ball bearings, adjustable pitch motor pulleys, motor insulated from airstream, belt guards.
5. Motors: Heavy duty, ball bearing type with overload protection.
6. Accessories: [Variable speed controller] [Disconnect switch] [Backdraft dampers].

1.5 INSTALLATION

A. Install per manufacturers requirements.

END OF SECTION

SECTION 233423

ROOFTOP INTAKE, EXHAUST, AND RELIEF VENTILATORS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for rooftop intake and exhaust gravity ventilators.

1.2 SUBMITTALS

A. Submittals are required and shall include material and dimensions.

1.3 COMPONENTS

A. Low Silhouette Roof Ventilators
1. Shall be constructed of heavy gauge aluminum.
2. Support members shall be constructed of galvanized steel.
3. Hood shall be removable from base or hinged.
4. Shall include 2 inch galvanized steel bird screens.
5. Underside of hood shall be insulated to reduce condensation.
6. Exterior finish shall be baked enamel.

B. Louvered Penthouse Units
1. Shall be constructed of heavy gauge aluminum.
2. Support members shall be constructed of galvanized steel.
3. Hood shall be removable from base or hinged.
4. Shall include 2 inch galvanized steel bird screens.
5. Underside of hood shall be insulated to reduce condensation.
6. Exterior finish shall be baked enamel.

1.4 INSTALLATION

A. Provide the number and type of ventilators as required.

B. Mount units on roof curbs.

END OF SECTION

SECTION 233513

DUST COLLECTION SYSTEM

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for woodworking shop dust collection cyclone separator, after-filter, ductwork, equipment hoods, floor sweeps, blast gates, and accessories.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting capacity, materials, controls, dimensions, and accessories and detailed ductwork layouts specific to each system.

1.3 QUALITY ASSURANCE

A. Design and installation shall be in accordance with the Industrial Ventilation Manual of the American Conference of Governmental Industrial Hygienists and the American National Standard for Fundamentals Governing the Design and Operation of Local Exhaust Ventilation Systems (ANSI/AIHA Standard Z9.2 – 2006).

B. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

1.4 DUST COLLECTOR

A. Primary collector shall be cyclone type for exterior installation.

B. Dust shall be precipitated into 55 gallon drums, (one or two as required).

C. Unit shall be constructed of heavy-gauge, cold rolled steel.

D. Final finish of primer and enamel paint.

E. Unit shall be factory assembled for final field assembly of major subassemblies.

1.5 AFTER-FILTER UNIT

A. After-filter shall be cloth tube type.

B. Dust removal shall be 100 percent down to 0.5 microns.

C. Unit shall be provided with a manually operated, motorized shaker.

D. Bottom of unit shall form a storage bin not less than 14 cubic feet for dust.

E. Unit shall be factory assembled for placement in field.

1.6 DUCTWORK AND ACCESSORIES

A. Ductwork shall be comprised of galvanized steel spiral pipe of not less than 22 gauge material.

B. Elbows used in installation shall be a minimum of 2 gauges heavier construction than the straight pipe of equal diameter.

C. Hoods shall be constructed of not less than 18 gauge galvanized steel material.

D. Flexible duct connections shall be noncollapsible, flexible metallic hose.

E. Blast gates shall allow for locking the gate in an open position or for removal of gate. Butterfly dampers are not permitted.

F. Cleanouts shall include a piano hinged door with spring clamps, locking latches, and edge felting to prevent air leaks.

1.7 INSTALLATION

A. Install in accordance with manufacturers requirements.

B. Secure all duct and elbow joints with self-tapping screws and caulk or hardcast type sealer. Duct tape is not acceptable.

C. Position cleanouts with hinged side at bottom center of ductwork.

D. Blast gates shall be positioned within ***easy*** reach of equipment operator.

E. Manufacturer's service representative shall provide compete check, test, and start-up on the system.

F. Construct hoods to suit actual equipment and site conditions.

END OF SECTION

SECTION 233515

WELDING EXHAUST SYSTEM

GENERAL GUIDELINES

1.1 SECTION INCLUDES
A. Qualitative requirements for source capture devices, ductwork, flexible hoses and accessories.

1.2 SUBMITTALS
A. Submittals are required and shall include product data noting capacity, materials, controls, dimensions, and accessories and detailed ductwork layouts.

1.3 QUALITY ASSURANCE
A. Design and installation shall be in accordance with 1) ANSI/AIHA Standard Z9.2 – 2006: American National Standard for Fundamentals Governing the Design and Operation of Local Exhaust Ventilation Systems and 2) Industrial Ventilation: A Manual of Recommended Practice, 4th Edition, Amercan Conference of Governmental Industrial Hygienists (ACGIH).

B. Flexible hoses shall meet UL-94 fire retardant requirements.

1.4 SOURCE CAPTURE DEVICES
A. Constructed of reinforced fiberglass for fire retardance.

B. Minimum 24 inches by 18 inches open face with an 8 inch diameter connection.

C. Vertical support rail that allows for adjustment of capture device height, designed for wall mounting.

D. Safety screen in throat.

1.5 DUCTWORK
A. Round ductwork shall be manufactured of heavy gauge galvanized steel with a spiral lockseam.

B. Fittings and couplings shall be constructed of 20 gauge galvanized steel.

1.6 FLEXIBLE HOSES
A. Manufactured of polyvinyl chloride reinforced with a hard drawn steel spiral bead wire.

B. Operating pressure of -7 psi to +5 psi.

C. Operating temperature of -10 degrees Fahrenheit to +180 degrees Fahrenheit.

1.7 INSTALLATION
A. Exhaust fans shall be as specified by Specification Section 233400 – HVAC Fans.
B. Install in accordance with manufacturers requirements.
C. Manufacturer's service representative shall provide compete check, test, and start-up on the system.

END OF SECTION

SECTION 233600

VARIABLE AIR VOLUME TERMINALS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for variable air volume reheat terminals and fan-powered variable air volume reheat terminals.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting the following:
1. Product data indicating dimensions, weights, capacities, and materials.
2. Static pressure requirements.
3. Sound performance levels.
4. Accessories.

1.3 QUALITY ASSURANCE

A. Construction standard shall meet NFPA 90A.

B. Product certification shall comply with ARI 880.

C. Sound power level rating shall comply with AMCA 300, ASHRAE 68, and AMCA 301.

D. Coil performance shall comply with ARI 410.

E. Insulation standard shall comply with UL 181.

1.4 COMPONENTS

A. Single-Duct Reheat Terminal Units
1. Configuration: Volume-damper assembly inside unit casing.
2. Casing: Zinc-coated steel
3. Casing Lining: 1-inch thick, 1-1/2 pound density fiberglass insulation with erosion-resistant coating or 0.75 inch thick, 1-1/2 pound density closed cell foam insulation (fiber free).
4. Air Inlets: Round or flat oval with air velocity sensor.
5. Volume Damper: [Galvanized steel] [extruded aluminum] [cylindrical flow control device] with maximum airflow leakage of [2 percent at 1-inch wg] [2 percent at 3-inch wg] [3 percent at 3-inch wg] [3 percent at 6-inch wg].
6. Damper Position: [Normally open] [Normally closed].
7. Multi-outlet Discharge Section: Insulated plenum with ductwork discharge collars and locking balancing damper.
8. Hot-Water Heating Coil: Copper tube and aluminum finned coil.
9. Velocity sensor: multi-point averaging type.
10. Controls: Electronic DDC controls.
11. Each unit shall include the following control accessories:
a. Control transformer and disconnect switch.
b. Mount controls in NEMA 250 Type 1 enclosure.

B. Fan-Powered Reheat Terminal Units
   1. Configuration: Volume-damper assembly inside unit casing.
   2. Casing: Zinc-coated steel
   3. Casing Lining: 1-inch thick, 1-1/2 pound density insulation with erosion-resistant coating.
   4. Air Inlets: Round or flat oval with air velocity sensor.
   5. Access: Removable panels with cam-lock fasteners.
   6. Volume Damper: [Galvanized steel] [extruded aluminum] [cylindrical flow control device] with maximum airflow leakage of [2 percent at 1-inch wg] [2 percent at 3-inch wg] [3 percent at 3-inch wg] [3 percent at 6-inch wg].
   7. Damper Position: [Normally open] [Normally closed].
   8. Fan: Series or parallel type unit located in acoustically lined plenum housing a direct-drive, forward-curved fan, and thermally protected PSC motor.
   9. Multi-outlet Discharge Section: Insulated plenum with ductwork discharge collars and locking balancing damper.
   10. Hot-Water Heating Coil: Copper tube and aluminum finned coil.
   11. Velocity sensor: multi-point averaging type.
   12. Filter: Attenuating air inlet section complete with 1 inch filter rack.
   13. Controls: Electronic DDC controls.
   14. Each unit shall include the following control accessories:
      a. Control transformer and fused disconnect switch.
      b. Fan solid state speed controller.
      c. Fan relay switch.
      d. Mount controls in NEMA 250 Type 1 enclosure.

1.5 INSTALLATION

A. Install in accordance with manufacturers requirements.
B. Startup and training to be provided by a factory-trained service technician.
C. Parallel fan-powered terminal units shall not be installed in classrooms or other acoustically sensitive spaces.

END OF SECTION

SECTION 233713

AIR OUTLETS AND INLETS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for supply air linear slot diffusers; return air linear diffusers; return air, exhaust air, and transfer air, grilles and registers; supply air registers; supply air diffusers; wall linear diffuser; egg crate return air or transfer air grilles; heavy duty wall return air grille or register; and above floor displacement type air devices.

1.2 SUBMITTALS

A. Submittals are required and shall be scheduled by room number to include material, sizes, quantities, finishes, and accessories.

1.3 QUALITY ASSURANCE

A. ASHRAE Standard 70 for performance testing.

B. NFPA 90A for installation.

1.4 COMPONENTS

A. Supply Air Linear Slot Diffusers
1. 22 gauge aluminum or heavy gauge steel diffusers assembly with factory baked white enamel finish or powder paint white finish.
2. 26 gauge zinc-coated steel inlet boot, maximum 12 inches high.
3. Single/multiple slots with extruded or stamped vanes.
4. Maximum 50 CFM/lineal ft./slot.
5. Third band SPL 40 DB without room credit.
6. 1/2 inch glass fiber acoustically insulated inlet plenum/boot.

B. Return Slot Diffusers
1. 22 gauge aluminum or heavy gauge steel diffuser assembly with factory baked white enamel finish or powder paint white finish.
2. 26 gauge zinc-coated steel inlet boot, maximum 12 inches high.
3. Single/multiple slots.
4. Maximum 100 cfm/lineal ft./slot.
5. 1/2 inch glass fiber insulated plenum/boot.

C. Return Air, Exhaust and Air Transfer Grilles and Registers
1. All aluminum construction.
2. Angled louvers spaced 1/2 inch on center.
3. One set of fixed louvers parallel to long dimension.
4. Baked white enamel finish or powder paint white finish.

D. Supply Air Registers
   1. All aluminum construction.
   2. Double deflection louvers.
   3. Front and rear louvers individually adjustable, horizontal to the front.
   4. Baked white enamel finish or powder paint white finish.

E. Supply Air Diffuser
   1. All 18 gauge steel diffuser.
   2. Solid face panel with curved back pan designed for VAV usage.
   3. Opposed blade volume damper in unaccessible locations.
   4. Baked white enamel finish or powder paint white finish.
   5. Provide with equalizing grid.

F. Wall Linear Diffuser
   1. All aluminum construction.
   2. Fixed bar type louvers.
   3. Provide with selected factory finish.

G. Eggcrate Grille Return Air Grille or Transfer Grille
   1. 1/2 inch by 1/2 inch by 1/2 inch aluminum grid.
   2. Aluminum border if required.
   3. Provide frame for appropriate ceiling mounting.
   4. Baked white enamel finish or powder paint white finish.

H. Heavy Duty Wall Return Air Grille (for use in gymnasiums and locker rooms)
   1. Heavy gauge steel construction.
   2. Angled louvers spaced 1/2 inch on center.
   3. Baked aluminum enamel or powder paint aluminum finish.

I. Displacement Type Air Devices
   1. Heavy duty galvanized steel construction
   2. Powder coated finish
   3. Rubber lip seal

1.5 INSTALLATION

A. Provide the number and type of air devices as required.

END OF SECTION

SECTION 233716

FABRIC AIR DISTRIBUTION DEVICES

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for fabric ductwork/air distribution devices and its suspension.

1.2 SUBMITTALS

A. The fabric duct manufacturer shall study the floor plans and application and the design data noted on the floor plans, and shall provide engineered to scale drawings showing the supports layout, duct runs, orifice layout and performance data, including throws.

B. Manufacturer shall have documented design support information including duct sizing, vent and orifice location, vent and orifice sizing, length and suspension. Parameters for design, including maximum air temperature, velocity, pressure and fabric permeability, shall be considered and documented in the shop drawing submittal.

1.3 QUALITY ASSURANCE

A. Fabric ducts shall be classified by Underwriter's Laboratories in accordance with the 25/50 flame spread / smoke developed requirements of NFPA 90-A. All sections must be labeled with the logo and classification marking of Underwriter's Laboratories.

B. Fabric ducts shall be treated with an EPA registered antimicrobial agent.

C. Manufacturer shall provide a 10-year warranty for products supplied for the fabric portion of this system.

D. Installation shall be in strict accordance with the manufacturer's instructions.

1.4 CONSTRUCTION

A. Fabric ducts shall be constructed of woven fire retardant fabric complying with the following physical characteristics:
   1. Fabric Construction: 100% Flame Retardant and treated with a machine wash-able anti-microbial agent from the manufacturer.
   2. Weight: 6.75 oz./yd^2 per ASTM D3776
   3. Air Permeability: 2 (+2/-1)cfm/ft^2 per ASTM D737, Frazier
   4. Temperature Range: 0 degrees F to 180 degrees F
   5. Fire Retardancy: Classified by Underwriters Laboratories in accordance with the flame spread/smoke developed requirements of NFPA 90-A and ICC AC167.
   6. Antimicrobial agent shall be proven 99% effective after 10 laundry cycles per AATCC Test Method 100.

1.5 SYSTEMS FABRICATION REQUIREMENTS

A. Air dispersion accomplished by linear vent and permeable fabric, linear vent to consist of many 3/16" diameter open orifices rather than a mesh style vent to reduce maintenance requirements of mesh style vents.

B. Size of and location of linear vents to be specified and approved by manufacturer.

C. Inlet connection to metal duct via fabric draw band with anchor patches as supplied by manufacturer. Anchor patches to be secured to metal duct via. zip screw fastener – supplied by contractor.

D. Inlet connection includes zipper for easy removal / maintenance.

E. Lengths to include required zippers as specified by manufacturer.

F. System to include Adjustable Flow Devices to balance turbulence, airflow and distribution as needed. Flow restriction device shall include ability to adjust the airflow resistance from 0.06 – 0.60 in w.g. static pressure.

G. End cap includes zipper for easy maintenance.

H. Fabric system shall include connectors to accommodate suspension system listed below.

I. Any deviation from a straight run shall be made using a gored elbow or an efficiency tee. Normal 90 degree elbows are 5 gores and the radius of the elbow is 1.5 times the diameter of the Fabric ductwork.

1.6 DESIGN PARAMETERS

A. Fabric diffusers shall be designed from 0.25" water gage minimum to 3.0" maximum.

B. Fabric air diffusers shall be limited to design temperatures between 0 degrees F. and 180 degrees F.

C. Design CFM, static pressure and diffuser length shall be designed or approved by the manufacturer, in accordance with the plans and specs.

1.7 SUSPENSION HARDWARE

A. Tension Cable: System shall be installed using a tension cable system including double strands (2 Row) of heavy weight stainless steel cable located 3" above the 10 and 2 o'clock locations of the Fabric ductwork system. Hardware to include cable, eye bolts, cable clamps and turnbuckle(s) as required. System attachment shall be made using nylon snap clips spaced 24 inches.

B. Suspended H-Track: System shall include double (2 Row) runs of aluminum H-Track system located 1.5" above the 10 and 2 o'clock (2 Row) locations of Fabric ductwork system. Hardware to include 10' sections of track, splice connectors, track endcaps and vertical cable support kits – consisting of a length of cable with a locking stud end and quick cable connectors. Radius aluminum track must be included for all radius sections. Fabric / Track attachment shall be either a continuous supporting cord or snap tabs, a detachable sliding tab positioned every 24" along the length of the system.

C. Surface mount ("D" shape): System shall include aluminum Flush-Mount system located flush with the top of the fabric duct system. Width between mounting points shall be 2" wider than the specified diameter of the D-Shape fabric ductwork. Hardware to include 12' sections of track, splice connections and end caps as required. System attachment shall be made by cord sewn into top side flaps of fabric ductwork system supported entire length.

1.8 DELIVERY, STORAGE AND HANDLING

A. Protect fabric air dispersion systems from damage during shipping, storage and handling.

B. Where possible, store products inside and protect form weather. Where necessary to store outside, store above grade and enclose with a vented waterproof wrapping.

1.9 CLEANING AND PROTECTION

A. Clean air handling unit and ductwork prior to the fabric ductwork system unit-by-unit as it is installed. Clean external surfaces of foreign substances that may cause corrosive deterioration of facing.

B. Temporary Closure: At ends of ducts not connected to equipment or distribution devices at time of ductwork installation, cover with polyethylene film or other covering that will keep the system clean until installation is completed.

C. If fabric ductwork systems become soiled during installation, they should be removed and cleaned following the manufacturers standard terms of laundry.

END OF SECTION

SECTION 233718

UNDERFLOOR AIR DISTRIBUTION SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The Contractor shall furnish and install a complete access floor air terminal system as shown on the drawings. All wiring, controls and other accessories required for a complete system shall be included. Contractor shall provide submittals, samples, and operation and maintenance documentation. Specific equipment includes: (List each type of terminal required on the project.)

1. Variable Volume Units
2. Variable Volume Units with Duct Collar
3. Perimeter Zone or Conference Room Heating/Cooling Units
4. Fan-Powered Underfloor Hydronic Heating Units
5. Power and Control Module for up to four (4) VAV units.
6. Power and Control Module for up to fourteen (14) VAV units
7. 25' Plug and Play Cable Set for Connection of VAV Actuators, power and control module, fan powered heating units, and/or cooling zones
8. 50' Plug and Play Cable Set for Connection of Controller to Thermostat
9. 25' Plug and Play Cable Set for Extension of Plug and Play Cable Sets
10. 25' Plug and Play Cable Set for Connection of Auxiliary Sensor to heating zones
11. PAP-E 5' Plug and Play Cable Set for Connection of fan powered heating units and heating zones
12. PAP-F 10' Plug and Play Cable Set for Connection of Controller to Thermostat

1.02 RELATED WORK NOT INCLUDED

A. The floor holes required for installation of floor air terminals shall be coordinated with the Access Floor Contractor. All floor openings shall be prepared by the Access Floor Contractor, as shown on the floor plan drawings. Required plenum barriers, sealing of plenum, structural supports, carpet cutouts and any other floor related appurtenances shall be prepared by the Access Floor Contractor as shown on the drawings.

B. All electrical power needed for terminal operation shall be coordinated with the Electrical Contractor. The electrical power shall be furnished by the Electrical Contractor and installed as shown on the drawings.

C. Control interfaces and/or integration with the Building Automation System (BAS) or other control system shall be furnished by the Controls Contractor.

1.03 QUALITY ASSURANCE

A. All equipment and components shall be suitable for use in an environmental air plenum.

B. All components within the air stream including under-floor terminals shall conform to the NFPA 90A Standard for Flame/Smoke/Fire contribution of 25/50/0.

C. All units shall be the product of a manufacturer regularly engaged in the production of terminal units and all supplied units shall be from the same manufacturer.

D. Units shall be specifically designed for an access floor installation and complete with all necessary controls and wiring as required to provide operation according to manufacturer's recommendations.

E. Terminal operation shall be coordinated with air handling system and control system to assure complete compatibility.

F. Equipment shall be listed under and conform to appropriate sections of U.L., CSA, E.T.L. and other testing laboratory requirements.

1.04 SUBMITTALS

A. Submit dimensioned drawings, performance and product data for approval. Include listing of discharge and radiated sound power level for each of second through sixth octave for fan-powered terminals. Data shall include all wiring diagrams, control sequences and power requirements as applicable to the product and coordination with other systems.

1.05 OPERATION AND MAINTENANCE DATA

A. Quantity: 3

B. Content:
1. Maintenance and Service Contracts: Provide a list, with each product, name, address and telephone number of:
   a. Subcontractor or installer.
   b. Maintenance contractor, as appropriate. Identify area of responsibility of each.
   c. Local source of supply for parts and replacement.
2. Table of Contents: List all products in the order in which they appear in the specifications and label accordingly.
3. Sections: All sections shall be separated with an appropriate tabbed section divider with the appropriate specification section number. Provide the manufacturer's written installation and maintenance instructions for all items required.
4. Routine Maintenance: Provide a list indicating all routine maintenance procedures based on recommended intervals.
5. Contents: Include copies of approved submittal data, installation instructions, operation and maintenance instructions and parts lists.

1.06 WARRANTY

A. The air terminal materials and workmanship shall be guaranteed to be free from defects for a period of one year after Owner acceptance.

B. Contractor and/or vendor shall maintain availability of replacement parts compatible with the terminals for no less than ten years after acceptance.

2.01 GENERAL DESCRIPTION

A. The Contractor shall furnish a pre-engineered, prefabricated, access floor air terminal system that includes all necessary components from a single source of responsibility/manufacturer. All components including any controls and wiring shall be furnished as a “plug-and-play” system of modular and interchangeable components that are factory prepared to operate as a complete system. (Because some owners may want special controls this section may need to be modified to address this issue.)

2.02 FABRICATION

A. VAV Terminal Units

1. Unit chassis shall be minimum 18-gauge galvanized steel that shall enclose and support all components. Chassis construction shall admit plenum air from only one direction to provide a method of adjusting delivery volume for floor velocity pressure.
2. Unit shall have a die cast aluminum trim ring that shall engage with the chassis and floor to provide complete support for the air grilles. Die cast aluminum ring color shall be as shown on the finish schedule or manufacturer’s standard color to be selected from submittal data. Trim ring shall be attached to chassis and floor panel by means of concealed removable screws. (A round trim ring option is available at no additional cost. Special colors are available at additional cost.)
3. Unit shall have one or more removable grilles made of die cast aluminum material that matches the trim ring in color. Grilles shall include a means for adjusting air throw and pattern and shall fit securely within the trim ring and chassis without mechanical fasteners. Grilles shall be capable of supporting a load of 1250 pounds (565 kg) without permanent damage. No openings in the grilles shall be larger than .30 inches (7.6 mm) for shoe heal penetration protection.
4. Unit shall include an integral damper and damper operator. Damper shall be made of 20-gauge galvanized steel and be sealed with felt or foam type gasket material. Damper operation shall provide a throttling of the airflow that produces a nominal constant velocity, variable volume flow from full shut-off to full open condition. The damper shall vary the active outlet area of the grilles while maintaining velocity of the supply air through the grille. Damper operator shall operate on 24VAC and use no more than 6 volt-amperes per unit. Damper motor electrical connection shall be by means of a modular connector, polarized to prevent incorrect connection. Noise produced by damper motor shall not exceed 35 dB-A at a distance of 1 meter from the unit.

B. Ducted Collar; VAV Terminal Units (These units provide control of the air flow for a ducted system.)

1. Unit chassis shall be minimum 18-gauge galvanized steel that shall enclose and support all components. Chassis construction shall admit plenum air from only one direction to provide a method of adjusting delivery volume for floor velocity pressure.

2. Unit shall have a die cast aluminum trim ring that shall engage with the chassis and floor to provide complete support for the air grilles. Die cast aluminum ring color shall be as shown on the finish schedule or manufacturer's standard color to be selected from submittal data. Trim ring shall attached to chassis and floor panel by means of concealed removable screws. (A round trim ring option is available at no additional cost. Special colors are available at additional cost.)
3. Unit shall have one or more removable grilles made of die cast aluminum material that matches the trim ring in color. Grilles shall include a means for adjusting air throw and pattern and shall fit securely within the trim ring and chassis without mechanical fasteners. Grilles shall be capable of supporting a load of 1250 pounds (565 kg) without permanent damage. No openings in the grilles shall be larger than .30 inches (7.6 mm) for shoe heal penetration protection.
4. Unit shall include an integral damper and damper operator. Damper shall be made of 20-gauge galvanized steel and be sealed with felt or foam type gasket material. Damper operation shall provide a throttling of the airflow that produces a nominal constant velocity, variable volume flow from full shut-off to full open condition. The damper shall vary the active outlet area of the grilles while maintaining velocity of the supply air through the grille. Damper operator shall operate on 24VAC and use no more than 6 volt-amperes per unit. Damper motor electrical connection shall be by means of a modular connector, polarized to prevent incorrect connection. Noise produced by damper motor shall not exceed 35 dB-A at a distance of 1 meter from the unit.
5. The chassis design shall include a removable end panel for attachment of a supply air duct using standard duct size of 6 inches (152 mm) round for a 10 inch deep unit and 5 inches (127 mm) round for a 7 inch deep unit.

C. Perimeter Zone Heating/Cooling VAV Terminal Units (These units provide control of the air flow from the plenum for cooling and from an attached duct for heating with a switchover mode of control.)

1. Unit chassis shall be minimum 18-gauge galvanized steel that shall enclose and support all components. The chassis design shall include an end panel for attachment of a supply air duct using standard duct size of 6 inches (152 mm) round for a 10 inch deep unit and 5 inches (127 mm) round for a 7 inch deep unit. Chassis construction shall admit plenum air from only one direction to provide a method of adjusting delivery volume for floor velocity pressure. Plenum air admittance openings shall be on opposite end of the chassis from the duct connection.
2. Unit shall have a die cast aluminum trim ring that shall engage with the chassis and floor to provide complete support for the air grilles. Die cast aluminum ring color shall be as shown on the finish schedule or manufacturer's standard color to be selected from submittal data. Trim ring shall be attached to chassis and floor panel by means of concealed removable screws. (A round trim ring option is available at no additional cost. Special colors are available at additional cost.)

3. Unit shall have one or more removable grilles made of die cast aluminum material that matches the trim ring in color. Grilles shall include a means for adjusting air throw and pattern and shall fit securely within the trim ring and chassis without mechanical fasteners. Grilles shall be capable of supporting a load of 1250 pounds (565 kg) without permanent damage. No openings in the grilles shall be larger than .30 inches (7.6 mm) for shoe heal penetration protection.
4. Unit shall include an integral damper and damper operator. Damper shall be made of die cast aluminum material and be sealed with felt or foam type gasket material. Damper operation shall provide a throttling of the airflow that produces a nominal constant velocity, variable volume flow from full shut-off to full open condition. The damper shall vary the active outlet area of the grilles while maintaining velocity of the supply air through the grille. Damper operator shall operate on 24VAC and use no more than 6 volt amperes per unit. Damper motor electrical connection shall be by means of a modular connector, polarized to prevent incorrect connection. Noise produced by damper motor shall not exceed 35 dB-A at a distance of 1 meter from the unit.
5. Unit damper shall be sequenced to admit heating air from duct connection and cooling air from the plenum. In switchover mode, unit shall also act as a return air grille to remove air from the space and deliver it through the duct connection to a heating terminal under the floor.

D. Fan Powered Underfloor Heating Terminal Unit – 150 CFM Nominal Size (These units are required when using terminals for perimeter heating. They include a power transformer to provide power to up to 14 VAV terminals and chaining ports for zones with up to 3 fan powered heating terminal units.)

1. Unit casing: 22-gauge minimum galvanized steel lined with 1/2 in. thick, 1-1/2 lb./ft.3 density, dual thermal/acoustical fiberglass insulation meeting NFPA 90A requirements and U.L. 181 erosion control requirements. Insulation shall be protected with continuous vapor barrier. Casing shall have a removable side or top panel suitable for equipment service. Leakage not to exceed 2% of design flow at 2.0" w.g. Enclosure to have Plug and Play connectors for attachment of thermostat inputs, thermostat outputs, and outputs to VAV terminals in the zone.
2. Fan assembly: Direct drive centrifugal with forward curved blades, internally suspended on rubber isolators. Motor to be permanent split capacitor with thermal overload protection and toggle disconnect.
3. Return air filter frame and 1" throw-away filter.
4. Discharge and radiated sound power levels shall not exceed those shown on the schedule.
5. Hydronic Heating Coil
   a. Heating coil shall be integral with the terminal unit, with coils having one row, same end connections. Tube-to-header joints shall be expanded and reinforced with brass bushing for pressure-tight joint. Maximum working ratings shall be 200 PSIG, 325°F. Plate-type aluminum fins with full fin collars for maximum fin-tube contact and accurate spacing, mechanically bonded to tubes for permanent fin-tube bond.
   b. Galvanized steel casing with flanged or drive and slip connection.

6. Control transformers rated for specified line voltage input and 24VAC output at 40VA for thermostat operation and 100 VA for VAV operation (adequate power for up to 14 VAV units in zone.)

E. Power and Control Module
1. 120 Volt, single-phase power input.
2. Integral Transformer, 24VAC, 40 volt-ampere output rating.
3. One modular output plug and play connector compatible with MIT Plug and Play wiring system.
4. Modular input connector for thermostat connection using Plug and Play wiring system.
5. Steel housing, minimum 24-gauge with knockouts.

F. Power and Control Module
1. 120 or 277 Volt, single-phase power input.
2. Integral Transformer, 24VAC, 90 volt-ampere rated output with 3-amp switching module.
3. Two modular output plug and play connectors compatible with Plug and Play wiring system.
4. One modular input connector for thermostat connection using Plug and Play wiring system (One is used for daisy-chaining zones larger than 14 terminals).
5. One modular output connector for daisy-chaining units (up to 3 total) using a single controller for use in zones larger than 14 boxes.
6. Steel housing, minimum 24-gauge with knockouts.

G. Plug and Play Cable Set for VAV connection
1. Plenum rated, 4 conductor, 16-gauge, 25 feet (8 m) long, with Plug and Play wiring connectors attached on each end.
2. Factory tested for continuity, shorts, opens and proper impedance.

H. Plug and Play Cable Set for Thermostat Connection
1. Plenum rated, 4 conductor, 16-gauge, 50 feet (16 m) long, with Plug and Play wiring connector attached on one end and pig tail on the other.
2. Factory tested for continuity, shorts, opens and proper impedance.

I. Plug and Play Extension Cable Set
1. Plenum rated, 4 conductor, 16-gauge, 25 feet (8 m) long, with male Plug and Play wiring connector attached on one end and female connection on the other end.
2. Factory tested for continuity, shorts, opens and proper impedance.

J. Plug and Play Cable Set for connection to auxiliary input sensor
1. Plenum rated, 2 conductor, 18-gauge, 25 feet (8 m) long, with Plug and Play wiring connector attached on one end and pig tail on the other.
2. Factory tested for continuity, shorts, opens and proper impedance.

K. Plug and Play Cable Set for connection to fan powered terminals
1. Plenum rated, 4 conductor, 16-gauge, 5 feet (2 m) long, with Plug and Play wiring connectors attached on each end.
2. Factory tested for continuity, shorts, opens and proper impedance.

L. Plug and Play Cable Set for Thermostat connection
   1. Plenum rated, 4 conductor, 16-gauge, 10 feet (2 m) long, with Plug and Play wiring connector attached on one end and pig tail on the other.
   2. Factory tested for continuity, shorts, opens and proper impedance.

M. Space Thermostat and DDC Controller (Required when using LON bus for local and remote setpoint adjustment and monitoring of a cooling only zone or cooling/heating zone with fan powered heating unit, 1 or 2 stage electric, or 2 position hot-water heat.)
   1. Plastic enclosure, UL 94-5V rated, suitable for wall mounting with control setpoint consisting of an adjustable setpoint knob. Size of enclosure shall be suitable for mounting on a single/double gang electrical box in either the horizontal orientation. Provide terminal block connection to wiring. Thermostat enclosure shall consist of a base and separate enclosure to permit attachment of wiring independently of the electronics.
   2. Device shall provide proportional-integral, PI, control and use an NTC thermistor with low drift and have compatible output/input with controller. Setpoint knob shall have optional range stops with maximum range of 55 to 90 degrees F. (12.8 to 32.2 C).
   3. Unit shall comply with FCC Part 15, NEC Class B, and be listed by UL.
   4. Device shall include an interface and jack for connection of LON bus.

N. Space Thermostat and DDC Controller (Required when using bus for local and remote setpoint adjustment and monitoring of a cooling only zone or cooling/heating zone with modulating heat.)
   1. Plastic enclosure, UL 94-5V rated, suitable for wall mounting with control setpoint consisting of an adjustable setpoint knob. Size of enclosure shall be suitable for mounting on a single/double gang electrical box in either the horizontal orientation. Provide terminal block connection to wiring. Thermostat enclosure shall consist of a base and separate enclosure to permit attachment of wiring independently of the electronics.
   2. Device shall provide proportional-integral, PI, control and use an NTC thermistor with low drift and have compatible output/input with VAV controller. Setpoint knob shall have optional range stops with maximum range of 55 to 90 degrees F. (12.8 to 32.2 C).
   3. Unit shall comply with FCC Part 15, NEC Class B, and be listed by UL.
   4. Device shall include an interface and jack for connection of LON bus.

3.01 INSTALLATION

A. Provide the number and type of components as required for complete and functional system.

END OF SECTION

SECTION 233800

KITCHEN HOOD VENTILATION SYSTEM

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for kitchen canopy hood exhaust and make-up air system complete with fans, heating equipment, roof curbs, ductwork, controls, fire suppression system, and related accessories.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting capacity, materials, controls, dimensions, and accessories and detailed ductwork and fire suppression layouts specific to each system.

1.3 QUALITY ASSURANCE

A. Canopies shall be labeled and listed in accordance with UL 710.
   1. Listing shall be for installation without exhaust dampers.

B. Fabrication shall be in accordance with NFPA 96.

C. Assembly shall bear the National Sanitation Foundation (NSF) Seal of Approval.

D. Fan performance rating shall comply with AMCA 210.

E. Fan systems shall be UL listed and labeled for transfer of grease laddened vapors.

F. Canopies shall comply with the requirements approved by BOCA, SBCC, and ICBO.

G. Gas-fired system shall comply with AGA requirements.

H. Rooftop, gas-fired make-up air handling units shall have the ETL label.

I. Balance of air systems shall be by an independent air balancing firm certified as NEBB or AABC.

J. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

K. Kitchen hood systems shall meet the requirements of ASHRAE Standard 90.1.

1.4 CANOPY

A. Canopy interior and exterior exposed surfaces shall be constructed of 18 gauge, type 304 stainless steel.

B. Integral duct collars for exhaust without fire dampers.

C. Liquid tight external welds at all joints and seams.

D. Filter housing shall be constructed of 304 stainless steel complete with UL Classified aluminum baffle-type grease filters.

E. [Incandescent] [fluorescent] vaporproof lights in quantity to provide a minimum of 50 footcandles on the lowest cooking surface.

F. Insulated supply air plenum with minimum 1 inch, 3 pounds per cubic foot material.

G. Integral supply air duct collar with 18 gauge steel fire damper having fusible link operation.

1.5 EXHAUST FAN

A. Upblast type arrangement and UL listed for operation in grease removal having built-in grease trough and isolated motor compartment.

B. Bird screens ***and dampers*** are not permitted.

C. Fan discharge shall be minimum 40 inches above roof surface.

D. Unit shall include a hinged base for access to duct and blower.

1.6 NO-HEAT SUPPLY AIR FAN

A. Fan shall be a forward-curved, double-width, belt-driven, double-inlet blower, roof-mounted in a downblast configuration, statically and dynamically balanced.

B. Fan motor shall include permanently lubricated ball bearings

C. Housing shall be constructed of heavy gauge, galvanized steel, primed and painted with removable top for service access.

D. Unit shall be provided with a minimum 12 inch high roof curb.

E. Filters shall be 1 inch thick aluminum mesh and UL Classified.

1.7 HEATED MAKE-UP AIR SYSTEM

A. Roof-mount makeup air system shall be factory assembled and tested.

B. Fan and motor assembly shall be mounted on vibration isolators.

C. Motors shall be permanently lubricated, heavy-duty, ball bearing-type.

D. Fan wheels shall be forward-curved, double-width, double-inlet type, statically and dynamically balanced.

E. Housing shall be constructed of heavy gauge, galvanized steel, primed and painted with removable panels for service access.

F. A pre-wired control center shall include master disconnect switch, fuse blocks, magnetic motors starters, control circuit transformer, distribution terminal control strip, all UL Listed.

G. Direct-fired gas heater section
1. Burner shall be constructed of stainless steel having a gas valve control with capillary type sensor, main and pilot gas valves and pressure regulators, main and pilot shut off valves, airflow switch, high limit control, flame safeguard control, flame rod and electronic ignition pilot.
2. Turndown range of 20 to 1.
3. Piping and controls housed within the galvanized housing of the make-up air unit.

H. Electric heater section
1. Heater terminal box and frame shall be constructed of heavy-gauge galvanized steel.
2. Heating elements shall be supported using ceramic insulators.
3. Heating element shall be a UL Listed open coil type electric heater.
4. Provide with a disc type automatic high limit switch and closed disc type manual reset switch.
5. Unit shall include modulating step controller, airflow switch, circuit fusing, and door interlocking disconnect switch.
6. Heater and controls housed within the galvanized housing of the make-up air unit.

1.8 FIELD FABRICATED DUCTWORK AND ACCESSORIES

A. Exhaust ductwork shall be constructed of 16 gauge carbon steel, welded liquid tight.

B. Supply ductwork shall be constructed of 18 gauge galvanized steel and installed with external duct insulation and vapor barrier.

C. Cleanouts are required in changes of direction of exhaust ductwork.

1.9 ELECTRICAL

A. Motor control panel enclosing motor contactors, overload relays, interface terminals for fire protection system and remote switch panel shall be located in the kitchen storage room.

B. Remote switch panel shall be mounted on face of kitchen canopy and shall include the following:
   1. Lights on-off switch
   2. Exhaust/supply fan systems on-off switch with pilot light
   3. [Temperature setting for heating make-up air system]

1.10 FIRE PROTECTION SYSTEM

A. Fire protection system shall be a wet chemical system and shall be installed to be in compliance with UL.

B. System to be activated by fusible links connected to an automan release.

C. Automan release shall trip 2 electric, double-pole, double-throw micro switches.

D. Piping shall be concealed wherever possible. Exposed piping, fittings, and nozzles shall be constructed of stainless steel with chrome plated elbows.

E. Supply fan shall shut down upon activation of fire suppression system. Exhaust fan shall remain running.

F. Provide automatic, non-electric; or manual reset, electric, gas appliance shut off valves.

G. Provide remote manual fire pull device.

H. Provide storage tank and mounting hardware.

1.11 INSTALLATION

A. Install in accordance with manufacturers requirements.

B. Manufacturer’s service representative shall provide compete check, test, and start-up on the system.

C. Locate the manual pull station a minimum of 10'-0" from the kitchen canopy in the path of egress from the cooking area.

END OF SECTION

SECTION 234323

AIR CLEANING SYSTEM

Spec Writer Note: If the project is to be LEED Certified, the IAQ procedure is not permitted in LEED Prereq. EQp1.

GENERAL GUIDELINES

1.1 DESCRIPTION OF WORK

A. Qualitative requirements for the design, performance and installation of an air purification system intended for use as part of the air handling units. For the purpose of compliance with the ventilation code using the indoor air quality procedure.

1.2 RELATED WORK PERTAINING TO OTHER SPECIFICATIONS

A. Testing, balancing and inspection services

B. Duct work

C. Electrical Wiring

D. Control Wiring

1.3 SUBMITTALS: The following information shall be submitted to the design professional prior to the release of any equipment for fabrication.

A. Product performance data for filters, gauges and housings.

B. Product drawings detailing all physical, electrical, duct work and control requirements.

C. Manufacturer's Follow-up Service Program.

1.4 REFERENCE CODES AND STANDARDS

A. ASHRAE Standards 62 & 52

B. UL Standard 867

C. CFR 39-75 Title 21 April 17, 1974

D. National Electric Code NFPA 70, 1990

1.5 QUALITY ASSURANCE

A. The Air Purification System shall be a product of an established manufacturer with installations in successful operation for a minimum of 10 years.

B. A qualified representative from the manufacturer shall be available to inspect the installation of the air purification system to ensure installation in accordance with manufacturer's recommendation.

C. The complete Air Purification System complete with power and control wiring, safety switches, airflow switches, controls, housing and filters shall be listed by either UL or ETL.

D. Provide Indoor Air Quality calculations using the formulas within ASHRAE Standard 62-01 to validate acceptable indoor air quality at the quantity of outside air scheduled.

1.6 DESIGN AND PERFORMANCE CRITERIA: The operation of the air purification system shall be through a combination of Catalytic, and Association / Disassociation processes.

A. Each air handling unit shall contain an Air Purification System capable of:
   1. Effectively controlling microorganisms (mold, bacteria, etc.).
   2. Controlling gas phase contaminants generated from food, human occupants and the school building.
   3. High efficiency particulate filtration.

B. The Air Purification System shall operate in such a manner so that agglomeration or precipitation of airborne particulate shall not be permitted to collect on occupants, walls, floor or furnishings by virtue of its operation.

C. Air Exchange Rate: Air exchange rates may vary through the full operating range of a VAV system. The quantity of air exchange shall not be increased due to requirements of the air purification system.

D. Velocity Profile: The air velocity through the plenum approaching the air purification system shall not exceed 1,000 fpm (5 m/s).

E. Humidity: Electrodes or gas phase filters shall not require preheat protection when the relative humidity of the entering air exceeds 85%. Relative humidity from 0 - 99% shall not cause damage, deterioration or dangerous conditions within the air purification system.

F. Ozone Generation: The operation of the electrodes unit shall conform to ASHRAE Standard 62-01 and CFR 39-75 with respect to ozone generation.

1.7 EQUIPMENT REQUIREMENTS

A. A schematic representation of the air purification system is indicated on the drawings. Each unit shall include mounting rack, electrodes, generator, safety switches, prefilters, primary filters, differential pressure gauge and accessories.

B. Electrode: Each unit shall include the required number of electrodes and power generators sized to the air handling unit capacity. Electrical power to the electrodes shall be interrupted when the airflow is less than 100 fpm or when access doors to the electrode plenum section are opened.

C. Plenum Specifications: Housings shall be of (horizontal / vertical) design with (single / double) wall construction. Refer to air handling unit specification for construction details.

D. Filter Gages: Differential pressure gages shall be provided to indicate filter status.

1.8 FILTRATION REQUIREMENTS

A. Provide particulate and gas phase filtration equipment in order to achieve the performance detailed within the IAQ Model described in paragraph 1.5 D. Performance of fibrous filters shall conform to ASHRAE Standard 52.2 unless specified otherwise. Provide a fully assembled and tested system from a single manufacturer.

1.9 ELECTRICAL REQUIREMENTS

A. Wiring, conduit and junction boxes shall be installed within housing plenums in accordance with NEC NFPA 70. Electrical service shall be 115/208/230 volts, 1 phase, 50/60 Hz. In the event line voltage varies 10% or greater from nominal or when electrical spikes or transients are present power conditioning shall be provided.

1.10 ASSEMBLY AND ERECTION

A. Assemble mounting racks within the air handling unit in accordance with manufacturer's recommendations and instructions.

B. The air purification system manufacturer shall complete all interconnecting control and power wiring. The electrical contractor shall complete single point power connections.

C. All equipment shall be assembled and installed in a workman like manner to the satisfaction of the owner, architect, and consulting engineer.

D. Any material damaged by water or moisture shall be replaced at no cost to the owner.

E. All equipment shall be protected from dust and damage on a daily basis throughout construction.

F. Clean all components prior to commissioning.

1.11 TESTING

A. Provide the manufacturer's recommended electrical and static pressure tests.

1.12 COMMISSIONING & TRAINING

A. A manufacturer's authorized representative shall provide start-up supervision and training of owner's personnel in the proper operation and maintenance of all equipment.

B. Service

1. A manufacturer's authorized service representative shall provide service support to insure satisfactory air purification system operation. The service program shall include at minimum, regular site visits, inspection of the air purification system and air handling unit, monitoring and validation, inspection of protected areas and the submission of a written report to the owner.
   a. Submit the Manufacturer’s Service Program with the shop drawing submittal.
2. Provide one (1) year Factory Follow-up Service including repairs to the gas phase equipment, replacement of electrodes or removal of disposable modules, installation of new modules with fresh media, administration of hauling and disposal of spent media modules through the owner’s normal channel of disposal and hauling.

3. Validate performance of the Air Purification System through accepted test procedures and independent testing.
4. Particulate filters are not covered by this service agreement and remain the responsibility of the Owner.

1.13 WARRANTY

A. The equipment shall be warranted against defects in material and workmanship for a period of 12 months from commissioning and acceptance.

END OF SECTION

SECTION 235100

BREECHING, CHIMNEYS, AND STACKS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for venting for fuel burning equipment.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, and dimensions. Detailed shop drawings denoting layouts, specific to project for each vent is required.

1.3 QUALITY ASSURANCE

A. Products and installation shall be in accordance with NFPA 211 and UL Listed.

B. Each vent section/fitting shall be labeled for UL compliance.

C. Installation shall be in conformance with OBC.

1.4 COMPONENTS

A. Type B Gas Vents
1. Round double-wall, with aluminized steel inner pipe and galvanized-steel outer pipe. Use for negative pressure venting systems

B. Steel, Positive-Pressure, Double-Wall Vents
1. Construction: Inner and outer shells separated by at least 1-inch air space, with positive sealing joints. The inner piping shall be stainless steel. The outer piping shall be aluminized steel construction. Use for all positive pressure systems including forced draft boilers and water heaters.

C. Rain cap shall be of galvanized steel construction and attached firmly to stack top.

D. Roof penetrations shall include an insulating thimble complete with proper flashing.

E. Cleanouts shall be provided at all changes in direction.

1.5 INSTALLATION

A. Provide independent or combined flues for each piece of gas burning equipment directly to the outside of the building.

B. Each flue shall be support from the building structure, not from or on the equipment.

END OF SECTION

SECTION 235213

ELECTRIC BOILERS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for electric resistance boilers.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, capacity, accessories, and dimensions.

1.3 QUALITY ASSURANCE

A. Unit shall be constructed in accordance with ASME Boiler and Pressure Vessel Code Section VIII.

B. UL Listed.

C. Constructed in accordance to the National Electric Code.

D. Controls wired in accordance to ANSI/UL 834.

E. Boiler shall have a minimum thermal efficiency of 95 percent.

1.4 COMPONENTS

A. Pressure vessel: Constructed of carbon steel with ASME stamp.

B. Pressure Rating: 60 psig, water.

C. Heavy-steel mounting base frame.

D. Removable access panels and doors for inspection and cleaning.

E. Insulation and jacket.

F. Hot-Water Boiler Trim:
1. Safety-Relief Valves: ASME rated.
2. Water Connections: Internal thermal circulation to mix return water with boiler water.
3. Dip tube.
4. Low-water cutoff.
5. Pressure and temperature gauges.
6. Temperature controls.
7. Boiler high-pressure-limit controller.

G. Heating Elements:
   1. Replaceable sheathed heating elements.
   2. Minimum 75 watts/sq. in. heat transfer.
   3. Wire with UL Listed conductors.

H. Power Panel:
   1. NEMA 1 enclosure with hinged door and key-locking handle.
   2. Mechanical lugs bolted to copper bus bars.
   3. NEMA Class J or K5 dual-element fuses.
   4. 3-pole magnetic contactors.
   5. Fused disconnect switch.

1.5 INSTALLATION

A. Install boilers and accessories in accordance with manufacturers requirements.

B. Startup shall be by a factory trained technician.

C. Set boilers on four inches thick reinforced concrete pad.

D. Boil out all boilers per the manufacturer's recommendations before using the boilers to heat the building in a temporary or permanent basis. The water shall be tested by the chemical treatment subcontractor for acceptability. The heating water system shall have the proper water treatment chemicals installed immediately after the system has been flushed, boiled-out and refilled and before the system is used for temporary or permanent heating of the building.

END OF SECTION

SECTION 235216

FLUE GAS CONDENSING BOILERS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for flue gas condensing boilers.

B. Qualitative requirements for gas fired, oil fired, or combination gas/oil burners.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, capacities, accessories, and dimensions.

1.3 QUALITY ASSURANCE

A. Gas trains shall comply with requirements of CSD-1.

B. Boilers shall be National Board listed.

C. Boiler shall have a minimum thermal efficiency of 88 percent at 120 degree Fahrenheit return water temperature.

D. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

E. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

1.4 COMPONENTS

A. Heat Exchangers:
   1. Fire tube design that is self-supporting, baffle-free, and warranted to withstand thermal shock.
   2. Copper finned tube design, gasket-free, and warranted to withstand thermal shock.

B. Pressure Rating: 160 psig, water.

C. Exhaust manifold shall include condensate drain.

D. Exhaust manifold shall be corrosion-resistant porcelain enameled cast iron or other corrosion resistant material.

E. Exhaust gas vent.

F. Insulation and jacket.

G. Hot Water Boiler Trim:
1. Safety-Relief Valves: ASME rated.
2. Low-water cutoff.
3. Pressure and temperature gauges.
4. Temperature controls.
5. Boiler high-pressure-limit controller.

H. Gas Burners: Power burner forced draft design.
1. Fuel: [Natural gas] [Propane gas].
2. Gas-pressure regulator.
3. Gas valves.
4. Manual shutoff.
5. Thermistor flame-sensing device.
6. Automatic 100 percent safety gas shutoff.
7. Burner Firing: Modulating.
8. Burner Ignition: Standing pilot or spark ignition.
9. Safety controls.
10. Flue-Gas Collector: Integral with boiler casing.
11. Gas Piping Train: Factory Mutual approved.

I. Factory-mounted control panel.
1. Dry contacts for DDC signal.
2. Alarm contacts for flame failure, low water cutoff, low temperature and high temperature alarms.

J. Motors: NEMA MG 1, general purpose, continuous duty, Design B, open-drip-proof type.

1.5 INSTALLATION

A. Set boilers on minimum 3-1/2 inch thick reinforced concrete pad.

B. Provide dual wall independent flues for each boiler.

C. Pipe all gas pressure regulator vents to the outside of the building

D. Boil out all boilers per the manufacturer's recommendations before using the boilers to heat the building in a temporary or permanent basis. The water shall be tested by the chemical treatment subcontractor for acceptability. The heating water system shall have the proper water treatment chemicals installed immediately after the system has been flushed, boiled-out and refilled and before the system is used for temporary or permanent heating of the building.

E. Combustion air shall be directly connected or the boiler controls shall be interlocked with the combustion air system to operate the combustion air make-up system when the boiler is firing. The boiler shall not operate without the combustion make-up air system operating.

END OF SECTION

SECTION 235223

CAST IRON BOILERS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for cast iron boilers.

B. Qualitative requirements for gas fired, oil fired, or combination gas/oil burners, power or atmospheric.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, capacity, accessories, and dimensions.

1.3 QUALITY ASSURANCE

A. Unit shall be constructed in accordance with the ASME Boiler and Pressure Vessel Code Section IV and shall be National Board listed.

B. Gas trains shall comply with requirements of CSD-1.

C. Boilers shall be UL 795 Listed.

D. Boiler shall have a minimum thermal efficiency of 80 percent.

E. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

F. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

1.4 COMPONENTS

A. Heat Exchangers: Cast iron sectional bolted together.
B. Pressure Rating: 60 psig, water.
C. Heavy-steel mounting base frame.
D. Removable access panels and doors for inspection and cleaning.
E. Observation ports.
F. Exhaust gas vent.
G. Insulation and jacket.
H. Hot Water Boiler Trim:
   1. Safety-Relief Valves: ASME rated.
   2. Dip tube.
   3. Low-water cutoff and auxiliary low-water cutoff.
   4. Pressure and temperature gauges.
   5. Temperature controls.
   6. Boiler high-pressure-limit controller.

I. Gas Burners: Power burner, forced draft design.
   1. Fuel: [Natural gas] [Propane gas].
   2. Gas-pressure regulator.
   3. Gas valves.
   4. Manual shutoff.
   5. Thermistor flame-sensing device.
   6. Automatic 100 percent safety gas shutoff.
   7. Burner Firing: Modulating.
   8. Burner Ignition: Standing pilot
   9. Safety controls.
   10. Flue-Gas Collector and Draft Hood: Integral with boiler casing.
   11. Gas Piping Train: Factory Mutual approved.

J. Oil Burners: Pressure-atomizing type.
   1. Fuel: No. 2 fuel oil.
   2. Operation and combustion-air controls.
   3. Oil pump.
   4. Oil-piping train.

K. Combination Gas/Oil Burners: Power burner, forced draft design with pressure-atomizing burner.
   1. Fuel: [Natural gas] [Propane gas] and No. 2 fuel oil.
   2. Burner operation and combustion-air controls.
   3. Gas pilot.
   4. Gas piping train.
   5. Oil pump.
   6. Oil-piping train.

L. Gas Burners: Atmospheric Design
   1. Tubular alloy steel burners with natural draft.
   2. Electronic pilot and burner ignition.
   3. Gas pressure regulator.
   4. Gas valves.
   5. Manual shutoffs
   6. Automatic 100 percent safety gas shutoff.
   7. Safety controls.
   8. Flue-gas collector and draft hood.
   9. Factory Mutual approved gas train.

M. Factory-mounted control panel.
   1. Dry contacts for DDC signal.
   2. Alarm contacts for low water cutoff, low temperature and high temperature alarms.

N. Motors: NEMA MG 1, general purpose, continuous duty, Design B, open-drip-proof type.

1.5 INSTALLATION

A. Set boilers on minimum 3-1/2 inch thick reinforced concrete pad.

B. Provide dual wall independent flues for each boiler.

C. Pipe all gas pressure regulator vents to the outside of the building

D. Boil out all boilers per the manufacturer's recommendations before using the boilers to heat the building in a temporary or permanent basis. The water shall be tested by the chemical treatment subcontractor for acceptability. The heating water system shall have the proper water treatment chemicals installed immediately after the system has been flushed, boiled-out and refilled and before the system is used for temporary or permanent heating of the building.

E. The boiler controls shall be interlocked with the combustion air system to operate the combustion air make-up system when the boiler is firing. The boiler shall not operate without the combustion make-up air system operating.

END OF SECTION

SECTION 235225

STEEL FIREBOX BOILERS

GENERAL

1.01 SECTION INCLUDES

A. Qualitative requirements for steel firebox boilers.

B. Qualitative requirements for gas fired, oil fired, or combination gas/oil burners.

1.02 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, capacities, accessories, and dimensions.

1.03 QUALITY ASSURANCE

A. Gas trains shall comply with requirements of CSD-1.

B. Units shall be constructed in accordance with the ASME Pressure Vessel Code Section IV and shall be National Board listed.

C. Boiler shall have a minimum thermal efficiency of 80 percent.

D. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

E. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

2.01 COMPONENTS

A. Heat Exchangers: 3 pass fire tube wet-back design with large fire box. 5 square feet of heating surface per boiler horsepower.

B. Pressure Rating: 60 psig, water.

C. Heavy-steel mounting base frame.

D. Removable access panels and doors for inspection and cleaning.

E. Observation ports.

F. Exhaust gas vent.

G. Insulation and jacket.

H. Hot Water Boiler Trim:
   1. Safety-Relief Valves: ASME rated.
   2. Water Connections: Internal thermal circulation to mix return water with boiler water.
   3. Dip tube.
   4. Low-water cutoff.
   5. Pressure and temperature gauges.
   6. Temperature controls.
   7. Boiler high-pressure-limit controller.

I. Gas Burners: Power burner forced draft design.
   1. Fuel: [Natural gas] [Propane gas].
   2. Gas-pressure regulator.
   3. Gas valves.
   4. Manual shutoff.
   5. Thermistor flame-sensing device.
   6. Automatic 100 percent safety gas shutoff.
   7. Burner Firing: Modulating.
   8. Burner Ignition: Standing pilot
   9. Safety controls.
   10. Flue-Gas Collector: Integral with boiler casing.
   11. Gas Piping Train: Factory Mutual approved.

J. Oil Burners: Pressure-atomizing type.
   1. Fuel: No. 2 fuel oil.
   2. Operation and combustion-air controls.
   3. Oil pump.
   4. Oil-piping train.

K. Combination Gas/Oil Burners: Pressure-atomizing type.
   1. Fuel: [Natural gas] [Propane gas] and No. 2 fuel oil.
   2. Burner operation and combustion-air controls.
   3. Gas pilot.
   4. Gas piping train.
   5. Oil pump.
   6. Oil-piping train.

L. Factory-mounted control panel.
   1. Dry contacts for DDC signal.
   2. Alarm contacts for low water cutoff, low temperature and high temperature alarms.

M. Motors: NEMA MG 1, general purpose, continuous duty, Design B, open-drip-proof type.

3.01 INSTALLATION

A. Set boilers on minimum 3-1/2 inch thick reinforced concrete pad.

B. Provide dual wall independent flues for each boiler.

C. Pipe all gas pressure regulator vents to the outside of the building

D. Boil out all boilers per the manufacturer's recommendations before using the boilers to heat the building in a temporary or permanent basis. The water shall be tested by the chemical treatment subcontractor for acceptability. The heating water system shall have the proper water treatment chemicals installed immediately after the system has been flushed, boiled-out and refilled and before the system is used for temporary or permanent heating of the building.

E. The boiler controls shall be interlocked with the combustion air system to operate the combustion air make-up system when the boiler is firing. The boiler shall not operate without the combustion make-up air system operating.

END OF SECTION

SECTION 235233

FLEXIBLE WATER TUBE BOILERS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for flexible steel water tube boilers

B. Qualitative requirements for gas fired, oil fired, or combination gas/oil fired burners, power or atmospheric.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, capacity, accessories, and dimensions.

1.3 QUALITY ASSURANCE

A. Unit shall be constructed in accordance with the ASME Boiler and Pressure Vessel Code Section IV and shall be National Board listed.

B. Gas trains shall comply with requirements of CSD-1.

C. Boiler shall be UL 795 listed.

D. Boiler shall have a minimum thermal efficiency of 80 percent.

E. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

F. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

1.4 COMPONENTS

A. Heat Exchangers: Flexible bent steel tubes wedged into steel headers
B. Pressure Rating: 160 psig, water.
C. Heavy-steel mounting base frame.
D. Removable access panels and doors for inspection and cleaning.
E. Observation ports.
F. Exhaust gas vent.
G. Insulation and jacket.
H. Hot Water Boiler Trim:
   1. Safety-Relief Valves: ASME rated.
   2. Water Connections: Internal thermal circulation to mix return water with boiler water.
   3. Dip tube.
   4. Low-water cutoff and auxiliary low water cutoff.
   5. Pressure and temperature gauges.
   6. Temperature controls.
   7. Boiler high-pressure-limit controller.

I. Gas Burners: Power burner, forced draft design.
   1. Fuel: [Natural gas] [Propane gas].
   2. Gas-pressure regulator.
   3. Gas valves.
   4. Manual shutoff.
   5. Thermistor flame-sensing device.
   6. Automatic 100 percent safety gas shutoff.
   7. Burner Firing: Modulating.
   8. Burner Ignition: Standing pilot
   9. Safety controls.
   10. Flue-Gas Collector and Draft Hood: Integral with boiler casing.
   11. Gas Piping Train: Factory Mutual approved.

J. Oil Burners: Pressure-atomizing type.
   1. Fuel: No. 2 fuel oil.
   2. Operation and combustion-air controls.
   3. Oil pump.
   4. Oil-piping train.

K. Combination Gas/Oil Burners: Power burner, forced draft design with pressure-atomizing oil burner.
   1. Fuel: [Natural gas] [Propane gas] and No. 2 fuel oil.
   2. Burner operation and combustion-air controls.
   3. Gas pilot.
   4. Gas piping train.
   5. Oil pump.
   6. Oil-piping train.

L. Gas Burners: Atmospheric Design
   1. Tubular alloy steel burners with natural draft.
   2. Electric pilot ignition.
   3. Gas pressure regulator.
   4. Gas valves.
   5. Manual shutoffs
   6. Automatic 100 percent safety gas shutoff.
   7. Safety controls.
   8. Flue-gas collector and draft hood.
   9. Factory Mutual approved gas train.

M. Factory-mounted control panel.
   1. Dry contacts for DDC signal.
   2. Alarm contacts for low water cutoff, low temperature and high temperature alarms.

N. Motors: NEMA MG 1, general purpose, continuous duty, Design B, open-drip-proof type.

1.5 INSTALLATION

A. Set boilers on minimum 3-1/2 inch thick reinforced concrete pad.

B. Provide dual wall independent flues for each boiler.

C. Pipe all gas pressure regulator vents to the outside of the building

D. Boil out all boilers per the manufacturer's recommendations before using the boilers to heat the building in a temporary or permanent basis. The water shall be tested by the chemical treatment subcontractor for acceptability. The heating water system shall have the proper water treatment chemicals installed immediately after the system has been flushed, boiled-out and refilled and before the system is used for temporary or permanent heating of the building.

E. The boiler controls shall be interlocked with the combustion air system to operate the combustion air make-up system when the boiler is firing. The boiler shall not operate without the combustion make-up air system operating.

END OF SECTION

SECTION 235239

PACKAGED FIRETUBE BOILERS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for package firetube boilers.

B. Qualitative requirements for gas fired, oil fired, or combination gas/oil burners.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, capacity, accessories, and dimensions.

1.3 QUALITY ASSURANCE

A. Unit shall be constructed in accordance with ASME Boiler and Pressure Vessel Code Section IV and shall be National Board listed.

B. Gas trains shall comply with Factory Mutual Insurance (FM) requirements.

C. Gas trains shall comply with the requirements of CSD-1.

D. Boiler shall be UL 715 listed.

E. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

F. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

1.4 COMPONENTS

A. Heat Exchangers: Horizontal- fire tube, multi-pass, dry-back or wet-back design.

B. Pressure Rating: 125 psig, water.

C. Heavy-steel mounting base frame.

D. Removable access panels and doors for inspection and cleaning.

E. Observation ports.

F. Exhaust gas vent.

G. Insulation and jacket.

H. Hot Water Boiler Trim:
   1. Safety-Relief Valves: ASME rated.
   2. Water Connections: Internal thermal circulation to mix return water with boiler water.
   3. Dip tube.
   4. Low-water cutoff.
   5. Pressure and temperature gauges.
   6. Temperature controls.
   7. Boiler high-pressure-limit controller.

I. Gas Burners: Power burner, forced draft design.
   1. Fuel: [Natural gas] [Propane gas].
   2. Gas-pressure regulator.
   3. Gas valves.
   4. Manual shutoff.
   5. Thermistor flame-sensing device.
   6. Automatic 100 percent safety gas shutoff.
   7. Burner Firing: Modulating.
   8. Burner Ignition: Standing pilot
   9. Safety controls.
   10. Flue-Gas Collector: Integral with boiler casing.
   11. Gas Piping Train: Factory Mutual approved.

J. Oil Burners: Pressure-atomizing type.
   1. Fuel: No. 2 fuel oil.
   2. Operation and combustion-air controls.
   3. Oil pump.
   4. Oil-piping train.

K. Combination Gas/Oil Burners: Power burner, forced draft design with pressure-atomizing oil burner.
   1. Fuel: [Natural gas] [Propane gas] and No. 2 fuel oil.
   2. Burner operation and combustion-air controls.
   3. Gas pilot.
   4. Gas piping train.
   5. Oil pump.
   6. Oil-piping train.

L. Factory-mounted control panel.
   1. Dry contacts for DDC control.
   2. Alarm contacts for low water cutoff, low temperature and high temperature cutoffs.

M. Motors: NEMA MG 1, general purpose, continuous duty, Design B, open-drip-proof type.

1.5 INSTALLATION

A. Set boilers on minimum 3-1/2 inch thick reinforced concrete pad.

B. Provide dual wall independent flues for each boiler.

C. Pipe all gas pressure regulator vents to the outside of the building.

D. Boil out all boilers per the manufacturer's recommendations before using the boilers to heat the building in a temporary or permanent basis. The water shall be tested by the chemical treatment subcontractor for acceptability. The heating water system shall have the proper water treatment chemicals installed immediately after the system has been flushed, boiled-out and refilled and before the system is used for temporary or permanent heating of the building.

E. The boiler controls shall be interlocked with the combustion air system to operate the combustion air make-up system when the boiler is firing. The boiler shall not operate without the combustion make-up air system operating.

END OF SECTION

SECTION 235700

HEAT EXCHANGERS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for shell and tube design; and plate and frame.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. ASME Boiler and Pressure Vessel Code Section VIII, Division 1.

1.4 WARRANTY

A. Provide 1 year parts and labor warranty.

1.5 COMPONENTS

A. Shell and Tube Exchangers
1. Shell shall be fabricated from steel, the head shall be cast iron.
2. Tube shall be constructed of seamless copper tubing
3. Piping connections shall be flanged or screwed connections.
4. Tube sheets shall be constructed of copper sheets.

B. Plate and Frame Exchangers
1. The plates shall be constructed of type 304 or 316 stainless steel.
2. Gasket material shall be one of the following: Nitrile rubber, EPDM, Butyl or Viton.
3. Piping connections shall be flanged or screwed connections.
4. Unit shall include aluminum shroud.
5. Frame shall be constructed of steel.

1.6 INSTALLATION

A. Install per the manufacturer's recommendations.

B. Provide a safety pressure relief valve on both water sides of each plate and frame heat exchanger. The relief valve shall be properly sized for the system application.

END OF SECTION

SECTION 236213

REFRIGERANT CONDENSING UNITS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for air-cooled refrigerant condensing units with single compressors.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. ASHRAE Standard 15.

B. Certified performance to ARI 210/270/340.

C. UL construction.

D. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

1.4 WARRANTY

A. Compressors shall include an extended 5 year parts warranty.

1.5 COMPONENTS

A. Air-Cooled Units, single compressor 1 to 10 tons
1. Compressor: Reciprocating or scroll type, hermetically sealed and isolated with single-speed or two-speed motor, crankcase heater, and internal temperature and motor overloads.
2. Condenser: Copper-tube, aluminum-fin coil with integral liquid subcooler.
3. Condenser Fan: Vertical discharge, direct-drive, propeller.
4. Accessories: Suction and liquid line service valves with gauge ports, replaceable core filter driers, sightglass/moisture indicator, thermal expansion valve, automatic reset timer, and relief solder joints.
5. Casing: Heavy-gauge, zinc-coated galvanized steel with baked enamel finish.
6. Provide condenser coil protection.
7. Refrigerant: Compressors shall utilize R-22 or R-134A refrigerant.
8. Provide all required safeties including: overcurrent, thermal overload, and single-phasing motor protection.

1.6 INSTALLATION

A. Install the unit per the manufacturer's recommendations.

END OF SECTION

SECTION 236215

MULTIPLE-COMPRESSOR REFRIGERANT CONDENSING UNITS

GENERAL GUIDELINES

1.1 SECTION INCLUDES
- A. Qualitative requirements for air-cooled refrigerant condensing units with multiple compressors.

1.2 SUBMITTALS
- A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE
- A. ASHRAE Standard 15.
- B. Certified performance to ARI 340/360.
- C. UL construction.
- D. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

1.4 WARRANTY
- A. Compressors shall include an extended 5 year parts warranty.

1.5 COMPONENTS
- A. Air-Cooled Units, multiple compressors
  1. Compressor: Reciprocating, rotary screw or scroll type. Semi-hermetic for the reciprocating or rotary screw. Hermetically sealed for the scroll type. Compressors shall be isolated from the unit frame for vibration control. Compressors shall include crankcase heaters, suction strainer, oil strainer, and oil charging connection. Motors shall have internal thermal protection.
  2. Condenser: Copper-tube, aluminum-fin coil with liquid subcooler.
  3. Condenser Fans: Minimum one fan per compressor. Vertical discharge, direct-drive, propeller.
  4. Accessories: Delay timer, automatic reset timer, suction and liquid line service valves with gauge ports, replacable core filter driers, sightglass/moisture indicator, thermal expansion valve, automatic reset timer, suction accumulator, liquid receiver, and relief solder joints.
  5. Casing: Heavy-gauge, zinc-coated galvanized steel with baked enamel finish.
  6. Refrigerant: Compressors shall utilize R-22 or R-134a.
  7. Provide all required safeties including overcurrent, thermal overload, and single-phasing motor protection.

1.6 INSTALLATION
- A. Install the unit per the manufacturer's recommendations.

END OF SECTION

SECTION 236416

PACKAGED, CENTRIFUGAL WATER CHILLER

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for packaged centrifugal compressor, water-cooled water chiller.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting capacities at specified conditions, materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. Capacity certified to ARI 590.

B. Evaporator/condenser shall be constructed to ASME Boiler and Pressure Vessel Code Section VIII.

C. ASHRAE Standard 15 Safety Code for Mechanical Refrigeration.

D. Conformance to ANSI/Ul 465.

E. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

1.4 WARRANTY

A. Compressors shall have an extended 5 year parts warranty.

1.5 COMPONENTS

A. Packaged centrifugal compressor water-cooled water chiller:
1. Compressor: Centrifugal design.
2. Refrigerant: Shall be R-134a or R-123.
3. Cooler: ASME vessel direct expansion, shell and tube design.
4. Condenser: ASME shell and tube vessel.
5. Evaporator shell shall be wrapped with 3/4 inch thick elastomeric foam insulation.
6. Starter: Unit mounted soft start design
7. Control panel: Unit mounted with complete diagnostics, direct digital control.
8. Provide all required safeties including: overcurrent, thermal overload, and single-phasing motor protection.
9. Provide complete charge of the selected refrigerant.
10. Provide with "marine" water boxes for the cooler and condenser piping connections. Option: Detachable piping connections.
11. Provide with safety flow switch for proof of flow.
12. Provide unit with refrigerant purge unit for applicable refrigerant.
13. Provide safety water flow switch.

1.6 INSTALLATION

A. Install per the manufacturer's requirements.

B. Set the chiller on properly sized vibration isolation devices.

C. Install the flow switch in the leaving water piping from the chiller and wire it into the chiller control panel. Chiller shall not start until proof of flow via the flow switch is established.

D. Vent the refrigerant safety relief valve to the outside of the building.

END OF SECTION

SECTION 236423

PACKAGED, SCROLL WATER CHILLER

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for packaged scroll compressor, air-cooled water chiller.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting capacities at specified conditions, materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. Capacity certified to ARI 590.

B. Evaporator/condenser shall be constructed to ASME Boiler and Pressure Vessel Code Section VIII.

C. ASHRAE Standard 15 “Safety Code for Mechanical Refrigeration”.

D. Conformance to ANSI/Ul 465.

E. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

1.4 WARRANTY

A. Compressors shall have an extended 5 year parts warranty.

1.5 COMPONENTS

A. Packaged air-cooled scroll water chiller:

1. Compressor : Hermetic scroll design.
2. Refrigerant: Shall be R-22 or R-134a
3. Evaporator: ASME vessel direct expansion, shell and tube design. Provide with thermostatically controlled electric heat tracing.
4. Condenser: Air-cooled condenser coils with integral sub-cooling circuit.
5. Evaporator shell shall be wrapped with 3/4 inch thick elastomeric foam insulation.
6. Starter: Unit mounted soft start design
7. Control panel: Unit mounted with complete diagnostics, direct digital control.
8. Provide all required safeties including: overcurrent, thermal overload, and single-phasing motor protection.
9. Provide complete charge of the selected refrigerant.
10. Provide with integral condenser fans
11. Provide with safety flow switch for proof of flow.
12. Condenser coil protection.
13. Provide with safety water flow switch.

1.6 INSTALLATION

A. Install per the manufacturer's requirements.

B. Set the chiller on properly sized vibration isolation devices.

C. Install the flow switch in the leaving water piping from the chiller and wire it into the chiller control panel. Chiller shall not start until proof of flow via the flow switch is established.

END OF SECTION

SECTION 236426

PACKAGED, ROTARY SCREW WATER CHILLER

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for packaged rotary screw air-cooled or water-cooled, water chiller.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting capacities at specified conditions, materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. Capacity certified ARI 590.

B. Evaporated/condenser shall be constructed to ASME Boiler and Pressure Vessel Code Section VIII.

C. ASHRAE Standard 15 Safety Code for Mechanical Refrigeration.

D. Conformance to ANSI/UL 465.

E. Units must meet the minimum efficiency requirements of ASHRAE Standard 90.1.

1.4 WARRANTY

A. Compressors shall have an extended 5 year parts warranty.

1.5 COMPONENTS

A. Water-cooled and air-cooled helical rotary screw chiller:
   1. Compressor: Semi-hermetic helical rotary screw design with double wall construction for sound attenuation.
   2. Refrigerant: Shall be R-22 or R-134a
   3. Cooler: ASME vessel direct expansion, shell and tube design. Provide thermostatically controlled electric heat tracing for exterior air-cooled chillers.
   4. Condenser: ASME vessel, shell and tube design for water-cooled design.
   5. Evaporator shell shall be wrapped with 3/4 inch thick elastomeric foam insulation.
   6. Starter: Unit mounted soft start design
   7. Control panel: Unit mounted with complete diagnostics, direct digital control.
   8. Provide all required safeties including: overcurrent, thermal overload, and single-phasing motor protection.
   9. Provide with "marine" water boxes for the cooler and condenser piping connections for water-cooled design.
   10. Provide complete charge of the select refrigerant.
   11. Provide integral multiple compressor fans for air-cooled design.
   12. Provide condenser coil protection on outdoor air-cooled units.
   13. Provide with water flow switch.

1.6 INSTALLATION

A. Install per the manufacturer's requirements.

B. Minimize the number of daily starts as recommended by the manufacturer.

C. Vent the refrigerant safety relief valve to the outside of the building.

D. Set the chiller on properly sized vibration isolation devices.

E. Mount the safety flow switch in the chilled water supply piping. Wire the flow switch to the chiller control panel. Chiller shall not start until proof of flow via the flow switch is established.

END OF SECTION

SECTION 236440

REFRIGERANT MONITORING SYSTEMS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for refrigerant monitoring equipment and breathing apparatus.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. Products and installation shall comply with requirements of ASHRAE Standard 15.

1.4 COMPONENTS

A. Gas Detection System

1. System shall be capable of detecting presence of any HCFC, CFC, or HFC refrigerant (R-22, R123, R-134a). Provide the appropriate sensors for the refrigerant being used.
2. The system shall indicate alarm and shut down the refrigeration equipment and start the refrigerant ventilation fan system.
3. Oxygen deprivation monitoring shall not be used in lieu of TLV-TWA monitoring for human safety exposure.
4. Sequential sampling and multi-point monitoring shall be required as defined in the latest issue of ASHRAE Standard 15.
5. The analyzer shall be microprocessor based and employ infrared (IR) sensor technology and shall accurately provide sensing down to 1 part per million.
6. Unit shall be factory calibrated for the refrigerant and sensors.
7. Sensors shall be capable of being installed up to 500 feet from the microprocessor.

B. Breathing Apparatus

1. Self-contained with 30 minutes of air. Provide with full face mask, breathing tube, air tank, controls and harness. Provide with wall mounted storage cabinet.

1.5 INSTALLATION

A. Provide refrigerant monitoring/alarm system for refrigeration equipment located inside the building.

B. The monitoring system shall shut-down all refrigeration equipment in the room, start the refrigerant emergency exhaust system, and sound the alarm.

C. Locate the breathing apparatus in a protective wall mounted enclosure immediately outside of the refrigeration room.

D. Mount and wire the remote audible alarms inside the room containing the refrigeration equipment and immediately outside of the refrigeration room.

END OF SECTION

SECTION 236500

PACKAGED COOLING TOWERS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for induced draft cross-flow package cooling towers, and forced-draft, counter-flow packaged cooling towers.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. Certified for thermal performance to CTI 201.

B. ASTM E84 for burning characteristics of building materials.

C. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

D. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

1.4 COMPONENTS

A. Induced-Draft, Cross-Flow Cooling Towers
1. Fan Type: Propeller with cast-aluminum, fixed-pitch or galvanized-steel, fixed-pitch blades.
2 Fan Drive: Gear, with speed reducer or belt drive.
3 Fan Motor: Two-speed or suitable for variable-frequency drive control, totally enclosed, fan-cooled.
4. Fan-vibration cutoff switch.
5. Hot-water distribution system.
6. Hot-Water Basin Control Valves: Globe.
7 Casing: Galvanized steel with polymer coating or stainless steel.
8. Collecting Basin: Galvanized steel with polymer coating or stainless steel.
9. Fill Material: Formed PVC or CPVC.
10. Drift Eliminator Material: Formed PVC.
11. Louver Material: Galvanized steel with polymer coating.
12. Water Level Control: Electric float switch with solenoid make-up valve.
13. Basin Heaters: Electric immersion sized to maintain a minimum 40 degree F pan water temperature.
14. Handrails, Ladders, and Safety Cage: Galvanized steel pipe.
15. Vibration Controls: Manufacturer recommended. Rubber and glass-fiber pad isolators.
16. Basin drain connection and overflow connections.
17. Anti-vortex suction diffuser/screen constructed of stainless steel.

B. Forced-Draft, Counter-Flow Cooling Towers
1. Fan Type: Propeller with cast-aluminum, fixed-pitch or galvanized steel, fixed-pitch blades. Centrifugal forward curved fans are also acceptable.
2. Fan Drive: Gear, with speed reducer or belt drive.
3. Fan Motor: Two speed or suitable for variable frequency drive control, totally enclosed, fan cooled.
4. Fan vibration cutoff switch.
5. Hot water distribution system.
6. Hot Water Basin Control Valves: Globe.
7. Casing: Galvanized steel with polymer coating or stainless steel.
8. Collecting Basin: Galvanized steel with polymer coating or stainless steel.
9. Fill Material: Formed PVC or CPVC.
10. Drift Eliminator Material: Formed PVC.
11. Louver Material: Galvanized steel with polymer coating.
12. Water Level Control: Electric float switch with solenoid makeup valve.
13. Basin Heaters: Electric immersion sized to maintain a minimum 40 degree F pan water temperature.
14. Handrails, Ladders, and Safety Cage: Galvanized steel pipe.
15. Vibration Controls: Manufacturer recommended. Rubber and glass fiber pad isolators.
16. Basin drain connection and overflow connections.
17. Anti-vortex suction diffuser/screen constructed of stainless steel.

1.5 INSTALLATION

A. Install cooling towers to conform with the manufacturer's requirements

END OF SECTION

SECTION 236533

CLOSED CIRCUIT FLUID COOLERS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for closed-circuit evaporative fluid coolers.

1.2 SUBMITTALS

A. Provide submittals indicating capacity at the specified conditions, electrical requirements, construction material, and dimensions.

1.3 QUALITY ASSURANCE

A. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

1.4 COMPONENTS

A. Coil: Continuous serpentine, cleanable, galvanized tubes with removable cover plates on headers.

B. Drift Eliminator Material: Hot-dip galvanized steel with polymer coating.

C. Hot Water Distribution System: Schedule 40 PVC with removable branch pipes.

D. Inlet Screens: Galvanized steel mesh with polymer coating mounted on removable frame.

E. Basin Heaters: Electric.

F. Circulating Pumps: Centrifugal, closed-coupled, bronze fitted with mechanical seals.

G. Water Level Control: Electric float switch with solenoid makeup valve.

H. Fan: Centrifugal
   1. Drive: Belt.
   2. Motor: Totally enclosed, fan-cooled energy-efficient type.
   3. Motor Speed: Single speed.
   4. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

I. Vibration cutout switch.

J. Discharge dampers, inlet dampers, and controls.

K. Casing Material: Galvanized steel with polymer coating or stainless steel.

L. Collecting Basin: Galvanized steel with polymer coating or stainless steel.

M. Vibration Controls: Manufacturer's recommended rubber and glass-fiber pads or restrained spring isolators.

1.5 INSTALLATION

A. Mount fluid cooler on vibration isolators.

B. Provide open circuit cooling tower chemical water treatment for control of scale, corrosion, and biological growth.

END OF SECTION

SECTION 237119

ICE STORAGE SYSTEM

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for ice storage tanks.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. Unit controls shall be UL or ETL listed and labeled.

1.4 COMPONENTS

A. Thermal ice storage tanks shall be constructed of galvanized steel or polyethylene.

B. Heat exchangers shall be constructed of polyolefin, polyethylene or galvanized steel.

C. The bottom, sides, and cover(s) of each ice storage tank shall be factory insulated to ensure standby losses do not exceed one percent of system capacity in 24 hours.

D. Ice storage tanks that are to be buried shall be specifically designed for burial.

E. An ice inventory measuring device shall be provided to interface with the HVAC Direct Digital Controls system.

1.5 Install per manufacturer's requirements.

1.6 Manufacturer shall check-test-start units.

END OF SECTION

SECTION 237200

AIR TO AIR ENERGY RECOVERY EQUIPMENT

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for total energy heat recovery wheels and energy recovery modules.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. Recovery performance shall be tested in accordance with ASHRAE Standard 84.

B. Units shall bear the ETL label and shall be ETL certified.

C. Recovery performance at specified conditions shall be guaranteed by the manufacturer.

1.4 COMPONENTS

A. Energy Recovery Wheel

1. The energy recovery wheel shall have a ***minimum heating and total cooling effectiveness of 80%, based on balanced airflow (relief airflow matching outside airflow). The effectiveness of this wheel shall not be below 70% under design airflow conditions.***
2. The unit shall be constructed of structural steel tubular frame with epoxy primer and finish. The cabinet shall be of 16 gauge bright galvanized steel construction.
3. The heat wheel transfer media shall be a coated aluminum or polymer media with air permeable matrix with laminar flow flutes coated with a renewable desiccant. The heat wheel media shall be driven by an electric motor.
4. The face velocity across each side of the media (supply and exhaust) shall be less than 800 FPM and more than 350 FPM with a purge method that prevents exhaust air from being recirculated.
5. Each unit shall include a frost control method. The control of the unit shall be provided by the DDC control system.

B. Energy Recovery Module

(This type of energy recovery does not meet the prescriptive path requirements of the energy code. If this type is to be used, compliance with the energy cost-budget method must be demonstrated – ASHRAE 90.1-2007.)

1. The energy recovery module shall have a heating net total effectiveness of 62% and a cooling net total effectiveness of 41%.
2. The module shall be constructed of 16 gauge galvanized steel with epoxy primer. Access doors shall have gasket, hinge, and door latches to provide a tight seal.

3. The fixed plate exchange module shall be fixed plate cross-flow construction. Water vapor transfer shall be through molecular transport by hydroscopic resin.

C. Furnish a digital display for readout of both air stream temperatures and control settings.

D. Provide filter racks and filters with a minimum MERV rating of 7 on both entering air sides of the wheel or energy recovery module.

E. Each unit shall include a frost control method. The control for the unit shall be provided through the building DDC control system.

1.5 INSTALLATION

A. Install per manufacturers requirements.

B. Manufacturer shall test-check-start units.

END OF SECTION

SECTION 237313

MODULAR INDOOR AIR HANDLING UNITS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for central station modular air handling units including fan sections hot water heating coils, chilled water cooling coils, filter sections, mixing boxes, face and bypass dampers, access modules, and other such equipment and accessories.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting the following:
1. Product data indicating dimensions, weights, capacities, and materials.
2. Fan performances including curves.
3. Sound power levels.
4. Filter data, mounting method, and performance.

1.3 QUALITY ASSURANCE

A. Construction standard shall meet NFPA 90A.

B. Product certification shall comply with ARI 430.

C. Sound power level rating shall comply with AMCA 300, ASHRAE 68, and AMCA 301.

D. Fan performance rating shall comply with AMCA 210.

E. Damper leakage rating shall comply with AMCA 500.

F. Coil performance shall comply with ARI 410.

G. Safety code for mechanical refrigeration shall comply with ASHRAE 15.

H. Filtration shall comply with ASHRAE 52.

1.4 COMPONENTS

A. Unit Casing
1. Galvanized steel framing on channel base with welding construction.
2. Zinc coated steel with primer coat and final finish of protective enamel.
3. Dual wall construction throughout.
4. 2 inch thick insulation with minimum R-value of R-8.3 ft^2●h●°F/Btu.
5. Double wall, stainless steel drain pan, insulated and sloped to assure drainage.
6. ***Access doors shall be 2" thick dual wall construction with hinge and door latches to provide a tight seal. Bolted doors are not acceptable.***

B. Water Coils
1. Common or individual with minimum 16 gauge galvanized steel casings and intermediate supports for lengths over 60 inches.
2. Constructed of seamless copper tubes with aluminum plate fins, cast iron or copper headers, with connections for drain valve and air vent.
3. Drainable serpentine type.
4. Tested at 300 psi under water.

C. DX Refrigerant Coils
   1. Constructed of seamless copper tubes with aluminum plate fins,
   2. Seamless copper suction header and distributor tube with low pressure drop distributors.
   3. Multi-circuited, fully intertwined, staggered row for full face cooling at variable air flows.
   4. Tested at 400 psi under water.

D. Face and Bypass Dampers
   1. Dampers shall be opposed acting, with break-formed dampers having gaskets and edge seals.

E. Access Section
   1. Section shall include an access door.
   2. Access sections shall be placed between coil sections to allow access for cleaning and repair.

F. Mixing Box
   1. Section shall be provided with return air and economizer air connections.
   2. Dampers shall be provided and installed by the Temperature Control Contractor.

G. Fans
   1. Fan type shall be (airfoil) (backward inclined) (forward curved) type.
      a. Double width, double inlet multi-blade fan wheel.
      b. Self aligning, grease lubricated ball bearings with lubrication fittings
      c. Fan and motor assembly internally isolated from unit casing.
   2. Fan type shall be plug type.
      a. Single width, single inlet, multi-blade fan wheel.
      b. Self aligning, anti-friction pillow block bearings.
      c. Fan and motor assembly internally isolated including spring-supported inertia pad.
   3. Fan assemblies shall be statically and dynamically balanced.
   4. Guards for belts and fans shall be provided to meet OSHA requirements.

H. Motors/Drives
   1. Heavy-duty, high efficiency designed specifically for use with electronic variable frequency drives. Efficiency shall meet the minimum requirements of IEEE 112, Test Method B.
   2. Temperature rating shall be 50 deg C maximum rise at 40 deg C ambient.
   3. Service factor shall be 1.15 for polyphase motors and 1.35 for single-phase motors.
   4. Each motor shall be mounted on an adjustable base.
   5. Noise rating shall be quiet.
   6. Overload protection shall be built-in thermal with automatic-reset.
   7. Sheaves shall be cast iron with v-belt sized for 150 percent BHP.
   8. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

I. Filter Section
   1. Filter section shall be a cartridge section separate from the mixing box.
   2. The pre-filters shall be 2 inch and have a minimum MERV rating of 7.
   3. The primary filters shall have a minimum ***MERV rating of 13***, and be mounted just after the pre-filters.
   4. Refer to "LEED For Schools" for additional requirements.

J. Vibration Isolation
   1. Each fan system shall be isolated from the cabinet with spring-type isolation.
   2. Fans shall include concrete-filled inertia bases where recommended by unit manufacturer.
   3. Thrust restraints shall be included for all fan types.

K. Lighting and Convenience Outlet Circuit
   1. 1 vapor-proof service light and 1 convenience outlet shall be provided in each fan section and mixing box section. (optional for units less than 15,000 cfm)

1.5 INSTALLATION

A. Install in accordance with manufacturers requirements.

B. Startup and training to be provided by a factory-trained service technician.

END OF SECTION

SECTION 237323

CUSTOM INDOOR AIR HANDLING UNITS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Central station custom air handling units including fan sections, hot water heating coils, chilled water cooling coils, filter sections, mixing boxes, access modules, and other such equipment and accessories. Custom air handling units are intended only to be used to accommodate unusual mechanical room configurations where modular air handling units will not fit space allocated.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting the following:
   1. Product data indicating dimensions, weights, capacities, and materials.
   2. Fan performances including curves.
   3. Sound power levels.
   4. Filter data, mounting method, and performance.

1.3 QUALITY ASSURANCE

A. Construction standard shall meet NFPA 90A.

B. Product certification shall comply with ARI 430.

C. Sound power level rating shall comply with AMCA 300, AMCA 301, and ASHRAE 68.

D. Fan performance rating shall comply with AMCA 210.

E. Damper leakage rating shall comply with AMCA 500.

F. Coil performance shall comply with ARI 410.

G. Safety code for mechanical refrigeration shall comply with ASHRAE 15.

H. Filtration shall comply with ASHRAE 52.

1.4 COMPONENTS

A. Unit Construction
   1. Unit base shall be constructed of structural steel channel with welded construction. Include lifting lugs and internal supports for spans over 96 inches.
   2. Exterior housing shall be dual wall constructed with minimum 16 gauge galvanized exterior skin and 20 gauge interior skin over 2 inch, 3 pounds per cubic foot insulation.
   3. Unit floor shall be minimum 16 gauge galvanized steel and shall be welded to the floor structural system.
   4. Access doors shall be dual wall, and installed in each fan section and mixing box section as a minimum. Each door shall be fully gasketed with heavy-duty hinges and adjustable latches. Insulation and panel construction shall match the rest of the unit sections.

5. Insulation shall be minimum 2 inch thick, R-8.3 ft^2●h●°F/Btu for all wall and door assemblies. Floor insulation shall be 2 inch, R-8.3 ft^2●h●°F/Btu and installed directly beneath floor surface.
6. The finish for the unit shall include a painted exterior over galvanized steel having a minimum A-60 application.

B. Water Coils
1. Common or individual with minimum 16 gauge galvanized steel casings and intermediate supports for lengths over 60 inches.
2. Constructed of seamless copper tubes with aluminum plate fins, cast iron or copper headers, with connections for drain valve and air vent.
3. Drainable serpentine type.
4. Tested at 300 psi under water.
5. Dual wall, insulated, stainless steel drain pan of IAQ design.

C. Access Section
1. Section shall include an access door.
2. Access sections shall be placed between coil sections to allow access for cleaning and repair.

D. Mixing Box
1. Section shall be provided with return air and economizer air connections.
2. Dampers shall be provided and installed by the Temperature Control Contractor.

E. Fans
1. Fan type shall be (airfoil) (backward inclined) (forward curved) type.
   a. Double width, double inlet multi-blade fan wheel.
   b. Self aligning, grease lubricated ball bearings with lubrication fittings
   c. Fan and motor assembly internally isolated from unit casing.
2. Fan type shall be plug type.
   a. Single width, single inlet, multi-blade fan wheel.
   b. Self aligning, anti-friction pillow block bearings.
   c. Fan and motor assembly internally isolated including spring-supported inertia pad.
3. Fan assemblies shall be statically and dynamically balanced.
4. Guards for belts and fans shall be provided to meet OSHA requirements.

F. Motors/Drives
1. Heavy-duty, high efficiency designed specifically for use with electronic variable frequency drives. Efficiency shall meet the minimum requirements of IEEE 112, Test Method B.
2. Temperature rating shall be 50 deg C maximum rise at 40 deg C ambient.
3. Service factor shall be 1.15 for polyphase motors and 1.35 for single-phase motors.
4. Each motor shall be mounted on an adjustable base.
5. Noise rating shall be quiet.
6. Overload protection shall be built-in thermal with automatic-reset.
7. Sheaves shall be cast iron with v-belt sized for 150 percent BHP.
8. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

G. Filter Section
   1. Filter section shall be a cartridge section separate from the mixing box.
   2. The pre-filters shall be 2 inch and have a minimum MERV rating of 7.
   3. The primary filters shall have a minimum ***MERV rating of 13*** and be mounted just after the pre-filters.
   4. Refer to "LEED for Schools" for additional requirements.

H. Vibration Isolation
   1. Each fan system shall be isolated from the cabinet with spring-type isolation.
   2. Fans shall include concrete-filled inertia bases where recommended by unit manufacturer.
   3. Thrust restraints shall be included for all fan types.

I. Lighting and Convenience Outlet Circuit
   1. 1 vapor-proof service light and 1 convenience outlet shall be provided in each fan section, and mixing box section.

1.5 INSTALLATION

A. Install in accordance with manufacturers requirements.

B. Startup and training to be provided by a factory-trained service technician.

END OF SECTION

SECTION 238113

UNITARY AIR CONDITIONING EQUIPMENT

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for packaged through-the-wall terminal air conditioning equipment and accessories.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting capacity, materials, controls, dimensions, and accessories.

1.3 QUALITY ASSURANCE

A. Refrigeration system shall meet ASHRAE 15.

B. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

C. Performance rating shall comply with ARI 310/380.

D. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

1.4 WARRANTY

A. The unit compressor shall be warranted for 5 years.

1.5 COMPONENTS

A. The cabinet shall be constructed of galvanized steel with removable front panel.
1. Mounting: Wall installation with wall sleeve.
2. Finish: Baked enamel over heavy, 18 gauge, phosphatized galvanized steel.
3. Subbase: Enameled steel.
4. Louvers: Extruded aluminum, architectural style grille with horizontal louvers and baked enamel finish.
5. Discharge grille and access door: Extruded aluminum.
6. Cabinet extensions matching cabinet construction.

B. The refrigeration system shall be direct-expansion indoor coils with capillary restrictor and constant-pressure expansion valve, hermetically sealed compressor, outdoor coil and fan, and coaxial tube-in-tube condenser.

C. The indoor air system shall include forward-curved centrifugal indoor fan and motor, and permanent filters. Motors shall be high efficiency, permanent split capacity type. A positive pressure ventilation damper with connection cable shall be included with each unit.

D. The outdoor fan system shall include forward-curved centrifugal fan with separate motor from indoor system. Motors shall be high efficiency, permanent split capacity type.

E. Heating coils shall be electric resistance type with fusible link and an overheat limit control.

F. Condensate drain shall be provided for direct flow to the exterior of building.

G. The control system shall include a unit mounted control panel for setting of fan speeds, heating/cooling mode and automatic control.
   1. A unit mounted thermostat shall sense the air temperature at the fan inlet for control. The setting shall be adjustable.

1.6 INSTALLATION

A. Install in accordance with manufacturers requirements.

END OF SECTION

SECTION 238123

COMPUTER ROOM AIR CONDITIONERS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for air conditioning units intended specifically for computer rooms including package unit, refrigerant piping and specialties, reheat control, valves, and unit control.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting capacity, materials, controls, dimensions, and accessories.

1.3 QUALITY ASSURANCE

A. Refrigeration system shall meet ASHRAE 15.

B. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

C. Units shall be UL Listed and CSA Certified.

D. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

1.4 WARRANTY

A. The entire unit shall be warranted for 5 years.

1.5 COMPONENTS

A. Cabinet and frame construction
   1. Welded, heavy gauge galvanized steel frame
   2. Zinc-coated steel with primer coat and baked enamel finish
   3. Minimum 2 inch, 2 pound density fiber insulation
   4. Hinged filter and grille for access

B. Filters
   1. 1 inch thick, disposable and ***minimum MERV 7.***
   2. Provide extra set at completion of work

C. Evaporator fan assembly
   1. Fan shall be direct-drive with double inlet blower.

D. Refrigeration system
   1. Direct expansion coil with aluminum fins, copper tubes, thermal expansion valve, liquid line filter-dryer, service shutoff valves, charging valves, and stainless-steel drain pan.
   2. Hermetic compressor with vibration mounts.

E. Condenser section
   1. Air-cooled, copper tubes, aluminum fins, with refrigerant circuit of counterflow design including desuperheating section.
   2. Fan shall be double inlet, direct drive with a 3-speed motor and low limit ambient control to prevent evaporator freezeup.

F. Reheat section
   1. Electric reheat coils shall be low-density, tubular type elements, with UL approved safety switches.

G. Condensate drain system
   1. The condensate drain system shall include a condensate pump with integral float switch, pump/motor assembly, and reservoir.

H. Control system
   1. The control system shall be solid state and shall include a remote thermostat and shutoff switch for field installation.

1.6 INSTALLATION

A. Install in accordance with manufacturers requirements.

B. Startup and training to be provided by a factory-trained service technician.

END OF SECTION

SECTION 238146

WATER SOURCE HEAT PUMPS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for packaged horizontal or vertical water source heat pump air conditioning/heating unit, unit-mounted controls, and accessories.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting capacity, materials, controls, dimensions, and accessories.

1.3 QUALITY ASSURANCE

A. Refrigeration system shall meet ASHRAE 15.

B. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

C. Performance rating shall comply with ARI/ASHRAE/ISO 13256-1.

D. Safety requirements shall comply with UL 484/559.

E. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

1.4 WARRANTY

A. Heat pump unit shall be warranted for one year for all parts including labor and a total of 5 years on compressor parts.

1.5 COMPONENTS

A. Unit shall be rated to operate with an entering water temperature from 25 degrees Fahrenheit to 115 degrees Fahrenheit. Note that operating the ground loop below 40 degrees will require glycol freeze protection.

B. The cabinet shall be constructed of galvanized steel with 0.5 inch, 1-1/2 pound per cubic foot density insulation. Internal sheet metal parts shall be protected with a thermosetting, plastic coating.

C. Heat pump shall include refrigeration circuit with single or dual capacity hermetic compressor.

1. Refrigerant air-to-air copper-tube coil heat exchanger.
2. Refrigerant shall be HFC
2. Water-to-refrigerant coaxial tube-in-tube heat exchanger.
3. Refrigerant flow control using capillary tube or thermal expansion valve.
4. High and low pressure safety cutoffs.
5. Pilot controlled reversing valve.

6. Thermal overload protection.
7. External vibration isolation.
8. Internal compressor vibration isolation.
9. Insulate water-to-refrigerant heat exchanger and refrigerant suction lines.

D. Forward curved, centrifugal type evaporator fan with multi-speed, high-efficiency PSC or ECM type motor including integral mounting brackets and thermal overload protection.

E. Galvanized steel insulated drain pan with external drain connection. Provide with solid-state liquid detection device in the drain pan to stop compressor if condensate accumulates.

F. Filter frame with 1 inch throwaway filter. Filter must be MERV 13 if designer is going after LEED EQ 5.0.

G. The control system shall include a unit-mounted microprocessor control panel design for interface to the building DDC electronic control system. Controller shall be capable of auto heating and cooling changeover and capacity control. Manufacturer shall provide all necessary control components (t-stats, humidistats, etc.) necessary for control of heat pump.

H. Units shall be finished with enamel paint to the manufacturer's standard color.

I. Provide interior acoustical insulation to deaden fan and compressor noise.

J. Provide insulated auxiliary drain pan under the coil connections if equipment is above finished ceilings.

1.6 INSTALLATION

A. Install in accordance with manufacturers requirements.

B. Hose kit and associated shutoff and flow control devices shall be field installed by the HVAC Contractor.

END OF SECTION

SECTION 238156

GROUND SOURCE HEAT PUMPS (GEOTHERMAL)

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for packaged horizontal or vertical ground source heat pump air conditioning/heating unit, unit-mounted controls, and accessories.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting capacity, materials, controls, dimensions, and accessories.

1.3 QUALITY ASSURANCE

A. Refrigeration system shall meet ASHRAE 15.

B. Units must meet minimum efficiency of 16 EER cooling and 3.5 COP Heating under ARI/ISO Standard 13256-1 Ground Loop Conditions (ARI 330). Multiple or variable speed heat pumps shall achieve this rating at high speed.

C. Performance rating shall comply with ARI/ASHRAE/ISO 13256-1.

D. Safety requirements shall comply with UL 484/559.

E. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

1.4 WARRANTY

A. Heat pump unit shall be warranted for one year for all parts including labor and a total of 5 years on compressor parts.

1.5 COMPONENTS

A. Unit shall be rated to operate with an entering water temperature from 25 degrees F. to 115 degrees F. Note that operating the ground loop below 40 degrees will require glycol freeze protection.

B. The cabinet shall be constructed of galvanized steel with 0.5 inch, 1-1/2 pound per cubic foot density insulation. Internal sheet metal parts shall be protected with a thermosetting, plastic coating.

C. Heat pump shall include refrigeration circuit with single or dual capacity hermetic compressor.
   1. Refrigerant air-to-air copper-tube coil heat exchanger.
   2. Refrigerant shall be HFC.
   2. Water-to-refrigerant coaxial tube-in-tube heat exchanger.

3. Refrigerant flow control using capillary tube or thermal expansion valve.
4. High and low pressure safety cutoffs.
5. Pilot controlled reversing valve.
6. Thermal overload protection.
7. External vibration isolation.
8. Internal compressor vibration isolation.
9. Insulate water-to-refrigerant heat exchanger and refrigerant suction lines.

D. Forward curved, centrifugal type evaporator fan with multi-speed, high-efficiency ECM type motor including integral mounting brackets and thermal overload protection.

E. Galvanized steel insulated drain pan with external drain connection. Provide with solid-state liquid detection device in the drain pan to stop compressor if condensate accumulates.

F. Filter frame with 1 inch throwaway filter. Filter must be MERV 13 if designer is going after LEED EQ 5.0.

G. The control system shall include a unit-mounted microprocessor control panel design for interface to the building DDC electronic control system. Controller shall be capable of auto heating and cooling changeover and capacity control. Manufacturer shall provide all necessary control components (t-stats, humidistats, etc.) necessary for control of heat pump.

H. Units shall be finished with enamel paint to the manufacturer's standard color.

I. Provide interior acoustical insulation to deaden fan and compressor noise.

1.6 INSTALLATION

A. Install in accordance with manufacturers requirements.

B. Hose kit and associated shutoff and flow control devices shall be field installed by the HVAC Contractor.

END OF SECTION

SECTION 238219

FAN COIL UNITS – FOUR PIPE

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for fan coil units and accessories.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting capacity, materials, controls, dimensions, and accessories.

1.3 QUALITY ASSURANCE

A. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

B. Performance rating shall conform to N.E.C requirements and shall be UL labeled.

C. Unit capacities shall be certified in accordance with ARI Standard 440-98.

1.4 WARRANTY

A. The entire unit shall be warranted for 5 years.

1.5 COMPONENTS

A. Cabinet and frame construction
1. Welded, heavy gauge galvanized steel frame
2. Zinc-coated steel with primer coat and baked enamel finish
3. Minimum 2 inch, 2 pound density fiber insulation
4. Hinged filter and grille for access

B. Filters
1. 1 inch thick, disposable and ***MERV 7*** efficiency.
2. Provide extra set at completion of work.

C. Centrifugal supply air fan
1. Fan shall be forwardly curved double width-double inlet, with common shaft mounted on a removable fan board, driven by a three-speed permanent split capacitor motor having built-in overload protection.

D. Chilled water cooling coil
1. Coil shall consist of seamless copper tubes with bonded aluminum fins. Coils shall be designed for 300 psi w.p.
2. A manual air vent shall be provided on each coil.

E. Hot water heating coil
1. Coil shall consist of seamless copper tubes with bonded aluminum fins. Coils shall be designed for 300 psi w.p.
2. A manual air vent shall be provided on each coil.

F. Condensate drain system

1. The condensate drain system shall include a condensate drain pan under the cooling coil, pitched to drain, and an auxiliary drain pan under the coil connections. Provide auxiliary drain pan and/or condensate high limit fan cutoff as required by code.

G. Control system

1. The control system shall be a complete system of electronic direct digital controls.

1.6 INSTALLATION

A. Install in accordance with manufacturers requirements.

B. Startup and training to be provided by a factory-trained service technician.

END OF SECTION

SECTION 238223

UNIT VENTILATORS – FOUR PIPE

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for unit ventilator units and accessories.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting capacity, materials, controls, dimensions, and accessories.

1.3 QUALITY ASSURANCE

A. Units shall be tested and performance certified in accordance with ARI 840-98.

B. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

C. Units shall be UL or ETL listed.

1.4 WARRANTY

A. The entire unit shall be warranted for 5 years.

1.5 COMPONENTS

A. The cabinet shall be constructed of galvanized steel with removable front panel.
1. Mounting: Wall installation with wall sleeve.
2. Finish: Baked enamel over heavy, 18 gauge, phosphatized galvanized steel.
3. Subbase: Enameled steel.
4. Louvers: Extruded aluminum, architectural style grille with horizontal louvers and baked enamel finish.
5. Discharge grille and access door: Extruded aluminum.
6. Cabinet extensions matching cabinet construction.

B. Centrifugal fans, forwardly curved double width-double inlet, with common shaft mounted on a removable fan board, driven by a single speed, permanent split capacitor motor having built-in overload protection and Class F winding insulation. The motor shall be factory wired to a solid state, single phase, variable speed controller with minimum turndown to 30% of total motor speed. A toggle type disconnect switch shall be furnished with each unit to provide electrical disconnect of power to all components.

C. Chilled water cooling coil and separate hot water heating coil for a four-pipe system, each consisting of seamless copper tubes with bonded aluminum fins. Coils shall be designed for 300 psi w.p. A manual air vent shall be provided on each coil.

D. Outside Air – Return air dampers with edge seals arranged for automatic operation modulating form zero to 100% outside air intake.

E. Coil face and bypass modulating dampers with edge seals, arranged for automatic operation to regulate heat output.

F. Insulated drain pan under the cooling coil and insulated auxiliary drain pan under the coil connections shall be furnished.

G. Air filter, 1" pleated filter with cardboard frame. MERV value shall be 7.0.

H. Control system
   1. The control system shall be a complete system of electronic direct digital controls.

1.6 Outside air intake louver and protective lattice grille. Louver shall have vertical blades and bird screen. Louver and grilles shall be furnished in Kynar 500 with color selected by the Architect. Louvers and grilles shall be standard sizes except where otherwise noted on the drawings.

1.7 INSTALLATION

A. Install in accordance with manufacturers requirements.

B. Startup and training to be provided by a factory-trained service technician.

END OF SECTION

SECTION 238233

CONVECTORS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for convectors and fin tube radiation.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. Radiation pressure tested to 200 psig.

1.4 COMPONENTS

A Hydronic Finned-Tube Radiation and Enclosure
1. Finned Tubes: Constructed of copper tube and aluminum fins
2. Enclosure: Steel, sloped front with factory baked enamel finish.
3. Provide with wall hang brackets for piping, finned tube element and enclosure support.

1.5 INSTALLATION

A. Install per manufacturers requirements.

END OF SECTION

SECTION 238239

CABINET UNIT HEATERS

GENERAL GUIDELINES

1.1 SECTION INCLUDES
- A. Qualitative requirements for ceiling mounted hydronic and electric cabinet unit heaters.

1.2 SUBMITTALS
- A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE
- A. Capacity rated in accordance with ARI.
- B. Hydronic coils shall be pressure tested to 400 psig.
- C. Units shall be UL or ETI listed and labeled.

1.4 COMPONENTS
- A Hydronic Cabinet Unit Heaters
  1. Cabinets shall be formed steel suitable for recessed ceiling mounting. Provide with stamped grilles for air inlet and outlet or ducted connections.
  2. Coils shall be constructed of seamless copper tubing that is mechanically bonded to aluminum fins.
  3. Fans shall be forward curved centrifugal direct drive.
  4. Provide with disconnect switch, fused motor protection and fan speed controller switch.
  5. Provide with 1 inch throw away fiberglass filter.
  6. Provide with end pockets on both ends of the cabinet suitable in size for concealing piping and valving.
  7. Provide factory enamel finish.
- B. Electric Cabinet Unit Heaters
  1. Cabinets shall be formed steel suitable for wall mounting (surfaced or semi-recessed to 8 inches) or recessed ceiling mounting. Provide with stamped grilles for air inlet and outlet (location dependent on style selected).
  2. Coils shall be constructed of nickel chromium wire in a metallic sheath with fins no closer than .16 inches and free from expansion noise and 60-Hz hum.
  3. Fans shall be forward curved centrifugal direct drive.
  4. Provide with disconnect switch, coil relay switches, and fan speed controller switch.
  5. Provide with fan and electric coil circuit protection.
  6. Provide factory enamel finish.

1.5 INSTALLATION
- A. Install per manufacturers requirements.

END OF SECTION

SECTION 238240

PROPELLER UNIT HEATERS

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for horizontal or vertical hydronic and electric propeller unit heaters.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

A. Capacity rated in accordance with ARI.

B. Hydronic coils shall be pressure tested to 400 psig.

C. Units shall be UL or ETI listed and labeled.

1.4 COMPONENTS

A Hydronic Propeller Unit Heaters
1. Cabinets shall be formed steel. Provide with louvered adjustable grilles for air outlet.
2. Coils shall be constructed of seamless copper tubing that is mechanically bonded to aluminum fins.
3. Fans shall be propeller type direct drive.
4. Provide factory enamel finish.

B. Electric Propeller Unit Heaters
1. Cabinets shall be formed steel. Provide with louvered adjustable grilles for air outlet.
2. Coils shall be constructed of nickel chromium wire in a metallic sheath with fins no closer than .16 inches and free from expansion noise and 60-Hz hum.
3. Fans shall be forward curved centrifugal direct drive.
4. Provide with fused fan and electric coil circuit protection.
5. Provide factory enamel finish.

1.5 INSTALLATION

A. Install per manufacturers requirements.

END OF SECTION

SECTION 238316

RADIANT HEATING HYDRONIC SYSTEM

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for hydronic ceiling radiation and enclosure.

1.2 SUBMITTALS

A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

B. Shop drawings are required denoting layout of each radiant panel.

1.3 QUALITY ASSURANCE

A. Radiation pressure tested to 400 psig.

1.4 COMPONENTS

A Hydronic ceiling radiation:
1. Panels: Constructed of extruded ribbed aluminum with copper serpentine coil. The coil shall be mechanically bonded to the aluminum panel.
2. Provide 2 inch thick fiberglass insulation on the top side of the radiant panel.
3. Provide factory enamel finish.

1.5 INSTALLATION

A. Install per manufacturers requirements.

END OF SECTION

26 DIVISION

ELECTRICAL

TABLE OF CONTENTS

DIVISION 26: ELECTRICAL

260513 Medium Voltage Cables 2001 to 35,000 v
260519 Low Voltage Electrical Power Conductors and Cables
260526 Grounding and Bonding of Electrical Systems
260529 Hangers and Supporting Devices
260533 Raceway and Boxes for Electrical Systems
260536 Cable Tray for Electrical Systems
260543 Underground Ducts and Raceways for Electric Systems
260923 Lighting Control Devices
261200 Medium Voltage Transformers
261300 Medium Voltage Switchgear
262200 Low Voltage Transformers
262413 Switchboards
262416 Panelboards
262419 Motor Control Centers
262726 Wiring Devices
262813 Fuses and Fuse Holders
262816 Enclosed Switches and Circuit Breakers
262913 Enclosed Controllers
263213 Package Engine Generators
263600 Transfer Switches
264313 Transient Voltage Suppression for Low-Voltage Electrical Power Circuits
265100 Interior Lighting
265561 Theatrical Dimming System
265600 Exterior Lighting

SECTION 260513

MEDIUM VOLTAGE CABLES ***601*** to 35,000 V

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for cables, related splices, and terminations.

1.2 QUALITY ASSURANCE

A. IEEE C2

B. NFPA 70 – National Electric Code

C. Underwriter's Laboratory

D. Trained and Certified Cable Splicer – by material manufacturer

1.3 CABLES

A. UL Cable Type MV 90

B. UL 1072, AEIC CS 8, ***ICEA S-94-649***, ICEA s-97-682 compliant

C. Conductor material shall be copper ***or aluminum***

D. Cross linked polyethylene 133 percent insulation

E. ***Bare*** copper shielding wire

1.4 SPLICE KITS

A. Comply with IEEE 404

B. Type recommended by manufacturer

1.5 TERMINATIONS

A. Comply with IEEE 48

1.6 INSTALLATION

A. Install cables according to IEEE 576

END OF SECTION

SECTION 260519

LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for building wire and cable for wiring systems of 600V or less

B. Qualitative requirements for connectors, splices, terminations, and accessories for electrical distribution systems rated 600 volt or less.

1.2 QUALITY ASSURANCE – Copper Conductors

A. NFPA 70 - National Electrical Code

B. Underwriter's Laboratory

C. Copper Conductors NEMA WC 70.

D. 600V Insulating Material NEMA WC 70.

E. Armored Cable and Metal Clad Cable NEMA WC 70.

F. Conductor Connection Torque Value UL 486A.

1.3 QUALITY ASSURANCE – Aluminum Conductors

A. NFPA 70 – National Electrical Code

B. Underwriter's Laboratory 1581 – table 10.1

C. Aluminum Association 8000 series

D. Conductor Connectors UL 486 B

E. UL Standard 44

F. ICEA S-95-658 NEMA WC 70

1.4 COPPER CABLE AND WIRING - 600V OR LESS

A. Conductor material shall be copper.

B. Wire and cable shall be rated 600V.

C. Minimum conductor size shall be #12 AWG

D. Type XHHW

E. Type THHN/THWN

F. Type AC, 3 conductor, 75C insulation, copper conductor, armored cable.

G. Type MC, 3 conductor, 75C insulation, copper conductor, metal clad cable.

1.5 ALUMINUM CABLE AND WIRING – 600v or less

A. Conductor material shall be aluminum

B. Minimum size conductor shall be No. 6 AWG

C. Type XHHW-2

D. 90 degree Celsius temperature rating

E. Cable rated for 600 volts

1.6 MANUFACTURED WIRING SYSTEMS

A. Premanufactured, relocatable, integrated electrical branch wiring system for lighting in accessible ceilings.

B. Minimum No. 12 AWG copper wire with 600-volt, 90 degree insulation.

C. Minimum No. 12 AWG insulated copper ground wire.

D. Pin and socket contacts connected to branch circuit conductor.

E. Metal constructed cable heads with corrosion-resistant heads.

F. Designed so no interconnection can occur between different electrical voltages.

G. System shall be completely modular in construction incorporating conversion modules, prefabricated receptacles located in top of light fixtures, modular selector cables for connecting to light fixtures, and cable extenders.

H. System shall be capable of being manufactured to conforming to light switching arrangements required.

1.7 COPPER PERFORMANCES

A. Type THHN/THWN or XHHW in raceway for service entrance wiring.

B. Type THHN/THWN in raceway for feeders and branch circuits.

C. Type THHN/THWN for exterior branch circuits.

D. Minimum conductor size shall be #12 AWG for power circuits, #14 AWG for controls.

E. Feeders and branch circuits shall be concealed above accessible ceilings, in walls, chases, and below slab-on-grade.

F. Manufactured wiring system installation shall be limited to wiring between light fixtures located in accessible acoustical tile ceilings and from junction box located above ceiling to fixtures. Conduit shall be provided from light fixture switch location to junction box located above ceiling.

1.8 ALUMINUM PERFORMANCES

A. Type XHHW-2 in raceway for service entrance wiring, branch circuit feeders to panelboards, and distribution panels.

B. Connectors shall be dual-rated (AL7CH or AL9CH).

C. Aluminum conductor is not approved for branch circuits to receptacles, lighting fixtures, or mechanical/electrical motor circuits.

D. Feeders and branch circuits shall be concealed above accessible ceilings, in walls, chases, and below slab-on-grade.

E. Aluminum conductors shall be connected, terminated, and torque per manufacturer's recommendations.

END OF SECTION

SECTION 260526

GROUNDING and BONDING OF ELECTRICAL SYSTEMS

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for grounding for low and medium voltage systems and equipment

B. Qualitative requirements for basic requirements for grounding for protection of life, equipment, circuits, and systems

C. Qualitative requirements for grounding of underground distribution components.

1.2 QUALITY ASSURANCE

A. NFPA 70 - National Electrical Code

B. UL 467

C. Bare solid copper conductors ASTM B3.

D. Bare stranded copper conductors ASTM B8.

E. Underground distribution components IEEE C2.

1.3 MATERIALS

A. Minimum No. 12 AWG 600V insulated copper equipment grounding conductor insulated with green colored insulation.

B. Stranded cable grounding electrode conductors.

C. Bare copper conductors.

D. Grounding bus consisting of bare annealed ¼ inch by 2 inch copper bars of rectangular cross section.

E. Braided No. 30 AWG bare copper wire bonding jumpers.

F. Copper clad steel 3/4 inch grounding rods.

1.4 PERFORMANCES

A. Conduit is not an allowable grounding means.

B. Continuous grounding conductor carried throughout the power system.

C. Grounding of voice, video and data systems.

D. Provide grounding of circuits, equipment, conduits and etc. as required by the NEC.

E. Ground manholes and handholes with grounding electrode and No. 1/0 AWG bare copper conductor.

END OF SECTION

SECTION 260529

HANGERS AND SUPPORTING DEVICES

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Hangers and supporting devices for electrical components

1.2 QUALITY ASSURANCE

A. NFPA 70 - National Electrical Code

B. Underwriter's Laboratory

1.3 MATERIALS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components:
1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel
2. Concrete Inserts: Steel or malleable-iron
3. Clamps for Attachments to Steel Structural Elements
4. Through Bolts: Structural type, hex head, and high strength
5. Toggle Bolts: All-steel springhead type
6. Hanger Rods: Threaded steel

1.4 Hangars, supports, and fastening methods used shall be suitable for the weight of the components being supported.

END OF SECTION

SECTION 260533

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for raceways, boxes, wireways, raceway fittings, and technology raceways.

1.2 QUALITY ASSURANCE

A. NFPA 70 - National Electrical Code

B. Underwriter's Laboratory

. C. Rigid Metal Conduit (RMC) ANSI C80.1.

D. Intermediate Metal Conduit (IMC) ANSI C 80.6.

E. Electrical Metallic Tubing (EMT) ANSI C 80.3.

F. Liquidtight Flexible Metal Conduit (LFMC) UL 360.

G. Underground Non-Metallic Conduit (RNC) NEMA TC 2, Type EPC-40-PVC.

1.3 RACEWAY MATERIALS

A. Rigid Metal Conduit.

B. Intermediate Metal Conduit.

C. Electrical Metallic Tubing (EMT).

D. Liquidtight Flexible Metal Conduit.

E. Underground Non-Metallic Conduit.

1.4 TECHNOLOGY RACEWAY

A. From technology outlet box provide two 1 inch conduits and extend the conduits to the associated telecommunications cable tray. Coordinate requirements with the Technology Designer.

B. Utility Entrances
   1. Two 4 inch for telephone service from service pole to main technology equipment room.
   2. One 3 inch for cable television service from service pole to main technology equipment room.
   3. One 4 inch from service pole to main technology equipment room for wide area network (WAN).

1.5 METAL WIREWAYS

A. Sheet metal sized for conductors.

B. NEMA 250 Type 1.

C. Screw-on covers.

D. NEMA 1 general purpose rating at interior of building.

E. NEMA 3R raintight rating at exterior applications.

1.6 OUTLET C-D DEVICE BOXES

A. Metal boxes NEMA OS 1 compliant.

B. Cast metal, fully adjustable, rectangular floor box.

C. Metal pull boxes NEMA OS 1 compliant.

D. Exposed boxes cast type FS or FSA.

E. Outlet boxes for technology shall be minimum 3 ½ inch deep.

1.7 FITTINGS

A. NEMA FB 1 listed.

B. Hazardous (classified) location UL 886 compliant.

C. EMT Fittings: Metal compression or set screw type.

1.8 PERFORMANCES

A. RNC conduit may be used under building slab on grade for branch feeder and branch circuits. Conduit shall be installed in drainage fill.

B. RNC conduit may be used for exterior branch circuits. Encase PVC conduit in concrete when under drives and parking areas.

C. Raceway installation shall comply with NECA 1.

ALLOWABLE CONDUIT USAGE

CIRCUIT IDENTIFICATION	***ALLOWABLE TYPE CONDUIT***						
	GRC	IMC	EMT**	RNC*	Flex	W.P.Flex	MC Cable
Underground secondary service entrance conduit	X			X			
Feeders to switchboards, panels, motors, transformers, exposed conduit	X	X	X				
Connections to interior light fixtures & transformers					X		
Connections to motors & motorized equipment, interior & exterior						X	
Underground interior feeder conduit	X	X		X			
Branch circuit wiring from light fixture to light fixture						X	X
Underground exterior branch conduit	X	X		X			
Exposed conduits	X	X	X				
Conduits in metal stud partitions			X				X
Conduits buried in block walls	X	X	X				
Conduits above suspended ceilings	X	X	X				
Misc. low voltage systems (fire alarm) up to 4”C size. (EMT not allowed underground or as otherwise limited above)	X	X	X				
Interior above ceiling conduits 3 ½” and larger except as otherwise permitted	X	X	X				

* With 3 inch concrete envelope under drives and sidewalks.
** Not approved for exterior or exposed below 8 feet AFF.

END OF SECTION

SECTION 260536

CABLE TRAY FOR ELECTRICAL SYSTEMS

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for cable tray.

1.2 QUALITY ASSURANCE

A. NFPA 70 - National Electrical Code.

B. Underwriter's Laboratory.

C. NEMA VE1 Cable Tray Systems.

1.3 MATERIALS

A. Non-corrosive metal constructed center spine or wire baskets.

B. Rungs at 9 inch on center.

C. Wire mesh basket.

D. Cold-rolled steel ventilated tray.

E. Minimum size shall be 18 inches wide with 6 inch loading depth.

F. Color coded rung caps.

1.4 PERFORMANCES

A. Provide grounding per NFPA 70.

B. Install per NEMA VE2.

C. Install with ½ inch threaded rods.

END OF SECTION

SECTION 260543

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRIC SYSTEMS

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for conduits, ducts, handholes, and manholes.

1.2 QUALITY ASSURANCE

A. NFPA 70 – National Electric Code.

B. ANSI C2.

1.3 NON-METALLIC CONDUITS

A. Rigid non-metallic conduit type EPC-40-PVC, NEMA TC2, UL 561.

1.4 NON-METALLIC DUCTS

A. Rigid non-metallic Type EB-20-PVC, ASTM F 512, UL 651A.

1.5 HANDHOLES

A. Reinforced – concrete complying with ASTM C 858.

B. Cast-iron weatherproof frame.

C. Cast-iron cover with “electric” or “communication” legend.

1.6 MANHOLES

A. Reinforced concrete complying with ASTM C 858.

B. Cast-iron weatherproof frame.

C. Cast-iron cover with “electric” or “communication” legend.

1.7 PERFORMANCE

A. Verify ductbank applications with local utility company.

B. Verify loading requirements of manholes and handholes depending on locations.

END OF SECTION

SECTION 260923

LIGHTING CONTROL DEVICES

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for time switches, outdoor photoelectric switches, indoor occupancy sensors, and lighting contactors.

1.2 QUALITY ASSURANCE

A. Underwriter's Laboratory

B. NFPA 70 – National Electric Code

1.3 TIME SWITCHES

A. Contact configuration: SPST, DPST, SPDT, or DPDT.

B. Comply with UL 917.

C. 40-amp contact rating.

D. Electromechanical or fully electronic.

E. Skip-a-Day mode.

F. Astronomic time dial.

1.4 OUTDOOR PHOTOELECTRIC SWITCH

A. Solid State with SPDT or DPST contacts required for application.

B. 1800 VA tungsten or 1000 VA inductive load.

C. Comply with UL 773 A.

D. Illumination monitoring range from 1.5 to 10 foot candles with turn "on" and "off" adjustments.

E. 15 second minimum time delay.

1.5 INDOOR OCCUPANCY SENSORS

A. Contacts rated to operate connected relay complying with UL 773 A.

B. Dry contacts rated for 20 amp ballast load ct 120 and 277 voH.

C. Power supply to server shall be 24-Vdc or 150-mA.

D. Recessed and concealed time delay and sensitivity adjustments.

E. LED indicator to show motion is being detected.

F. Equipped with bypass sensor override switch in case of sensor failure.

G. Passive infrared type.

H. Ultrasonic type.

I. Dual technology combination of infrared and ultrasonic.

1.6 LIGHTING CONTACTORS

A. Electrically or mechanically held type complying with NEMA ICS 2 and UL 508.

B. Two through 12 poles field convertible contacts.

C. 20-A tungsten lighting rating or 30-A fluorescent lighting rating.

D. NEMA 250 type I indoor enclosure.

1.7 INSTALLATION

A. Install and aim sensors to achieve 90 percent of area.

B. Verify operation of each lighting control device and adjust time delays.

END OF SECTION

SECTION 261200

MEDIUM VOLTAGE TRANSFORMERS

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for pad mounted, liquid filled transformers.

1.2 QUALITY ASSURANCE

A. ANSI C57.12.26

B. NFPA 70- National Electric Code

C. IEEE C 57.12

D. Underwriter's Laboratory

E. ANSI C57.12.13.

F. Mineral Oil ASTM D 3487

1.3 MATERIALS

A. The mineral oil filled transformer shall be compartmental type, self-cooled and weather protected.

B. Tap changing mechanism for accurate voltage adjustment without opening the tank.

C. Compartments for medium and low voltage separated by a steel barrier.

D. Surge arresters for each primary phases.

E. Primary fuses complying with IEEE C 37.47.

F. Arranged for radial or loop feed as required for application.

G. Primary and secondary voltage as required.

H. Mineral Oil tested according to ASTM D 117.

I. Basic input level shall be standard value for primary equipment voltage per applicable IEEE standard.

END OF SECTION

SECTION 261300

MEDIUM VOLTAGE SWITCHGEAR

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for metal enclosed interruptor switchgear.

1.2 QUALITY ASSURANCE

A. NFPA – National Electric Code

B. Underwriter's Laboratory

C. IEEE C2

D. IEEF C37.20.3

1.3 METAL-ENCLOSED INTERRUPTOR SWITCHGEAR

A. Suitable for application in 3-phase, 60 Hz, solidly grounded-neutral system.

B. System Voltage: KV nominal to match utility voltage available.

C. 600 amp main continuous bus rating.

D. Power fuses to comply with NEMA SG-2.

E. Outdoor enclosure of weatherproof steel construction.

F. Surge arrestors to comply with NEMA LA1.

G. Tin-plated copper or aluminum busing.

1.4 INSTALLATION

A. Coordinate location and voltage with local electric utility and authority having jurisdiction.

B. Provide arc flash hazard label on equipment per the National Electrical Code.

END OF SECTION

SECTION 262200

LOW VOLTAGE TRANSFORMERS

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for dry type distribution transformers rated 600V or less, buck-boost transformers, and energy efficient dry type transformers.

1.2 QUALITY ASSURANCE

A. Dry Type Distribution Transformers: NEMA TP-1.

B. High Efficiency Dry Type Distribution Transformers: Department of Energy CSL 3.

C. Buck-Boost Transformers NEMA ST 1, UL 506.

D. Sound levels NEMA ST1-4 and ANSI C89.1.

1.3 DRY TYPE TRANSFORMERS (NEMA TP-1)

A. Transformers shall be dry type gravity ventilated for wall or floor mounting.

B. KVA rating shall be as denoted on the drawings.

C. Transformers rated 7.5 kVA through 24 kVA shall have two -5 percent taps, below rated voltage.

D. Transformers rated 25 kVA and larger shall have two 2-1/2 percent F.C.A.N. taps and four 2-1/2 percent F.C.B.N. taps, unless otherwise noted.

E. Coils: continuous windings without splices except for taps.

F. Insulation Class for Transformers 14 kVA and smaller: 180 degrees C, UL component recognized insulation system with a maximum of 115 degrees C rise above 25 degrees C ambient temperature.

G. Insulation Class for Transformers 15 kVA and Larger: 220 degrees C, UL component recognized insulation system with a maximum of 150 degrees C rise above 40 degrees C ambient temperature.

H. Cores shall be manufactured with non-ageing silicon steel.

I. The core and coil assembly shall be mounted on vibration pads and bolted to the enclosure.

J. Copper or aluminum windings to brace coil layers.

K. Enclosure shall be heavy gauge steel.

L. There shall be no metal to metal contact between the core, coil, and the enclosure.

1.4 DRY TYPE TRANSFORMER (***NEMA Premium***)

A. Transformer shall be dry type gravity ventilated.

B. KVA rating shall be as shown as drawings.

C. Transformers rated 30 KVA–300 KVA shall have two 2-1/2% F.C.A.N. and two 2-1/2% F.C.B.S. taps. Transformers rated 15 KVA–500 KVA shall have one 5% F.C.A.N. and one 5% F.C.B.N. tap.

D. Copper ***or aluminum***-wound, 3-phase, common core insulation transformer built to NEMA ST20.

E. 200% rated neutral, 60 Hz, 10kV BIL.

F. Insulation class 220 degrees C.

G. Labeled K Rating: K-7.

H. Minimum efficiency shall comply with the following when tested per ***10 C.F.R. Part 431 and TP-2 procedures***:

Three Phase Efficiencies	
KVA Size	Efficiency
15	***97.90***
30	***98.25***
45	***98.39***
75	***98.60***
112.5	***98.74***
150	***98.81***
225	***98.95***
300	***99.02***
500	***99.09***
750	***98.16***
1000	***99.23***

1.5 BUCK-BOOST TRANSFORMER

A. Self-cooled dry type: continuous duty rating.

B. Ventilated enclosure NEMA 250 Type 2.

END OF SECTION

SECTION 262413

SWITCHBOARDS

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for switchboards and fusible bolted-pressure contact switch.

1.2 QUALITY ASSURANCE

A. Switchboards 600 v or less: NEMA PB-2.

B. NFPA 70 - National electrical Code

C. Underwriter's Laboratory

1.3 SWITCHBOARDS

A. Nominal system voltage, main bus continuous with uniform capacity for entire length of bus.

B. Short circuit rating of 65K, 100K, or 200K to meet or exceed application.

C. Low voltage circuit breakers to be continuous current, interrupting, and short-time current ratings for each circuit breaker suitable for use. Voltage and frequency ratings same as switchboard.

D. Fusible switch branch units.

E. Three-phase, four-wire configuration.

F. Front connected, front accessible with fixed main device, panel-mounted branches and sections front and rear aligned.

G. Tin plated copper or aluminum neutral and phase bussing.

H. Minimum .25 by 2 inch full length ground buss.

I. One hundred percent rated full length neutral buss.

J. Utility Metering Compartment: Acceptable to local utility company.

K. Integral fusible or circuit breaker type main switch.

L. NEMA 1 enclosure.

1.4 FUSIBLE BOLTED-PRESSURE CONTACT SWITCH

A. Labeled for use as service equipment.

B. Manual handle operation for opening and closing.

C. Contact interruption capability: twelve times switch rating.

D. Ground fault relay: comply with UL 1053.

E. Fused switch: NEMA KS 1 Type HD with clips to accommodate specified fuses.

1.5 INSTALLATION

A. Provide arc flash hazard label on equipment per the National Electrical Code.

1.6 MULTI-FUNCTION DIGITAL METERING MONITOR

A. Microprocessor-based unit.

B. Mounted flush or semi-flush in unit.

C. RS485 / RS232 and Modbus protocol digital communications output.

D. Monitoring functions including:

1. Phase currents each phase
2. Phase to phase voltages
3. Phase to neutral voltages
4. Megawatts – kilowatt hours
5. Megavars
6. Power factor
7. Power demand
8. Harmonics

END OF SECTION

SECTION 262416

PANELBOARDS

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for lighting and appliance branch circuit panelboards and distribution panelboards.

1.2 QUALITY ASSURANCE

A. Lighting and appliance branch circuit panelboards – NEMA PB 1.

B. Distribution Panelboards: NEMA PB.1.

C. NFPA 70 - National Electrical Code

D. Underwriter's Laboratory

1.3 LIGHTING AND APPLIANCE BRANCH CIRCUIT PANELBOARDS / DISTRIBUTION PANELBOARDS

A. Tin plated copper or aluminum phase and neutral bussing.

B. Integral ground bus.

C. Lighting and appliance branch circuit panelboards to be provided with circuit breaker type overcurrent protective devices with short circuit current available at terminals.

D. Distribution panelboards to be provided with fusible or circuit breaker type overcurrent protective devices with short circuit current rating available at terminals.

E. Mechanical type main and neutral lugs.

F. Feed-through lugs suitable for use with conductor material. Locate at opposite end of incoming lugs on main device.

G. Bus bars in lighting and appliance branch circuit panelboards and distribution panel assemblies shall be adequately braced to withstand the maximum short circuit current at the point of application.

1.4 INSTALLATION

A. Provide arc flash hazard label on equipment per the National Electrical Code.

END OF SECTION

SECTION 262419

MOTOR CONTROL CENTERS

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for motor control centers rated 600 V or less.

1.2 QUALITY ASSURANCE

A. NFPA 70 - National Electrical Code

B. Underwriter's Laboratory

1.3 MOTOR CONTROL CENTER

A. NEMA 250 Type 1 indoor enclosure.

B. Modular construction with individual doors.

C. Compartments constructed to allow for removal of units without opening adjacent doors.

D. Copper or tin plated aluminum bus.

E. Full size neutral bus.

F. Non-insulated equipment ground bus.

G. Phase, neutral, and ground buses to have same capacity the entire length.

H. Unit to have short circuit withstand rating shall as rating of section.

I. NEMA size 3 and smaller controllers shall be constructed with drawout mountings.

J. Equipment unit with controller to meet application as specified in specification section 262913.

1.4 INSTALLATION

A. Provide arc flash hazard label on equipment per the National Electrical Code.

END OF SECTION

SECTION 262726

WIRING DEVICES

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES QUALITATIVE REQUIREMENTS FOR:

A. High Capacity Floor Boxes

B. Duplex Receptacles and Integral GFCA Receptacles

C. Tamper-Resistant Duplex Receptacles

D. Wall Switches

E. Wall Switch Occupancy Sensors

F. Dimmer Switches

G. Poke Through Assemblies

H. Device Coverplates

1.2 QUALITY ASSURANCE

A. High Capacity Floor Boxes: Underwriter's Laboratory Listed.

B. Duplex Receptacles and Integral GFCA Receptacles: Underwriter's Laboratory 498, NEMA WD 1.

C. Tamper-Resistant Duplex Receptacles: NEMA WD 1, UL 498..

D. Wall Switches: NEMA WD 1, UL 20.

E. Wall Switch Occupany Sensors: Underwriter's Laboratory.

F. Dimmer Switches: UL 1472.

G. Poke Through Assemblies: Underwriter's Laboratory.

1.3 HIGH CAPACITY FLOOR BOXES

A. Stamped steel 8 gang 2 compartments units.

B. Fully adjustable.

C. Rectangular steel with carpet flange and carpet insert.

D. Blank aluminum plate where floor finish is not carpet.

1.4 DUPLEX RECEPTACLES AND INTEGRAL GFCI RECEPTACLES

A. 1-pole, 3 wire, grounding.

B. 20 amp, 125 volt rated.

C. Heavy Duty Specification grade, Duplex, back and side wired.

D. Ground fault protection where required shall be built into receptacle. Trippins values shall conform: UL 1436 and UL 943.

1.5 TAMPER-RESISTANT DUPLEX RECEPTACLES

A. 1-pole, 3 wire, grounding.

B. 20 amp, 125 volt rated.

C. Hospital grade.

1.6 WALL SWITCHES

A. 20 amp, 120/277 volt rated with ground screw.

B. Specification grade.

1.7 WALL SWITCH OCCUPANY SENSORS

A. Adaptive technology with adjustable time delay.

B. 180 degree field of view.

C. 1800 watts at 120-volt.

D. 4155 watts at 277-volt.

E. Passive infrared.

F. Push “on”-“off” occupant switch

1.8 DIMMER SWITCHES

A. Architectural grade, rotary knob series.

B. 120 volt, wattage as required by fixture wattage.

1.9 POKE THROUGH ASSEMBLIES

A. Factory fabricated.

B. Fire rated or non-fire rated assemblies.

C. Flush with floor type.

1.10 DEVICE COVERPLATES

A. Stainless steel jumbo size with U.S. 32D finish.

B. Configuration of plates to match devices.

C. Weatherproof type stainless steel with U.S. 32D finish on exterior mounted duplex receptacles.

1.11 PERFORMANCES

A. Provide receptacles on roof as required by National Electric Code.

B. Toggle type in classrooms and key type in public areas.

C. Provide tamper-resistant receptacles in pre-kindergarten and kindergarten classrooms.

END OF SECTION

SECTION 262813

FUSES AND FUSE HOLDERS

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for cartridge fuses rated 600 V and less and spare fuse cabinets.

1.2 QUALITY ASSURANCE

A. NFPA 70 - National Electrical Code

B. Underwriter's Laboratory

C. Cartridge Fuses: NEMA FU 1

1.3 CARTRIDGE FUSES

A. Fuses shall be nonrenewable cartridge type, noninterchangeable type.

B. Service entrance fuses shall be Class R or Class L rejection type, time delay, high interrupting, current limiting, dual element.

C. Feeder fuses shall be Class L or J time delay.

D. Motor branch circuit shall be NEMA Class "RK1" time delay.

E. Other branch circuits Class J time delay.

1.4 SPARE FUSE CABINET

A. Wall mounted steel constructed unit with hinged door and cam lock and pull.

B. Three spare fuses for each type and size.

END OF SECTION

SECTION 262816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for molded case circuit breakers, fusible and non-fusible switches, bolted-pressure contact switches, enclosures.

1.2 QUALITY ASSURANCE

A. Molded Case Circuit Breakers: UL 489, NEMA AB 1.

B. Fusible and Non-Fusible Switches, NEMA KS 1.

C. Bolted-Pressure Contact Switches UL 977.

D. Enclosures, NEMA AB 1 and NEMA KS 1.

E. NFPA 70 - National Electrical Code

1.3 MOLDED CASE CIRCUIT BREAKER

A. Interrupting capacity to meet available fault current at point of application.

B. Magnetic trip elements.

C. Lugs: Suitable for number, size, trip ratings, and conductor material.

D. GFCI Circuit Breakers: Single and two pole with 5mA trip sensitivity.

E. Type SWD for switching fluorescent lights.

F. Type HACR for heating, air conditioning, and refrigerant equipment.

G. Shunt trip: 120 v coil energized from separate circuit.

1.4 FUSIBLE AND NON-FUSIBLE SWITCHES

A. Fusible Switches, 1200 amp and Smaller: NEMA KS 1, Type HD (heavy duty) with lockable handle.

B. Non-fusible Switches: NEMA KS 1, Type HD (heavy duty) with lockable handle.

1.5 BOLTED-PRESSURE CONTACT SWITCHES

A. Labeled for use as service equipment.

B. Manual handle operation for opening and closing.

C. Contact interruptions capability: twelve times switch rating.

D. Ground fault relay comply with UL 1053.

1.6 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions.
   1. Outdoor locations: NEMA 250 Type 3R
   2. Kitchen areas: NEMA 250 Type 4X, stainless steel.

1.7 INSTALLATION

A. Series rated circuit breaker not acceptable.

END OF SECTION

SECTION 262913

ENCLOSED CONTROLLERS

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for across-the-line, manual, and magnetic controllers; and reduced-voltage controllers.

1.2 QUALITY ASSURANCE

A. NFPA 70 - National Electrical Code

B. Underwriter's Laboratory

1.3 ACROSS-THE-LINE MANUAL CONTROLLERS

A. Manual controller with quick make or quick break toggle switch or push button.

B. General purpose Class A type.

C. Equipped with heaters and sensors in each phase matched to nameplate full-load current of motor.

1.4 ACROSS-THE-LINE MAGNETIC CONTROLLERS

A. Nonreversing across the line full voltage type.

B. NEMA ICS 2 Class A full voltage.

C. 120 volt control circuit obtained from integral control transformer.

D. Heavy duty type, hand/off/auto selector switch with pilot light and test push button.

E. Equipped with under voltage and phase-failure relays.

1.5 COMBINATION ACROSS-THE-LINE CONTROLLER / DISCONNECT

A. Nonreversing across-the-line full voltage type.

B. NEMA ICS 2 Class A full voltage.

C. 120 volt control circuit obtained from integral control transformer.

D. Heavy duty, fusible switch with rejection type fuses. NEMA KS 1.

E. Heavy duty type, hand/off/auto selector switch with pilot light and test push button.

F. Equipped with under voltage and phase-failure relays.

1.6 REDUCED-VOLTAGE ENCLOSED CONTROLLERS

A. Solid state controller suitable for use with polyphase induction motor.

B. Adjustable acceleration rate and adjustable starting torque control.

C. Surge suppressor in solid-state power circuit.

D. LED indicators showing motor and control status.

E. Heavy duty type, hand/off/auto selector switch with pilot light and test push button.

F. Equipped with under voltage and phase-failure relays.

1.7 ENCLOSURES

A. NEMA 250 Type 1 for indoor applications.

B. NEMA 250 Type 3R for outdoor applications.

C. NEMA 250 Type 1 for kitchen areas.

END OF SECTION

SECTION 263213

PACKAGE ENGINE GENERATORS

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for packaged engine generator system

1.2 QUALITY ASSURANCE

A. Compliance with NFPA 110

B. Factory testing

C. Field testing

D. NFPA 70 - National Electrical Code

E. UL 2200 – Stationary generators
UL 142 – Subbase fuel storage tanks

F. Installation of stationary generator - NFPA 37

1.3 PACKAGED GENERATOR SYSTEM CHARACTERISTICS

A. Type: Standby automatically started engine coupled to an AC generator unit.

B. Ratings: Voltage, frequency, and power output ratings suitable for use.

C. Maximum transfer time to assume full load: Per NEC.

D. Fuel type: Diesel or natural gas dependent upon application and authorities having jurisdiction.

E. Fuel supply: Minimum per NEC.

1.4 PACKAGED GENERATOR SYSTEM COMPONENTS

A. Engine

B. Cooling system: liquid-cooled unit mounted radiator.

C. Subbase diesel double wall fuel storage tank with leak monitor or natural gas supply.

D. For outdoor generator set provide weatherproof steel housing, louvers, and dampers.

E. Provide vibration isolators.

F. Critical type muffler/silencer.

END OF SECTION

SECTION 263600

TRANSFER SWITCHES

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Qualitative requirements for automatic transfer switch for packaged engine generators.

1.2 QUALITY ASSURANCE

A. NFPA 70 – National Electric Code.

B. NFPA 110 – Emergency and Standby Power Systems Level 1

C. NEMA ICS 1

1.3 AUTOMATIC TRANSFER SWITCH

A. Fault current and withstand ratings adequate for available fault currents.

B. Solid state controls.

C. Double-throw type, incapable of pauses or intermediate positions stops.

D. 3 pole (phase) switching type.

END OF SECTION

SECTION 264313

TRANSIENT VOLTAGE SUPPRESSION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES
- A. Transient Voltage Surge Suppressors

1.2 QUALITY ASSURANCE
- A. NFPA 70 - National Electrical Code. Including article 285, NEC 2002.
- B. Underwriter's Laboratory
- C. Transient Voltage Surge Suppressors: UL 1449 2nd Edition and UL 1283, ANSI/IEEE C62.41 Category A, B, C, and C62.45 testing.
- D. NEMA LS-1

1.3 TRANSIENT VOLTAGE SURGE SUPPRESSORS
- A. Individually fused Metal oxide varistors (MOVs) or each mode of protection is to be protected with surge rated fuses and thermal disconnects.
- B. Line protection
  1. Line to line
  2. Line to neutral
  3. Line to ground
  4. Neutral to ground

- C. UL 1449 Edition suppressed voltage rating:

Voltage Configuration	L-N	L-G	N-G	L-L
120/208 Three Phase Wye	400v	400v	400v	800v
277/480 Three Phase Wye	800v	800v	800v	1200v

- D. One percent variation in metal oxide varistors.
- E. LED indicator light.
- F. Rated as a UL 1283 electromagnetic interference filter.
- G. NEMA 1 rated enclosure.

1.4 SERVICE ENTRANCE
- A. Integral or external mounting.
- B. Minimum single surge current rating of 120k per node.

1.5 BRANCH PANELBOARD
- A. Integral or external mounting.
- B. Minimum single surge current rating of 80k per node.

1.6 INSTALLATION
- A. Install transient voltage surge suppressors on the load side of the main disconnect at the main switchboard and each branch circuit panelboard serving duplex receptacles. Utilize a spare 30 to 60a two or three pole breaker for TVSS disconnect.

END OF SECTION

SECTION 265100

INTERIOR LIGHTING

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for interior lighting fixtures, lamps and ballast, emergency lighting units, exit sign, and lighting fixture support.

1.2 QUALITY ASSURANCE

A. Underwriter's Laboratory

B. NFPA 70 - National Electrical Code

C. Fluorescent fixtures UL 1598.

D. Explosionproof fixtures UL 844.

E. Track lighting UL 1574.

F. Exit signs UL 924.

G. Emergency lighting UL 924.

H. Solid state lighting (LED) UL 1598.

1.3 FLUORESCENT INTERIOR LIGHTING FIXTURES

A. Fluorescent Troffers
1. Static Recessed 2 by 4 foot, 2 by 2 foot, or 1 by 4 foot
2. .125 inch Prismatic virgin acrylic A12 lens
3. Flat steel door
4. Number of lamps as required
5. Steel construction

B. Fluorescent Troffers – Specular Reflector
1. Static recessed 2 foot by 4 foot, 2 foot by 2 foot, or 1 foot by 4 foot
2. 0.125 inch prismatic virgin acrylic A12 lens
3. Flat steel door
4. 0.020 inch aluminum reflector, 92% specular, 3% diffuse
5. Number of lamps as required
6. Steel construction

C. Fluorescent Wraparound Fixtures
1. One piece acrylic prismatic
2. Number of lamps as required
3. Four foot length
4. Steel construction
5. Surface or suspended mounting

D. Fluorescent Strip Fixtures
   1. No lenses
   2. Four foot length
   3. Asymmetric or Symmetric reflectors as required.
   4. Steel construction

E. Fluorescent Recessed Cans
   1. Minimum 6 inch diameter
   2. Clear alzak reflector
   3. Compact fluorescent
   4. Open lens unless required.

F. Fluorescent Parabolic type
   1. Static Recessed 2 by 4 foot, 2 by 2 foot, or 1 by 4 foot
   2. Lens appropriate for insuring 80 percent visual comfort probability
   3. Number of lamps as required
   4. Steel construction

G. Fluorescent Recessed Indirect/Direct
   1. Static recessed by 2 by 4 foot, 2 by 2 foot
   2. Perforated metal round shield
   3. Number of lamps as required
   4. Matte white aluminum reflector
   5. Steel housing construction

H. Fluorescent Pendant High-Bays
   1. 15 inch minimum round
   2. Steel stem or aircraft cable support
   3. Open or enclosed bottom
   4. UV stabilized prismatic acrylic reflector
   5. Die-cast aluminum ballast housing
   6. Compact fluorescent lamps
   7. Number of lamps as required
   8. Safety chain
   9. Wireguard

I. Interior Track Lighting
   1. Track
      a. Surface or recessed track
      b. Two circuit minimum
      c. Standard lengths with all fittings
   2. Fixtures
      a. Shape per Design Professional
      b. Incandescent 120 volt type
      c. Color selection by design professional

J. High output Fluorescent High-Bay Industrial Fixtures
   1. Sizes
      a. 16” x 4’
      b. 2’ x 4’
      c. 16” x 8’
      d. 2’ x 8’

2. Steel Construction
3. No lens
4. High output T5HO lamps
5. 95% reflectance segmented specular aluminum reflector
6. Full wireguard

K. Labels and Miscellaneous
1. Wet and damp location labels as required.
2. Provide wireguards on fixtures, exit signs, and emergency lighting in gymnasiums.

L. Installation
1. Chain hang troffer type fixtures from structural steel independent of grid or screw attach fixtures to grid and grid support at each corner of grid.

1.4 INCANDESCENT ***TRACK*** LIGHTING

A. Types
1. ***Open front type***
2. Round ***or flat back***
3. Porcelain socket

1.5 SOLID STATE LIGHTING (LED) LUMINAIRES
A. Types
1. Recessed or surface mount
2. Comply with IES LM-79
3. CRI 75 minimum
4. Color consistency NEMA SSL 3
5. B50 rating at least 50,000 hours per IES LM-80

1.6 EXPLOSIONPROOF FIXTURES

A. Types
1. Comply with hazardous classification for its location per the National Electrical Code
2. Lamp type suitable for condition.

1.7 EMERGENCY LIGHTING UNITS

A. Type
1. Provide from fixtures above connected to emergency generator.

1.8 EXIT SIGNS

A. Type
1. Cast aluminum construction
2. Color by design professional
3. LED lamp type
4. Wireguards as required
5. Red lettering
6. Directional arrows

1.9 LINEAR FLUORESCENT BALLAST

A. Electronic type with maximum 10 percent total harmonic distortion.
B. Rapid start, instant start, or programmed start type.
C. Suitable for T8, T5, or T5HO lamps.
D. 95 percent minimum power factor.
E. Class A sound rating.
F. .71, .88, or 1.15 ballast factor.

1.10 DIMMABLE LINEAR FLUORESCENT BALLAST

A. Electronic type.
B. 100 percent to 5 percent dimming range.

1.11 COMPACT FLUORESCENT BALLAST

A. Electronic type with maximum 20 percent total harmonic distortion.
B. Programmed rapid start.
C. 95 percent minimum power factor.
D. 95 percent or higher ballast factor.
E. Class A sound rating.

1.12 DIMMABLE COMPACT FLUORESCENT BALLAST

A. Electronic type.
B. 100 percent to 5 percent dimming range.

1.13 DIGITAL ELECTRONIC DIMMING BALLAST

A. Provides a continuous 2-wire dimming signal.
B. Internal circuitry to limit inrush current.
C. Operating voltages of 120/240/277 volts at 50 or 60 Hz.
D. Continuous flicker free dimming range from 100% to 10%.
E. Capable of connecting one or multiple sensors.
F. Capable of generating digital communication commands to digital bus.
G. Capable of monitoring lamp and ballast conditions.
H. Total harmonic distortion (THD) less than 20%.
I. Power factor greater than 95%.
J. Ballast factor greater than 85% for T8 lamps and equal to 1.0 for T5 and T5HO lamps.

1.14 FLUORESCENT LAMPS

A. T8 rapid-start low-mercury lamps, rated 32 W maximum, nominal length of 48 inches, 2950 initial lumens (minimum), CRI 85 (minimum), color temperature 4100K, and average rated life 30,000 hours, unless otherwise indicated.

B. T8 rapid-start low-mercury lamps, rated 17 W maximum, nominal length of 24 inches, 1350 initial lumens (minimum), CRI 85 (minimum), color temperature 4100K, and average rated life 20,000 hours, unless otherwise indicated.

C. T8 rapid-start low-mercury lamps, rated 28 W maximum, nominal length of 18 inches, 2725 initial lumens (minimum), CRI 85, color temperature 4100K, and average rated life 36,000 hours, unless noted otherwise.

D. T8 rapid-start low-mercury lamps, rated 32 W maximum, nominal length of 48 inches, 3100 initial lumens (minimum), CRI 85, color temperature 4100K, and average rated life of 36,000 hours, unless rated otherwise.

E. T5 rapid-start low-mercury lamps, rated 28 W maximum, nominal length of 45.2 inches, 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 3500K, and average rated life 20,000 hours, unless otherwise indicated.

F. T5HO rapid-start high output low-mercury lamps, rated 54 W maximum, nominal length of 45.2 inches, 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 3500K, and average rated life 20,000 hours, unless otherwise indicated.

G. Compact Fluorescent Lamps: 4-pin, low mercury, CRI 80 (minimum), color temperature 3500K, average rated life of 10,000 hours at 3 hours operation per start, and suitable for use with dimming ballasts, unless otherwise indicated.
   1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
   2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
   3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
   4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
   5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
   6. 55 W: T4, triple tube, rated 4300 initial lumens (minimum).

1.15 LIGHT FIXTURES SUPPORT COMPONENTS

A. 1/4 inch minimum diameter thread steel rod hangers

B. ½ inch steel tubing with swivel ball fittings and ceiling canopy.

END OF SECTION

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK.

SECTION 265561

THEATRICAL DIMMING SYSTEM

GENERAL ***GUIDELINES***

1.1 SECTION INCLUDES

A. Stage dimming and control.

B. Stage lighting.

1.2 QUALITY ASSURANCE

A. NFPA - National Electrical Code.

B. Underwriter's Laboratory.

C. Light Fixtures UL 1573.

D. Main Control Console UL 508.

1.3 MAIN CONTROL CONSOLE

A. Minimum 48 channel single scene microprocessor based.

B. Non-volatile memory disk backup.

C. Minimum 12 scene masters.

D. Console receptacles located at stage managers panel, at rear of cafetorium and in booth (if one is provided).

E. Minimum 10 foot cables for power and signal.

F. Tabletop unit.

1.4 DIMMER RACK

A. Dual 2400 watt dimmers.

B. Free standing rack mounted with cooling fan(s).

C. Primary circuit breaker with fault current rating for point of service.

D. Capable of data transmission with USITT DMX 512.

1.5 LIGHTING UNITS

A. Front Lighting (cafetorium ceiling)

1. Connector Strips: Approximately 4 inch by 4 inch with flush receptacles, hangers, interior terminal strip.

For School	Overall Dimmed Length Circuits	Number of Receptacles	Minimum Quantity
Middle 10’	Six each	Six each	Two
High 10’	Six each	Six each	Three

Locate at minimum the distance equal to proscenium height from the stage out onto the ceiling, centered on proscenium edges plus at proscenium center line for high school.

2. Lighting Instruments: Ellipsoidal spotlights, 6 inch by 20 degrees, 575 watt lamp, 36 inch leads, connector, color frame, safety cable, “C” Clamp.

For School	Minimum Quantity	Initial Location
Middle	Six	Three each connector strip
High	Nine	Three each connector strip

E. Overstage Lighting (Electrics): Should appear approximately 3 feet back, then at intervals of approximately eight feet.

1. Connector strips approximately 4 inch by 4 inch plus junction box, with receptacles on 18 inch pigtails, double pipe hangers. Provide additional (*) three receptacles at ends and center on a circuit switched at stage managers panel for worklights.

For School	Minimum overall Length	Dimmed Circuits	Number of Receptacles	Minimum Quantity
Middle	3/4 proscenium width	Twelve	Fifteen*	Two
High	3/4 proscenium width	Eighteen	Twenty-one*	Two

2. Additional Overstage: Third Electric (fourth electric if stage is more than 25 foot deep). Four, 4 circuit/receptacle plug boxes on flexible cables capable of reaching a point 5 feet above the stage floor.

3. Spotlights: Fresnel Spotlights: 6 inches, 750 watt lamp, 36 inch leads, connector, color frame, safety cable, “C” Clamp.

For School	Minimum Quantity	Initial Location
Middle	Twelve	Six each connector strip
High	Eighteen	Nine each connector strip

4. Striplights: 7'-6" x 4 circuit, with red, green, blue, and clear roundels, 200 watt lamps, 36 inch leads at each end with appropriate connectors.

For School	Minimum Quantity	Initial Location
Middle	Six	Three each connector strip
High	Six	Three each connector strip

5. Stage Worklights: Scoops: 10 inches, 150 watt lamp 36 inch leads, connector, color frame, safety cable, "C" Clamp.

For School	Minimum Quantity	Initial Location
Middle	Six	Three each connector strip
High	Six	Three each connector strip

C. Backstage Worklights:
   1. 200 watt incandescent in industrial reflectors to limit spill onto the stage.
   2. Minimum two each side of either type stage.

1.6 MISCELLANEOUS

A. Provide stage managers panel to allow control of area lighting functions.

B. Provide a minimum of two floor pockets, one each side of the stage, each with three dimmed circuits/receptacles and one constant duplex receptacle.

1.7 INSTALLATION

A. Neutrals from system feed to be 130 percent of hot line size.

B. All branch circuits are to be two wire no common neutrals.

C. All strips and floor pockets shall be grounded per NEC.

END OF SECTION

SECTION 265600

EXTERIOR LIGHTING

GENERAL GUIDELINES

1.1 SECTION INCLUDES

A. Qualitative requirements for exterior luminaries with lamps and ballast; and poles.

1.2 QUALITY ASSURANCE

A. Underwriter's Laboratory

B. NFPA 70 - National Electrical Code

C. Luminaires UL 1598.

D. High intensity discharge (HID) ballast UL 1029.

E. Solid state lighting (LED) UL 1598

1.3 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead load weight of luminaire, supports, lowering devices as stated in AASHTO LTS-4.

B. Fixtures and poles shall be designed for wind load pressures conforming to the Ohio Basic Code.

1.4 LUMINAIRES

A. Listed and labeled for installation in wet location.

B. Metal parts free of burrs, sharp corners, and edges.

C. Constructed of corrosion-resistant aluminum.

D. Rigidly formed housings that provide weathertight and lighttight enclosures.

E. Stainless steel exposed hardware.

F. Doors and frames shall prevent accidental falling during relamping or ballast replacement.

G. Heat and aging-resistant reslient gasket to seal lenses to luminaire door.

1.5 FLUORESCENT BALLAST AND LAMPS

A. Low temperature ballast for reliable starting and operation of lamps to minus 20 degrees Fahrenheit.

B. Ballast to have less than 10 percent total harmonic distortion.

C. Electromagnetic ballast to be high power factor Class P.

D. Fluorescent lamps shall be low-mercury type and reliable starting and operation to minus 20 degrees Fahrenheit.

1.6 BALLAST FOR HID LAMPS

A. Constant wattage autotransformer or high power factor type.

B. Minimum starting temperature of minus 22 degrees Fahrenheit.

C. High pressure sodium ballast shall be electro magnetic type with solid state igniter/starter and minimum starting temperature of minus 40 degrees Fahrenheit.

1.7 HID LAMPS

A. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), color temperature 1900K, and average rated life of 24,000 hours, minimum.

B. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature 4000 K.

C. Pulse-Start Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K.

D. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000 K.

1.8 SOLID STATE LIGHTING (LED) LUMINAIRES

A. Wall or pole mounted

B. Comply with IES LM-79

C. CRI 75 minimum

D. Color consistency NEMA SSL 3

E. B50 rating at least 50,000 hours per IES LM-80

1.9 DRIVERS FOR SOLID STATE LIGHTING (LED) LUMINAIRES

A. Comply with ANSI 82.11

B. UL 935 approved

C. 100 to 277-volt input rating

D. 24v DC output rating

E. Power Factor: .90 or higher

1.10 POLES

A. Structural Characteristics: Comply with AASHTO LTS-5.

1.11 STEEL POLES

A. Poles complying with ASTM A 500 Grade B carbon steel with minimum yield of 46,000 psig.

B. One piece construction.

C. Weld ½ inch threaded lug for grounding conductor connections.

D. Vibration dampeners for Mode 1 and Mode 2

E. Factory-painted finish.

1.12 ALUMINUM POLES

A. Poles complying with ASTM B429 / B429M constructed with extruded seamless 6063 alloy.

B. Heat treated full length shaft to produce a T6 temper.

C. 1/2” threaded lug for grounding conductor connections.

D. A356 aluminum anchor base welded to shaft.

E. Vibration dampeners for Mode 1 and Mode 2.

F. Integrally-colored or electrolytically deposited color coating complying with AAMA 611.

1.13 FIBERGLASS POLES

A. 65% fiberglass with resin.

B. Resin color uniform throughout entire wall thickness UV inhibited.

C. Direct embedded along pedestrian walkways.

D. Concrete base mounted in vehicular traffic areas.

1.14 CONCRETE POLES

A. Poles: Manufactured by centrifugal spin-casting process or of cast concrete.

B. Cure with wet steam and age for a minimum of 15 days before installation.

C. Fabricate poles with a hard, non-porous surface that is resistant to water, frost, and road and soil chemicals and that has a maximum water-absorption rate of 3 percent.

END OF SECTION