

DIVISION 23 Heating, Ventilation, and Air Conditioning

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Dec. 2, 2013	23 31 13 General 1.09 ADDED	Exposed ductwork info	PD&C

PSD TECHNICAL SPECIFICATION

DIVISION 23 Heating, Ventilation, and Air Conditioning

Table of Contents

SECTION 23 05 00 – COMMON WORK RESULTS FOR HVAC.....2

SECTION 23 05 29 – HANGERS AND SUPPORTS HVAC64

SECTION 23 05 53 – IDENTIFICATION FOR HVAC EQUIPMENT66

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING FOR HVAC67

SECTION 23 07 00 – HVAC INSULATION69

SECTION 23 30 00 – HVAC AIR DISTRIBUTION70

SECTION 23 31 13 – DUCTWORK.....74

SECTION 23 33 00 – AIR DUCT ACCESSORIES78

SECTION 23 34 00 – HVAC FANS.....80

SECTION 23 35 13 – DUST COLLECTION SYSTEMS82

SECTION 23 36 00 – AIR TERMINAL UNITS84

SECTION 23 37 00 – AIR OUTLETS AND INLETS84

SECTION 23 50 00 – CENTRAL HEATING EQUIPMENT.....85

SECTION 23 51 00 – BREECHINGS, CHIMNEYS, AND STACKS89

SECTION 23 52 00 – HEATING BOILERS90

SECTION 23 55 00 – FUEL-FIRED HEATERS.....92

SECTION 23 57 00 – HEAT EXCHANGERS FOR HVAC93

SECTION 23 60 00 – CENTRAL COOLING EQUIPMENT93

SECTION 23 65 13 – FORCED-DRAFT COOLING TOWERS98

SECTION 23 71 20 – GLYCOL SYSTEMS99

SECTION 23 72 00 – OUTDOOR AIR VENTILATION (AIR TO AIR SYSTEMS).....101

SECTION 23 74 00 – PACKAGED OUTDOOR HVAC EQUIPMENT101

SECTION 23 81 43 – HEAT PUMPS.....102

SECTION 23 82 00 – CONVECTION HEATING AND COOLING UNITS103

SECTION 23 05 00 – COMMON WORK RESULTS FOR HVAC

Part 1: General

1.01 Summary

THERMAL COMFORT DESIGN CONDITIONS

1. For outdoor design conditions, confirm climate zone design parameters and discuss with project manager. PSD specifies:
 - i. Cooling 90°F dry bulb
 - ii. Heating 5°F dry bulb
2. For indoor design calculations, the following conditions should be used unless otherwise discussed with project manager.
 - i. Cooling 72°F dry bulb
 - ii. Heating 72°F dry bulb

PSD has demonstrated significant energy savings through space cooling systems, which account for over 15.4 percent of electricity used in commercial buildings. According to CEE (Consortium for Energy Efficiency), studies show that at least 25 percent of all rooftop units are oversized resulting in increased energy costs and increased equipment wear. Properly sized equipment dramatically cuts energy costs, increases the life of the equipment, cuts utility bills, and reduces pollution. PSD specifies cooling load to not exceed 1 ton/1,000 sq. ft. C. It is desirable that the most energy efficient options be considered, including:

Outside air for cooling systems: Systems should be designed with economy cycles that automatically allow the quantity of outside air supplied to the building to be varied to net maximum efficiency while maintaining indoor air quality.

Energy and/or heat recovery systems: Systems should be designed to provide as close to balanced outdoor and exhaust airflows as is practical for maximum benefit and efficiency.

Related Sections

Definitions

EER (energy efficiency ratio) is the cooling capacity (in Btu/hour) of the unit divided by its electrical input (in watts) at standard peak rating conditions.

SEER (seasonal energy efficiency ratio), unlike EER, but weighs performance during the cooling season.

COP (coefficient of performance) is the heating capacity (in Btu/h) at standard heating conditions divided by its electrical input (also in Btu/h).

HSPF (heating seasonal performance factor) weighs heating performance at various conditions.

AFUE (annual fuel utilization efficiency): of heat output of the furnace or boiler compared to the total energy consumed by a furnace.

Submittals Required

Quality Assurance

Scheduling

Delivery, Storage, and Handling

Regulatory Requirements

Part 2: Products

Manufacturers

Products

A. NOISE AND VIBRATION CONTROL

1. Provide vibration isolators for motor driven equipment. Vibration isolators shall be Mason Industries, Inc., Vibration Mountings and Control Co., Korfund, Anaconda, Flexonics, Hydro-Flex, Resistoflex.

B. Electric Motors: All three-phase motors are protected by a phase monitors.

Include the following features on all motors:

Ball bearings with lube lines extended to accessible location.

Cast iron or steel base with provision for slide adjustment unless directed otherwise.

Conduit box with ample room for lead terminal connections.

Numbered leads of ample length for connection, terminating in the conduit box.

Permanently stamped nameplate.

Single speed 1750 RPM, unless specified otherwise.

Rated for continuous duty in ambient, not exceeding 40°C.

All motor wiring and windings shall be copper.

Power Factor:

Motors shall have a labeled power factor, at nameplate rating and rated voltage, of not less than 85%. For motors 5 hp and greater and not less than 80% for motors smaller than 5hp. If a motor draws less than 1000 watts labeled rating, it is excluded from the above P.F. requirement. If, through motor or design (i.e., RPM less than 1200), an 85% power factor is not available, the supplier of that motor shall furnish power factor correction components capable of correcting that non-conforming motor to 90% or better.

Energy Efficiency:

Electric motors less than 1 hp and greater than/equal to 0.5 hp shall be specified as Electronically Commutated Motor (ECM) type.

Electric motors 1 hp and greater shall be of the premium efficiency type as defined by the Consortium for Energy Efficiency (CEE). Motors shall have a nominal nameplate efficiency that meets or exceeds the values in Table 1. Those motors that exceed the efficiency requirements listed in Table 1 by at least one numeric percent qualify as an "Enhanced" Premium efficient electric motor under the Xcel Energy Rebate program.

Table 1 - CEE PREMIUM EFFICIENCY™ CRITERIA

Nominal Full Load Efficiencies							
Covered Equipment 1-200 horsepower NEMA design A and B, three phase, integral horsepower, general purpose motors (1200, 1800, 3600 RPM).							
Open Drip-Proof (ODP)				Totally Enclosed Fan-Cooled (TEFC)			
Horsepower	1200 RPM	1800 RPM	3600 RPM	Horsepower	1200 RPM	1800 RPM	3600 RPM
1	82.5	85.5	77.0	1	82.5	85.5	77.0
1.5	86.5	86.5	84.0	1.5	87.5	86.5	84.0
2	87.5	86.5	85.5	2	88.5	86.5	85.5
3	88.5	89.5	85.5	3	89.5	89.5	86.5
5	89.5	89.5	86.5	5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	7.5	91.0	91.7	89.5

10	91.7	91.7	89.5		10	91.0	91.7	90.2
15	91.7	93.0	90.2		15	91.7	92.4	91.0
20	92.4	93.0	91.0		20	91.7	93.0	91.0
25	93.0	93.6	91.7		25	93.0	93.6	91.7
30	93.6	94.1	91.7		30	93.0	93.6	91.7
40	94.1	94.1	92.4		40	94.1	94.1	92.4
50	94.1	94.5	93.0		50	94.1	94.5	93.0
60	94.5	95.0	93.6		60	94.5	95.0	93.6
75	94.5	95.0	93.6		75	94.5	95.4	93.6
100	95.0	95.4	93.6		100	95.0	95.4	94.1
125	95.0	95.4	94.1		125	95.0	95.4	95.0
150	95.4	95.8	94.1		150	95.8	95.8	95.0
200	95.4	95.8	95.0		200	95.8	96.2	95.4

Single Phase Motors: Furnish for all applications 1/6 through 3/4 HP, single phase, capacitor start, capacitor run, drip-proof, thermally protected motors, for 120 volt 60 hertz current.

Three-Phase Motors: Furnish for all applications 1 HP and larger, 3-phase general purpose, drip-proof, squirrel cage induction motors, for 208V, 60Hz current.

Motors used with adjustable speed drives to be inverter duty and compatible with the drive.

Motors to be sized for an operating load factor between 60% and 75%.

For 208 volt three-phase power, 200 volt motors are to be used. 208-230 volt motors are not acceptable for 208 volt power.

2. V-Belt Drives:

i. Capacity of V-Belt Drives at rated RPM shall be not less than 150% of motor nameplate horsepower rating.

3. Motor starters:

i. Starters shall be across-the-line, with manual reset, trip-free thermal overload relay in each ungrounded conductor, necessary auxiliary contacts, proper NEMA Standard enclosure for location, and hand-off-automatic switches in cover. Provide H-O-A magnetic motor starters for all 3-phase motors. Provide manual motor starters for locally controlled single-phase motors. For single-phase motors interlocked with external devices provide H-O-A magnetic starters or relay and switch rated at locked rotor motor amps and manual starter. Starters, except those furnished mounted in or on equipment, shall be by the same one of the following manufacturers:

Sprecherschuh preferred.

Cutler Hammer.

Square D

ii. For all motors, devices to protect the motor against loss of phase (single phasing protection) shall be provided. Devices to meet this requirement shall be of the current sensing type, and may be provided either as an integral part of the thermal

overload or as a separate device. Units shall have manual reset and adjustable limits. Provide an approved reduced voltage starter, such as a closed transition autotransformer type.

Variable Frequency Drives:*

ABB is PSD's standard/preferred for VFD, Yaskawa approved alternative, Square D not accepted

Variable Frequency Drives shall have separate phase monitors.

ii. No NEMA 3R Variable Frequency Drives to be mounted outside.

iii. Drive shall convert the constant frequency AC line voltage to a variable frequency, variable voltage AC output suitable for control of a standard NEMA design B induction motor over a 6:1 speed range.

Provide secondary starters to control motors independently of variable frequency drives, single speed, in case of VFD failure.

Drives shall be as manufactured by ABB, or equal as approved (Yaskawa) by the Engineer and Owner.

Variable Frequency Drives for motors 5 HP and less shall have the following features:

Controller input: 230 volts, 1 phase, 60 Hz.

Controller output: 0-230 volts, 3 phase, 0-60 Hz. Where 480 volt service is used, drive manufacturer shall provide a 480/230 volt single phase isolation transformer with the VFD.

Controller Type: Transistorized "six-step" type, designed to minimize harmonic generated noise in the motor and on the line.

AC line fuses and/or circuit breaker, with voltage transient protection.

Control circuit transformer with 24 volt fused secondary.

Manual speed potentiometer, HAND-AUTO switch, and 4-20 milliamp signal follower, fully isolated and suitable for grounded or ungrounded input signal.

Instantaneous overcurrent shutdown with indicator light when current exceeds 150%. Provide time-overcurrent overload protection for the motor.

Current limiting protection to shut down drive under output short circuit conditions without damage to the controller.

Minimum and maximum speed adjustments.

Variable Frequency Drives for motors shall have the following features:

Controller Input: [460] [230] [208] volts, 3 phase, 60 Hz.

Controller Output: 0-[460] [230] [208] volts, 3 phase, 0-60 Hz.

Controller Type: "Six-step" type, designed to minimize harmonic generated noise in the motor and on the line.

Overcurrent rating: 150% for one minute, minimum.

Enclosure type: NEMA 1.

AC line fuses and/or circuit breaker.

AC line reactors in the drive cabinet for protection without requirement for an input isolation transformer.

Control power transformer with fused primary and 24v or 120v fused secondary.

Manual speed potentiometer, hand-auto switch, and 4-20 milliamp signal follower, fully isolated and suitable for grounded or ungrounded input signal.

Instantaneous overcurrent shutdown with indicator light when current exceeds 150%. Inverse characteristic time-overcurrent overload protection for the motor.

Current limiting protection to shut down drive under output short circuit conditions without damage to the controller.

Input phase loss and undervoltage protection.

Drive shall ride through a momentary power interruption of up to 400 milliseconds without tripping.

Torque/current limit control which will slow the motor without tripping when the motor is subjected to an overload or when accelerating a high inertia load.

Troubleshooting diagnostic features:

- Diagnostic test meter with selector switch to monitor internal power supply voltages, input and output amps, speed reference signal.
- LED indicators for instantaneous overload, motor overload trip, GTO or SCR status, current limit, and other drive functions as required.
- Test mode switch to allow operation and setup of control electronics with power circuitry disabled UL listed.

Part 3: Execution

Preparation

Installation

Cleaning and Protection

A. DISINFECTING AND SPECIAL CLEANING 1.

Ductwork Systems:

- i. As the system of ductwork, supplying air to the building is put into service in whole or in part, provide 2" pleated filters at fan intake to keep the mechanical system and building clean.

END OF SECTION 23 05 00

SECTION 23 05 29 – HANGERS AND SUPPORTS HVAC

Part 1: General 1.01

Summary

Types of supports and anchors specified in this section include the following:

- Hanger-Rod Attachments.
- Building Attachments.
- Saddles and Shields.
- Spring Hangers and Supports.
- Miscellaneous Materials.

Roof Equipment Supports.

Anchors.

Equipment Supports.

Supports and anchors furnished as part of factory- fabricated equipment are specified as part of equipment assembly in other sections.

Related Sections

Definitions

Submittals Required: Product Data, Shop Drawings, Certifications, O&M data

Quality Assurance

Scheduling

Delivery, Storage, and Handling

Regulatory Requirements

Part 2: Products

Manufactures

Products

MISCELLANEOUS MATERIALS

Steel Plates, Shapes, and Bars: ASTM A 36.

Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

ROOF EQUIPMENT SUPPORTS

General: Construct roof equipment supports using minimum 18-ga galvanized steel with fully mitered and welded corners, 3" cant, internal bulkhead reinforcing, integral base plates, pressure treated wood nailer, 18-ga galvanized steel counterflashing and rigid insulation.

Configuration: Construct of sizes as indicated, compensate for slope in roof so top of support is dead level.

Part 3: Execution

3.01 Preparation A.

INSPECTION

B. PREPARATION

3.02 Installation

SHEET METAL DUCT HANGERS AND SUPPORTS

EQUIPMENT SUPPORTS

Housekeeping bases shall be 4" thick minimum, extended 4" beyond machinery bedplates.

SPIRAL LOCK SEAM DUCT HANGERS AND SUPPORTS D. PREFABRICATED ROOFTOP EQUIPMENT

SUPPORTS 1. Equipment Bases:

- i. Equipment base: shall be solid top, equipment base with integral duct curb, and stepped cant to match roof insulation. Base: shall pitch to match roof pitch and provide level unit installation.
- ii. Base: shall be constructed of reinforced 18 gauge galvanized steel, with all welded components, full mitered corners, factory installed 1-1/2" thick rigid fiberglass insulation, wood nailer, and galvanized steel counter-flashing. Base shall be shipped as one piece.

All supports shall be installed in accordance with manufacturer's recommendations.

E. FLASHING AND SAFING

As needed for weather or water-proofed walls, floors, and roofs.

Lead flashing around ducts and pipes passing from equipment rooms, for sound control. F.

SLEEVES AND SEALS

1. Ducts

Roof curbs for duct penetrations REQUIRED.

Counterflash REQUIRED.

3.03 Cleaning and Protection

END OF SECTION 23 05 29

SECTION 23 05 53 – IDENTIFICATION FOR HVAC EQUIPMENT

Part 1: General

1.01 Summary

A. Types of identification devices specified in this section include the following

Plastic Tape.

Plastic Duct Markers.

Valve Tags.

Valve Schedule Frames.

Engraved Plastic-Laminate Signs.

Equipment Markers.

Plasticized Tags.

1.02 Related Sections

1.03 Definitions

1.04 Submittals Required: PRODUCT DATE, SCHEDULES

1.05 Quality Assurance

1.06 Scheduling

1.07 Delivery, Storage, and Handling

1.08 Regulatory Requirements

Part 2: Products

2.01 Manufactures

2.02 Products

Part 3: Execution

3.01 Preparation

3.02 Installation

A. MECHANICAL EQUIPMENT IDENTIFICATION

1. General: Install equipment marker on each individual items of mechanical equipment.

Provide signs for the following general categories of equipment.

Main building systems control and operating valves, including safety devices and hazardous units such as gas outlets.

Room thermostats. iii. Fuel-burning units including boilers and water heaters. iv. Pumps, chillers, and similar motor-driven units. v. Fans and blowers.

HVAC units.

Tanks and pressure vessels.

Water treatment systems and similar equipment.

2. Text of Signs: In addition to the identified unit, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

3.03 Cleaning and Protection

- A. View of mechanical identification devices ARE NOT TO BE OBSTRUCTED.

END OF SECTION 23 05 53

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING FOR HVAC

Part 1: General

- 1.01 Summary
- 1.02 Related Sections
- 1.03 Definitions
- 1.04 Submittals Required: See Div 1
- 1.05 Quality Assurance
- 1.06 Scheduling
- 1.07 Delivery, Storage, and Handling
- 1.08 Regulatory Requirements

Part 2: Products

2.01 Manufactures

Balancing shall be done by a firm specializing in this work.

Griffith Engineering Service, Denver, Colorado.

Fort Collins/Midwest.

TAB Services of Denver, Colorado.

Lawrence H. Finn & Assoc., Greeley, Colorado.

JPG Engineering, Sedalia, Colorado.

Air-Right, Denver, Colorado.

2.02 Products

Part 3: Execution

Preparation

Installation A. GENERAL

Firm having total professional responsibility for the final testing, adjusting and balancing of the entire system, air and hydronic. All balancing shall be performed by qualified technicians in the employ of the pre-qualified firm.

Instruments shall be used and applied which are best suited to the system function being tested. Instruments shall be in first- class state of repair and have been calibrated within a period of six months prior to starting the job. Instruments shall be recalibrated upon completion of the job if required by the Design Engineer to prove reliability.

All air systems and all hydronic systems shall be balanced using an applicable proportionate procedure.

After all adjustments are made; a detailed written report shall be prepared and submitted for approval. Final acceptance of this project will not be made until a satisfactory report is received and field verified.

The Design Engineer will field verify the report in the following manner:

- i. Select quantities to be tested at random. (Quantity shall not exceed 10% of total.)
- ii. Require balancing firm to read the quantities in his presence.
- iii. Field tested values shall be within plus or minus 10%.

AIR BALANCING PROCEDURES

Before any adjustments are made, room is to be closed off with windows & doors closed. The systems are to be checked for such items as dirty filters, duct leakage, damper leakage, equipment vibrations, correct damper operations, etc. All fan systems, major duct sections, registers, diffusers, etc., are to be adjusted to deliver design air quantities within plus or minus 5%. Individual air outlets, when one of three or more serving a space, may have a tolerance of 10% above average. Design CFM is based on filters being approximately 50% loaded with dirt at 0.45" SPD. Pressure drop across filters during balancing shall be simulated to that condition. After balancing is completed, check motor amperage with the filters clean.

Exhaust and recirculation air systems shall be adjusted for air and the proper relationship between supply and exhaust established.

Distribution system shall be adjusted to obtain uniform space temperatures free from objectionable drafts and noise within the capabilities of the system.

Sheaves and/or belts shall be exchanged as required to adjust the RPM of all fans so they handle specified air quantity.

HYDRONIC BALANCING PROCEDURES

Before any adjustments are made, strainers shall be cleaned, temperature control valve operation shall be checked, pump rotation shall be checked, pressure reducing valves shall be adjusted, etc.

Using system flow meters and P/T taps, the balancing firm shall adjust the quantity of fluid handled by each pump and supplied to each coil, piece of radiation, heat exchanger, etc., to meet design requirements.

Test the hydronic fluid with a refractometer as manufactured by Misco Co., or prior approved equal, for 30% propylene glycol, or analysis by Dow Chemical Co.

MISCELLANEOUS

All installed thermal overload protection shall be observed and noted in the data sheets. If thermal overload protection is incorrect, it shall be the responsibility of the balancing firm to see that proper overload protection is installed at the completion of the job.

The adjusting crew shall measure and set any special conditions; check and adjust outside and return air intakes so that the system will deliver substantially the same volume on either; make tests and record data as required in "REPORT" below.

All balancing devices, i.e., dampers and valves shall be clearly marked as to the final balanced position. Plug all test holes, replace access doors and belt guards.

When deemed necessary, 24-hour space temperature recording shall be taken and any required partial rebalance of the system shall be performed without additional cost.

Boiler efficiency shall be checked and results included in this report, either by the boiler manufacturer's representative or by the Balancing Contractor. Efficiency shall be measured either by flue gas temperature and percent carbon dioxide or by the ratio of output Btuh to input Btuh. Output Btuh shall be by GPM flow through the boiler and temperature rise. Input Btuh shall be by full firing rate CFM of gas through the gas meter, converted to Btuh.

3.03 Cleaning and Protection

END OF SECTION 23 05 93

SECTION 23 07 00 – HVAC INSULATION

Part 1: General 1.01

Summary

A. Types of mechanical insulation specified in this section include the following:

Equipment Insulation: Fiberglass. Calcium Silicate

Ductwork System Insulation: Fiberglass.

1.02 Related Sections

1.03 Definitions

1.04 Submittals Required: Product Data, Samples

1.05 Quality Assurance

1.06 Scheduling

1.07 Delivery, Storage, and Handling

1.08 Regulatory Requirements

Part 2: Products

2.01 Manufactures

2.02 Products

Part 3: Execution

3.01 Preparation A.

INSPECTION

3.02 Installation

EQUIPMENT INSULATION

1. Cold Equipment (Below Ambient Temperature):

i. Application Requirements: Insulate the following cold equipment:

Refrigeration equipment, including chillers, tanks and pumps, including any cold surfaces not factory insulated.

Drip pans under chilled equipment.

Cold water storage tanks.

Cold and chilled water pumps.

Expansion tanks.

Air separators. ii. Insulate each item of equipment specified above with the following types and thicknesses of insulation:

Rigid Fiberglass: 2" thick for surfaces above 35 deg. F (2 deg. C) and 3" thick for surfaces 35 deg. F (2 deg. C) and lower.

Flexible Elastomeric Sheet: 3/4" thickness for surface temperatures above 35oF (2oC), 1" thickness for surface temperatures below 35oF (2oC).

2. Hot Equipment (Above Ambient Temperature):

i. Application Requirements: Insulate the following hot equipment:

Boilers (not pre-insulated at factory).

Hot water storage tanks.

Water heaters (not pre-insulated at factory)

Hot water expansion tanks.

Hot water pumps.

Air separators. ii. Insulate each item of equipment specified above with the following types and thicknesses of insulation:

a. Fiberglass: 2" thick. Do not use for equipment above 450°F (232°C).

SOUND INSULATION

1. Sound insulation shall be applied to the interior of ducts as listed below:

i. All exhaust, relief, and return ducts and all rectangular supply ducts.

INSTALLATION OF EQUIPMENT INSULATION

3.03 Cleaning and Protection

END OF SECTION 23 07 16

SECTION 23 30 00 – HVAC AIR DISTRIBUTION

Part 1: General

1.01 Summary

1.02 Related Sections

1.03 Definitions

1.04 Submittals Required

1.05 Quality Assurance

A. Codes and Standards:

1. ASHRAE 62: Meet or exceed standard.

1.06 Scheduling

1.07 Delivery, Storage, and Handling

1.08 Regulatory Requirements

Part 2: Products

2.01 Manufactures

2.02 Products

BALANCING DAMPERS*

1. Approved manufacturers ONLY. Install upstream of each supply register or diffuser.

SHEET METAL WORK – LOW VELOCITY SYSTEMS

All ductwork located where exposed to the weather shall be of double wall insulated construction. Interior sheet shall be of same material as connecting from inside of building. Exterior sheet exposed to weather shall be zinc-coated iron or steel sheet. Insulation shall be one inch thick, 3-pound density fiberglass. All exterior seams shall be soldered watertight. All interior joints shall be coated with Minnesota Mining's Scotchweld adhesive No. 1838 B/A or equal. All ductwork shall be constructed in accordance with requirements for Low Velocity System, SMACNA. EXHAUST FANS*

Manufactured by Penn, Pace, Acme, Cook, Jenn-Air, Greenheck, or approved equal. 12" minimum roof curb and neoprene gasket required.

All exhaust fans over 1/4 horsepower shall be belt driven.

All fans shall be dynamically and statically balanced at the factory.

Fan ratings shall be based upon tests performed in strict accordance with the AMCA Standard 210-67 Test Code for Air Moving Devices. Each fan shall carry, near the manufacturer's nameplate, the seal authorized by AMCA indicating that ratings are certified. Fans not bearing this seal will not be acceptable.

STATIONARY LOUVERS*

Manufactured by American Warming and Ventilating, Arrow, Industrial Louvers, Dowco, Louvers and Dampers, Inc., or approved equal.

Provide anchor clips and caulk as required for a sound, watertight installation. Make airtight duct connections to installed louvers.

KILN HOOD, KH-1*

1. Acceptable Manufacturers:

- i. Vent-A-Kiln Corp. No substitutes. Model No. 1437, 37" hood diameter with standard overhead counterweight pulley system. System is to be complete with appropriate exhaust fan, 2 speed control, flexible exhaust duct, etc., as needed.

2. System is to be complete with mechanical and electrical connections. Motor 1/25 HP, 115 V, with cord and plug.

ROOFTOP AIR CONDITIONING*

1. Manufacturers

- i. Prior Approved product.

2. General:

- i. Exterior Surfaces: Phosphatized, zinc-coated steel with epoxy resin primer and baked enamel finish.

Controls: All RTU's will be digital ready and compatible with BAS system being used. No factory controllers that must interface with BAS allowed. BAS will run and control RTU.

Minimum efficiency of Unitary Air Conditioners and Condensing Units. All packaged units shall have a minimum ARI rated efficiency meeting or exceeding the Minimum Required Efficiency listed below. (Note: The efficiency levels from the 2011 standards are listed here. Check www.xcelenergy.com for future updates).

Item (Rooftop AC Units & Condensing Units)	Min. Required Efficiency
Air Cooled < 65,000 Btuh (< 5.4 tons)	13.5 SEER
Air Cooled 65,000 – 135,000 Btuh (5.5 – 11.3 tons)	11.0 EER
Air Cooled 135,000 – 240,000 Btuh (11.4 – 19.9 tons)	10.8 EER
Air Cooled 240,000 – 760,000 Btuh (20 – 63.3 tons)	9.8 EER
Air Cooled > 760,000 Btuh (> 63.3 tons)	9.4 EER
Condensing Unit > 65,000 Btuh and > 5.4 tons	11.0 EER

Minimum efficiency of packaged terminal air conditioners. All PTAC's shall have a minimum ARI rated efficiency meeting or exceeding the Minimum Required Efficiency listed below. (Note: The efficiency levels from the 2011 standards are listed here. Check www.xcelenergy.com for future updates).

Item (Packaged terminal air conditioners)	Minimum Required Efficiency
PTAC's	11.0 EER

FIRE DAMPERS*

Install fire damper with code-approved sleeves in all duct openings AS NEEDED. Fabricated and installed in accordance with the UL requirements and bearing UL-label, with access door in duct, folding blade dampers with fusible link, Ruskin IBD, Tuttle & Bailey, Prefco LP Series, Air Balance 119, United Sheet Metal, National Controlled Air VB and HB, or equal, use frame CR for all round ducts. Use frame B for rectangular and square ducts.

Provide ceiling mounted fire dampers to protect grille, register, and diffuser ceiling penetrations where indicated on plans. Unit shall be UL labeled for protection against fire and heat radiation in a roof-ceiling assembly. Damper units shall be Model CFS by National Controlled Air, Inc., or Air Balance Model 219.

FIRE/SMOKE DAMPERS*

Install fire/smoke damper with code-approved sleeves. Fabricated and installed in accordance with the UL requirements and bearing UL-label, with access door in duct, multiple blade dampers with fusible link and electric operator.

Damper to be similar to Prefco Products Inc. Model 5010 with 120-volt electric damper operator Model 5920 with reusable electric McCabe Link and automatic damper reset. Must satisfy UL 33, UL 873, UL 555S, and UL 86A.

Damper shall be able to open and/or close in 15 seconds, from signal from smoke detector, and shall fail closed on loss of power.

Acceptable Manufacturers:

- i. Prefco.
- ii. Ruskin.
- iii. Tuttle & Bailey.
- iv. Air Balance.
- v. United Sheet Metal.
- vi. National Controlled Air.
- vii. Or Approved Equal.

COMBINATION FIRE/SMOKE DAMPERS WITH INTEGRAL DUCT SMOKE DETECTORS

Motor-Driven Smoke Dampers: Provide UL labeled, Class II minimum, motor-driven smoke dampers in sizes indicated, with casing constructed of 16 gauge steel with bonded red acrylic enamel finish, type 304 stainless steel side seals, stainless steel edge seals, bronze oilite bearings, single lock blades, with damper factory mounted electric motor, stainless steel closing springs, motor mounting bracket, along with the following features. Temperature class 250°F.

Out of airstream in-jamb linkage with stainless steel pivots.

The electric damper actuator shall be 120-volt, 2-position motor designed to power open and fail closed.

Damper actuator shall fail close upon loss of power.

Type B or C housing for respective duct type.

U.L. 555 (minimum)

Leakage not greater than 10 CFM per square foot at 1" W. C. pressure differential.

Integral Duct Smoke Detector: Each fire/Smoke damper shall be provided with a factory mounted duct smoke detector. Detector shall be photoelectric type, with sampling tube, 120V connection, and auxiliary contacts for fire alarm system connection. Detector shall be suitable for 300-4,000 fpm duct velocity, 32° F to 120°F air temperature.

Combination Fire/Smoke Dampers shall be factory-wired to accept 120V service, and fire alarm connections for completely functional damper operation.

Ruskin Model FSD60, with DSDF duct smoke detector, or equivalent.

Part 3: Execution

Preparation

Installation

Hang ducts from beams and joists whenever possible. REGISTERS, GRILLES, AND DIFFUSERS* 1.

Adjust air pattern controllers so that drafts are not created.

2. Selection based on NC less than 30.

RELIEF/INTAKE HOODS (RH & IH)*

1. Hoods to be manufactured by Penn, Greenheck, Jenn-Air, Loren Cook, Louvers & Dampers, Inc., Acme, or approved equal.

Units shall be furnished complete with bird screen and anti-condensate coating.

3.03 Cleaning and Protection

END OF SECTION 23 30 00

SECTION 23 31 13 – DUCTWORK

Part 1: General

1.01 Summary

A. Extent of metal ductwork

DUCT SERVICE	TYPE/CONSTRUCTION
Supply air between fan and terminal boxes (medium pressure).	Galvanized steel, spiral, round or rectangular factory fabricated.
Rectangular supply air from discharge of terminal box to air devices (low pressure).	Galvanized sheet metal spiral round or rectangular factory or shop fabricated.
Return air ductwork.	Galvanized steel; factory or shop fabricated.
General building exhaust.	Galvanized sheet metal; factory or shop fabricated.
Transfer ducts.	Internally lined galvanized sheet metal as described above for low pressure supply; factory or shop fabricated.
Sound elbows for R.A. grilles	Galvanized sheet metal (internally lined).
Outdoor air intake ductwork.	Galvanized sheet metal, rectangular, factory or shop fabricated.
Kitchen grease exhaust.	Carbon steel all welded construction per local code and latest NFPA 96. Provide fire-rated external duct wrap as specified.
Exterior uninsulated ductwork.	Aluminum or painted galvanized.

1.02 Related Sections

1.03 Definitions

1.04 Submittals Required: Product Data, Shop Drawings, Record Drawings, Maintenance Data

1.05 Quality Assurance

Manufacturer's Qualifications: similar service for not less than 5 years.

Installer's Qualifications: at least 3 years of successful installation C. References to SMACNA, ASHRAE and NFPA are minimum requirements.

D. Codes and Standards:

1.06 Scheduling

1.07 Delivery, Storage, and Handling

Protection Prevent end damage and prevent dirt and moisture from entering ducts and fittings.

Cleaning: Clean shop and factory-fabricated ductwork and accessories at the time of fabrication, and protect from dirt and debris with shrink-wrap or equivalent pallet wrap. C. Storage: store ductwork inside and protect from weather.

D. Temporary Closure: At ends of ducts polyethylene film or other covering

1.08 Regulatory Requirements

1.09 Exposed ductwork in classrooms/throughout building (approach to be approved by PSD in full): A.

Painting is not required.

Collars required at all penetrations (at ceilings, etc.).

Sealing of penetration required if angle of ceiling/barrier does not allow a collar (caulking).

Exposed duct to be cleaned and undamaged – left in a finished condition. Pookied joints are to be covered/not left exposed.

Part 2: Products

Manufactures

Products

DUCTWORK MATERIALS

- 1. Exposed Ductwork Materials: Free from visual imperfections including pitting, seam marks, roller marks, stains, dents, discolorations, and other imperfections, including those which would impair painting.

DUCTWORK

- 1. External Wrap (Thermal):
 - i. Do not install insulation over access panels.
- 2. Internal Liner (Sound) (Rectangular Ducts):

FACTORY-FABRICATED MEDIUM PRESSURE DUCTWORK

General: Provide factory-fabricated duct and fittings. All fittings shall be low loss conical type.

Round Ductwork: Construct of galvanized sheet steel complying with ASTM A 527 by the following methods and in minimum gages listed.

Diameter	Minimum Gauge	Method of Manufacture
3" to 14"	26	Spiral Lockseam
15" to 26"	24	Spiral Lockseam
27" to 36"	22	Spiral Lockseam
37" to 50"	20	Spiral Lockseam

Provide locked seams for spiral duct; fusion-welded butt seam for longitudinal seam duct. Provide internal stiffener rings and external reinforcement as required to meet operating static pressures.

Fittings and Couplings: Construct of minimum gages listed. Provide continuous welds along seams.

Diameter	Minimum Gauge
----------	---------------

3" to 36"	20
38" to 50"	18

3. Flat-Oval Ductwork: Construct of galvanized sheet steel complying with ASTM A 527, of spiral lockseam construction, in minimum gages listed.

Maximum Width	Minimum Gauge
Under 25"	24
25" to 48"	22

i. Fittings and Couplings: Construct of minimum gages listed. Provide continuous weld along seams.

4. Internally Insulated Duct and Fittings: Construct with outer pressure shell, 1" thick insulation

layer, and perforated inner liner. Construct shell and liner of galvanized sheet steel complying with ASTM A 527, of spiral lockseam construction, use longitudinal seam for over 59", in minimum gages listed

Nominal Duct Diameter	Outer Shell	Inner Liner
3" to 12"	26 ga.	24 ga.
13" to 24"	24 ga.	24 ga.
25" to 34"	22 ga.	24 ga.
35" to 48"	20 ga.	24 ga.

i. Fittings and Couplings: Construct of minimum gages listed. Provide continuous weld along seams of outer shell.

Nominal Duct Diameter	Outer Shell	Inner Liner
3" to 34"	20 ga.	20 ga.
36" to 48"	18 ga.	20 ga.

Part 3: Execution

Preparation

Installation

A. INSTALLATION OF METAL DUCTWORK

All ductwork shall be sealed.

Routing: vertically and horizontally and avoid diagonal runs wherever possible. Run ductwork in shortest route which does not obstruct useable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Limit clearance to 1/2" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Locate insulated ductwork for 1" clearance outside of insulation. Conceal

ductwork from view, PSD IS OPEN TO EXPOSED DUCT – SITE SPECIFIC. Do not encase horizontal runs in solid partitions.

Electrical Equipment Spaces: Do not route ductwork through transformer vaults and their electrical equipment spaces and enclosures.

Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gage as duct. Overlap opening on all four sides by at least 1 1/2". Fasten to duct only.

DUCTWORK AND DUCT ACCESSORIES

General: Interior of all ducts shall be smooth and free from obstruction with joints welded or brazed and held air tight with "hard cast" mineral impregnated woven fiber tape.

Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

Materials:

Galvanized Steel Ducts: ASTM A653/A653M galvanized steel sheet, lock-forming quality, having G90 zinc coating in conformance with ASTM A90/A90M.

Touch up bare steel areas with Zincilate 810-C, zinc-rich coating.

Duct, fittings and appurtenances shall be manufactured by the Kirk & Blum Manufacturing Company or approved equal.

4. Ductwork:

The following minimum metal thickness shall be applied:

<u>Diameter</u>	<u>U.S. Standard Gage for Class 1</u>
Less than 8 inch	22 gage
8 inch to 18 inches	20 gage
20 to 30 inches	18 gage

Fabricate and support [to UL 181] in accordance with SMACNA [HVAC Duct Construction Standards - Metal and Flexible 2 inch pressure class, Round Industrial Duct Construction Standard and Rectangular Industrial Duct Construction Standard, and ACGIH Industrial Ventilation Manual.

T's, bends, and elbows shall be welded high-pressure type.

INSTALLATION OF FLEXIBLE DUCTS

Maximum Length: For any duct run using flexible ductwork, do not exceed 5' - 0".

Lay in diffusers will require adjustable 90 for flex connection.

No flex connected directly to lay in diffuser.

INSTALLATION OF FIRE-RESISTIVE DUCT WRAP

3.03 Cleaning and Protection A.

FIELD QUALITY CONTROL 1.

General:

Ductwork pressure tests shall be observed by Architect/Engineer prior to installation of insulation.

Test Failures.

B. EQUIPMENT CONNECTIONS

1. Provide access doors where required for service, maintenance and inspection of ductwork accessories.

END OF SECTION 23 31 13

SECTION 23 33 00 – AIR DUCT ACCESSORIES

Part 1: General 1.01

Summary

- A. Types of ductwork accessories required for project include the following:

- Manual Volume Dampers.
- Control Dampers.
- Counterbalanced Relief Dampers.
- Turning Vanes.
- Duct Hardware.
- Duct Access Doors.
- Flexible Connections.

1.02 Related Sections

1.03 Definitions

1.04 Submittals Required: Product Data, Shop Drawings, Record Drawings, Maintenance Data

1.05 Quality Assurance

- A. Manufacturer's Qualifications: not less than 5 years.

1.06 Scheduling

1.07 Delivery, Storage, and Handling

1.08 Regulatory Requirements

Part 2: Products

2.01 Manufactures

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

1. Combination Fire/Smoke Dampers:
 - i. Air Balance, Inc.
 - ii. Phillips Industries, Inc. Conaire Division
 - iii. Ruskin
 - iv. Greenheck
 - v. Prefco
 - vi. Nailor Industries
 - vii. Pottorff
 - viii. Approved equal.

2.02 Products

A. TURNING VANES

Fabricated Turning Vanes: Provide fabricated 22 gauge, single blade or 24 gauge double bladed 4-1/2" radius, 3-1/4" spacing turning vanes and type 2, 4-1/2" wide runners, constructed in accordance with SMACNA "HVAC Duct Construction Standards" Fig 2.3.

Manufactured Turning Vanes: Provide airfoil double bladed turning vanes constructed of 1 1/2" wide curved blades set at 3/4" o.c., supported with bars perpendicular to blades set at 2" o.c., and set into side strips suitable for mounting in ductwork.

Do not use trailing edge turning vanes. B. DUCT HARDWARE:

General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:

Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes, consisting of slot and cover, for instrument tests.

Quadrant Locks: Provide for each manual volume damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

DUCT ACCESS DOORS

General: Provide access doors, at all fire dampers, smoke dampers, temperature control dampers, branch balancing dampers, duct heating coils, upstream of all turning vanes, outside air plenums, inlet of fans, upstream of all duct smoke detectors and all other equipment requiring service and/or access.

Construction: Construct of same or greater gage as ductwork served, provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. All access doors shall have gasket and will be air tight. Provide one side hinged, other side with one handle-type latch for doors 12" high and smaller, 2 handle type latches for larger doors. For spiral ductwork, use United McGill combination access section type ARF-SD for non-insulated duct systems and type ARF-ID double wall insulated door for insulated ducted systems (all supply ductwork).

Hand entry access door openings: 24" x 24" minimum if the duct permits. Personnel entry doors: 18" x 42" minimum.

ACCESS PANELS*

Permit inspection and maintenance of all automatic dampers, fire dampers, control equipment, coils, and other equipment requiring maintenance. Panels shall not be located in top side of ducts. Ceiling panels to be compatible with type ceiling used.

Panels shall be attached to duct with zinc-plated cam latches. 18" x 18" and smaller panels shall have a minimum of two latches. Larger panels shall have a minimum of 4 latches. Panels shall set in rigid frame with sponge rubber gasketing to prevent air leakage. Panels may be of single wall uninsulated construction.

- i. Where duct size permits, access panels shall be minimum 18" x 16" or 2" smaller than duct size, whichever is smaller.

FLEXIBLE CONNECTIONS

General: Provide flexible duct connections wherever ductwork connects to vibration isolated equipment. Construct flexible connections of neoprene-coated flameproof fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment. Shelf life shall be verified to not exceed six (6) months. Any sign of cracking on interior or exterior shall be cause for replacement immediately.

Flexible Piping shall be used to connect exhaust drop pipes to machines.

Flexible pipe shall be kept to a length not to exceed 36 inches. ii. Automation Industries, Inc., Flexible Tubing Division, "Spiratube TDS", nylon cover, with vinyl scuff straps, galvanized spring steel helix, nylon liner; with operating range of -10 degrees to 200 degrees F; High-Tech type RFH or approved equal. iii. Use stainless steel clamps and other accessories as required for a complete installation.

Lay in diffusers will require adjustable 90 for flex connection. No flex connected directly to lay in diffuser

Part 3: Execution

Preparation

Installation

INSTALLATION OF DUCTWORK ACCESSORIES

Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.

Provide fire/smoke dampers, where ducts and outlets pass through rated components, and where required by authorities having jurisdiction.

Where fire/ smoke dampers are installed in rated construction, provide firestopping between fire smoke damper sleeve and substrate.

FIELD QUALITY CONTROL

1. Test **every** fire/smoke damper for proper operation, letter REQUIRED certifying this work is complete and all dampers are functioning properly.

3.03 Cleaning and Protection

ADJUSTING AND CLEANING

Label access doors in per label and identification requirements.

Final positioning of manual dampers.

EXTRA STOCK

One EXTRA FUSIBLE link for every 10 installed of each temperature range; obtain receipt.

END OF SECTION 23 33 00

SECTION 23 34 00 – HVAC FANS

Part 1: General 1.01

Summary

A. This Section includes the following types of air-handling equipment:

Centrifugal fans.

Inline centrifugal fans.

Centrifugal roof ventilators.

Air intake and relief hoods.

Pre-fabricated roof curbs.

1.02 Related Sections

1.03 Definitions

1.04 Submittals Required: Product Data, Shop Drawings, Wiring Diagrams, Record Drawings, and Maintenance Data.

1.05 Quality Assurance

A. Manufacturer's Qualifications: similar service for not less than 3 years.

1.06 Scheduling

1.07 Delivery, Storage, and Handling

1.08 Regulatory Requirements

Part 2: Products

2.01 Products

A. FANS, GENERAL

General: factory fabricated and assembled, factory tested, and factory finished, with indicated capacities and characteristics.

Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

Belt Drive System	Requirement
1-4.9hp	Have at least 2 belts
5-9.9hp	Have at least 3 belts
10-14.9hp	Have at least 4 belts
15-19.9hp	Have at least 5 belts
20hp and greater	Have at least 6 belts

Belts: Oil-resistant, non sparking, and non static.

Motors and Fan Wheel Pulleys: Adjustable pitch for use with motors through 5 HP; fixed pitch for use with motors larger than 5 HP. Select pulley so that pitch adjustment is at the middle of the adjustment range at fan design conditions. Provide energy efficient motor

i. Belt Guards: Provide steel belt guards for motors mounted on the outside of the fan cabinet.

Shaft Bearings: Provide type indicated, having a median life "Rating Life" AFBMA L10 of 200,000 calculated in accordance with AFBMA Standard 9 for ball bearings and AFBMA Standard 11 for roller bearings.

Factory Finish:

Sheet Metal Parts: Prime coating prior to final assembly.

2. Exterior Surfaces: Baked-enamel finish coat after assembly.

Part 3: Execution

3.01 Preparation per manufacturer recommendations

3.02 Installation A.

DEMONSTRATION

1. Demonstration Services: factory-authorized service representative to train Owner's maintenance

Procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
Familiarization with contents of Operating and Maintenance Manuals.

END OF SECTION 23 34 00

SECTION 23 35 13 – DUST COLLECTION SYSTEMS

Part 1: General

1.01 Summary

1.02 Related Sections

1.03 Definitions

1.04 Submittals Required: Shop Drawings, Product Data, Manufacturer's Certificate, Operation and Maintenance Data.

1.05 Quality Assurance

QUALIFICATIONS

Years [documented] experience.

Installer: minimum three years documented experience.

WARRANTY

1. Furnish five year manufacturer warranty for dust collection systems.

EXTRA MATERIALS

1. Two sets of filters for filter separator, TWO SETS OF FILTER BAGS, TWO SETS OF BELTS FOR EACH FAN.

Scheduling

Delivery, Storage, and Handling

Regulatory Requirements

Part 2: Products

2.02 Manufactures

A. Products: DUST COLLECTOR

1. **NO SHAKERS WILL BE ALLOWED**

Part 3: Execution

3.01 Preparation

3.02 Installation

3.03 Cleaning and Protection

END OF SECTION 23 35 13

SECTION 23 36 00 – AIR TERMINAL UNITS

Part 1: General 1.01

Summary

A. Types of air terminals specified in this section include the following:

Central Air Terminals

Shutoff Single Duct

Reheat

1.02 Related Sections

1.03 Definitions

1.04 Submittals Required: Product Data, Shop Drawings, Wiring Diagrams, Record Drawings, and Maintenance Data.

1.05 Quality Assurance

A. Manufacturer's Qualifications: not less than 5 years.

1.06 Scheduling

1.07 Delivery, Storage, and Handling

1.08 Regulatory Requirements

Part 2: Products

2.01 Manufactures

2.02 Products

Part 3: Execution

3.01 Preparation

3.02 Installation

A. Duct Connections: Connect ductwork to air terminals.

3.03 Cleaning and Protection

END OF SECTION 23 36 00

SECTION 23 37 00 – AIR OUTLETS AND INLETS

Part 1: General 1.01

Summary

Fiberglass ductwork is not accepted.

Ductwork exposed on roofs is strongly discouraged. Review with the owner any proposed exposed ductwork.

Do not install turning vanes in unequal ells. Use expansion transitions and duct splits with equal ells.

Do not use "extractors" at duct branch takeoffs, use 45-degree standard branch. Extractors may be used at duct mounted sidewall diffusers.

Consultant to specify pressure, air speed, and show on drawings using SMACNA standards.
 Do not use splitter dampers.
 Include volume control devices required for air balancing on the contract documents.
 Consultant to provide a specific list of work items for renovation of existing equipment and duct work. Global statements to rehabilitate "as required or necessary" are not acceptable.

- Related Sections
- Definitions
- Submittals Required
- Quality Assurance
- Scheduling
- Delivery, Storage, and Handling
- Regulatory Requirements

Part 2: Products

2.01 Manufactures

2.02 Products

A. DUCTWORK

<u>Diameter</u>	<u>Collar</u>	<u>Blade</u>
3" thru 14"	11	14
15" thru 26"	10	12
27" thru 36"	9	10

GRILLES, DIFFUSERS, REGISTERS

- 1. Use of duct socks to be approved by PSD HVAC Department.

VARIABLE AIR VOLUME (VAV) BOXES 1. If authorized by the District.

Part 3: Execution

Preparation

Installation

So that duct interiors may be cleaned, external duct wrap insulation is preferred over duct lining.

Consider the use of mufflers or sound attenuators to reduce fan noise.

Locate manual dampers for diffuser control as far from the diffuser as possible but still in the room or preferably the adjacent corridor to minimize noise.

3.03 Cleaning and Protection

END OF SECTION 23 37 00

SECTION 23 50 00 – CENTRAL HEATING EQUIPMENT

Part 1: General

- 1.01 Summary
- 1.02 Related Sections
- 1.03 Definitions
- 1.04 Submittals Required
- 1.05 Quality Assurance
- 1.06 Scheduling
- 1.07 Delivery, Storage, and Handling
- 1.08 Regulatory Requirements

Part 2: Products

- 2.01 Manufactures
- 2.02 Products A.

STRAINERS

Strainers for water, 2" and smaller shall be cast iron or semi-steel, screwed "Y" strainer, 250 lb. construction, and 1/2 inch ball valve with capped hose adapter, to be capped with brass not plastic, for blow-down. Strainer shall be Armstrong No. A1SC, or prior approved equal for 2-1/2" and less, Armstrong No. A1FL for 2 1/2" and larger.

Screens for water service shall be stainless steel. For strainers 2 inches and less, strainers shall be 20-mesh or 1/32" perforations. For strainers 2 1/2" to 8", mesh shall be perforated brass with 1/16" openings.

AIR SEPARATOR*

Acceptable Manufacturers:

- i. Amtrol.
- ii. Bell & Gossett (Rolairtrol).
- iii. Taco.
- iv. Spirol Vent (Preferred)
- v. Approved Equal.

Separator shall be the centrifugal type, with strainer, line size, with a Hoffman #79 auto air release valve. 125 psi working pressure. Pipe discharge to glycol feeder (preferred) or floor drain

Air separator shall be suitably supported in piping system with clearance provided for strainer removal.

AIR VENTS*

Provide manual (not automatic) air vent valves at the high point wherever drops occur in the direction of water flow, at the top of all supply risers and at the high point of return risers on all hot water heating supply and return mains. Air vent ball valves shall be installed on the top of the risers in an accessible location. A 1/4" copper tube shall extend from a reducer provided at the high point to a point where a bucket can be placed to catch any drips. No Armstrong air vents will be allowed. Use Hoffman of applicable size. Or approved equal.

Add air vents to high points in RTU piping.

Provide isolation ball valves for replacement.

The high side of heating elements on up-fed cabinet unit heaters, etc., shall be piped complete with a 3/4" x 4" high air chamber with a reducer at the top from which a 1/4" copper tube shall be extended to an accessible manual (not automatic) air vent valve as above.

BACKFLOW PREVENTER*

Acceptable Manufacturers: Watts. Watts 909QT only

Shall be the reduced pressure type with atmospheric vent, for boiler water make-up.

Bronze body and accessory construction and replaceable seats.

Bronze body ball valve test cocks, unions, full port ball valve shut-offs on inlet and outlet, and bronze inline strainer.

Watts Model U909 QTS, 3/4" size with strainer on inlet side and spring check valve on upstream side.

EXPANSION TANK*

Acceptable Manufacturers:

Amtrol.

Armstrong

Bell & Gossett. iv.

Taco.

v. Or approved equal.

Tank shall be the elastomeric bladder type, with positive water and air separation, pressurized.

Size as specified and as required for proper venting pressure.

With vertical mounting support feet, air charging valve, and air pressure gauge. Accessible floor-type with isolation and union.

FINNED TUBE RADIATION (FTR-1)* 1. Acceptable Manufacturers:

American Air Filter.

Sterling. iii. Trane. iv. Vulcan.

v. Approved Equal.

Cover shall be complete with hangers, supports and accessories. Provide end pieces, joining pieces, mounting brackets and accessories as required for a complete installation. Provide end caps. Copper tube and aluminum fins.

Enclosure shall be minimum 16-gauge construction, with access panels and factory backed enamel paint. Cover shall also conceal HWS & HWR piping from wall to unit ventilator.

FLOW VENTURIS (FV)*

1. Acceptable Manufacturers:

Aeroquip Barco.

Gerand.

Approved Equal.

Description: Cast iron or brass body flow measuring device of venturi type with readout plugs constructed for 125 psig working pressure. Provide with nameplate showing capacity data with integral or separate curves of head pressure versus capacity for range of flows.

Flow Measuring Device Schedule:

Drawing

<u>Code</u>	<u>Make</u>	<u>Model</u>	<u>Delta P</u>	<u>Flow, GPM</u>	<u>Press. Drop</u>
-------------	-------------	--------------	----------------	------------------	--------------------

FV-1 Barco - - - -

HOT WATER HEATING COILS*

- 1. Acceptable Manufacturers:
 - i. Airtherm.
 - ii. McQuay.
 - iii. Trane.
 - iv. Approved Equal.

2. Hot water heating coils shall be constructed of 1/2" O.D. minimum copper tubes expanded into aluminum plate fins and cast iron or seamless copper headers. Coil circuiting shall be single tube continuous with same end connection. Casings shall be constructed of 16 gauge galvanized steel with fins recessed into channels to minimize air bypass. Casing shall include -1/2" flanges for duct connections. Coils shall be rated for 150 psig working pressure and shall have capacities and characteristics as scheduled on the plans. Coil water velocity shall not exceed 5 feet per second.

3. Supervise all installations to ensure proper pitch for drainage and venting. Make all connections and install all specialties as detailed after installation in duct system.

4. Coils shall be isolated with ball valves, unions and balance valves, installed to allow easy coil removal.

HOT WATER HEATING PUMP AND DOMESTIC HOT WATER CIRC PUMPS*

- 1. Acceptable Manufacturers:
 - i. Taco
 - ii. Bell & Gossett
 - i. Grundfos Magna
 - v. ~~Patterson Enviroflo~~
 - vi. Armstrong
 - vii. Wilo

2. Pumps shall have mechanical seals designed for hot water service to 220°F, steel shafts, renewable wearing rings, bronze impellers, and casings designed for 150 PSIG working pressure. Pumps, except close-coupled type, shall have flexible couplings of non-metallic or single barrel spring design. Multiple spring couplers will not be accepted.

Provide one (1) extra set of mechanical seals for each pump.

Pump manufacturer shall machine the pump impellers, if necessary, to meet capacities scheduled. Pumps shall be dynamically balanced prior to shipment.

Extreme care is to be exercised when installing pumps such that no strain whatsoever is placed on the mains due to pump position.

Motors shall be built for pump service, with electrical characteristics as indicated.

Motors shall have built-in thermal overload protection. And premium efficiency.

Ball valve isolations on each side of pumps.

Install hot water heat pumps on return side to prevent overheating.

3. Domestic Hot Water recirculating pumps shall be the cartridge type, system lubricated, bronze body, and stainless steel shaft, rotor, and faceplate. 1/25 HP. Taco is preferred.

UNIT HEATERS*

- 1. Acceptable Manufacturers: Modine is standard of design. (NO STANDARD UNIVENTS) No Reznor units accepted.

Part 3: Execution

Preparation

Installation

Cleaning and Protection

END OF SECTION 23 50 00

SECTION 23 51 00 – BREECHINGS, CHIMNEYS, AND STACKS

Part 1: General

1.01 Summary

1.02 Related Sections

1.03 Definitions

1.04 Submittals Required: Product Data, Shop Drawings, Quality Control Submittals, Record Drawings

1.05 Quality Assurance

1.06 Scheduling

1.07 Delivery, Storage, and Handling

1.08 Regulatory Requirements

Part 2: Products

2.01 Manufactures

2.02 Products

Part 3: Execution

3.01 Preparation

3.02 Installation

INSTALLATION OF DOUBLE WALL CONNECTORS, BREECHINGS AND VENTS

The system shall have a 10" minimum clearance to combustibles with flue gases not exceeding 1000°F continuous.

The inner pipe joints shall be field sealed with Containment Bands and high temperature sealant.

Stacks extending above the roof must terminate a minimum of 3'-0" above the roof or parapet per NFPA 211, or as required by local code.

INSTALLATION OF DAMPERS

1. Install barometric and thermostatically operated dampers in accordance with manufacturer's instructions. Locate as close to draft hood collar as possible.

3.03 Cleaning and Protection A.

ADJUSTING AND CLEANING

1. Clean breechings internally during installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth.

END OF SECTION 23 51 00

SECTION 23 52 00 – HEATING BOILERS

Part 1: General

1.01 Summary

- A. Heating water boilers only, no steam except in limited applications in old buildings to replace like equipment.

1.02 Related Sections

1.03 Definitions

1.04 Submittals Required

1.05 Quality Assurance

1.06 Scheduling

1.07 Delivery, Storage, and Handling

1.08 Regulatory Requirements

Part 2: Products

2.01 Manufactures

2.02 Products

- A. CONTROLS: BAS will be able to interface with the firing rate of the boiler.

Temperature controller capable of interfacing with temperature controls shall be supplied as a part of the boiler package. Sequence of operation by the Consultant.

Water Boiler Standard Controls:

Low limit (operating) temperature control.

High limit temperature control.

Combination pressure-temperature-altitude gauge(s) to indicate boiler water temperature, system pressure, and elevation.

ASME certified pressure relief valve(s) set to 50 psi, ASME working pressure.

Low water cut-offs, McDonnell Miller No. 63, as required by codes, with test and check valves.

The boiler shall be furnished with a factory-constructed wiring harness to facilitate wiring the electrical safety controls into the limit control circuits. Provide the following indication/warning lights:

Call for heat light. ii. Main burner "ON." iii. Pilot burner "ON."

iv. Failure lights to indicate burner lock out for any reason, magnetic starter trip-out, low water cut-out, or manual high limit trip-out.

High-Low Fire Control:

The boiler shall be furnished with a water temperature controller and/or proportional staging control to control the high fire operator of the operating gas valve.

Control shall be adjusted to permit low-fire and high-fire control.

Actual control of the high/low firing shall be done through the control system.

The boiler shall be furnished with a Honeywell 7800 Flame Guardian WFG electronic control system. The Honeywell system must have an LED display installed.

The Flame Guardian system shall be factory pre-wired, with pilot proving air flow proving and main flame proving control modules to provide intermittent electronic pilot ignition with proven low-fire start, high-fire run operation.

The Flame Guardian system shall provide nominal 4-second flame response timing with 90-second lockout in the event the pilot flame is not proven. Safety pilot burner shall be intermittent.

At least two sections with inspection and cleanout tappings on each end.

Full opening and removable access doors at each end.

1. ACCEPTABLE MANUFACTURERS:

i. Buderus is preferred- both condensing and non-condensing

ii. Burnham.

i. Weil-McLain.

ii. Lochinvar

~~iv. Aereco~~

v. Dedietrich for cast iron sectional

vi. *Or approved equal*

BURNER

1. Acceptable Manufacturers:

Power Flame.

Approved Equal - Burner shall be capable of delivering the necessary air at 5000 ft. elevation for proper combustion, to pressurize the firebox and to deliver sea level Btuh output at 5000 ft. elevation.

2. Burner startup and combustion test:

Factory-authorized technician shall perform start-up.

A complete combustion test report shall be submitted to the Engineer indicating the following:

Percent of Carbon Dioxide (CO₂).

Stack temperature.

Stack pressure.

Room temperature.

Manifold gas pressure.

Boiler shall have an input and gross output as scheduled when fired with natural gas. Boiler shall be tested for and shall bear ASME symbol for low pressure heating boiler, 85% minimum efficiency.

Minimum efficiency of Boilers. All packaged boilers shall have a minimum ARI rated efficiency meeting or exceeding the Minimum Required Efficiency listed below. (Note: The efficiency

levels from the 2011 standards are listed here. Check www.xcelenergy.com for future updates).

Item (Boiler)	Minimum Required Efficiency
Non-Condensing Boiler	85% AFUE
Condensing Boiler	92% AFUE

Part 3: Execution

Preparation

Installation

Provide a single 4" minimum raised reinforced concrete housekeeping pad for all boiler units that rests on top of the boiler room floor.

Boiler shall be field assembled. Boiler shall be complete with air eliminator, insulated jacket, cast iron sections, forced draft burner, approved gas train, pressure relief valve, and controls. With pressurized fire box for forced draft venting.

3.03 Cleaning and Protection

END OF SECTION 23 52 00

SECTION 23 55 00 – FUEL-FIRED HEATERS

Part 1: General 1.01

Summary

A. Types of fuel-fired heaters specified in this section include the following:

- 1. Gas-Fired Propeller Unit Heaters.

1.02 Related Sections

1.03 Definitions

1.04 Submittals Required: Product Data, Shop Drawings, Wiring Diagrams, Record Drawings, and Maintenance Data.

1.05 Quality Assurance

A. Manufacturer's Qualifications: not less than 5 years.

1.06 Scheduling

1.07 Delivery, Storage, and Handling

1.08 Regulatory Requirements

Part 2: Products

2.01 Manufactures

2.02 Products

A. GAS-FIRED PROPELLER UNIT HEATERS

Part 3: Execution

3.01 Preparation

- 3.02 Installation
 - A. INSTALLATION OF GAS-FIRED PROPELLER UNIT HEATERS
 - B. START-UP
- 3.03 Cleaning and Protection

END OF SECTION 23 55 00

SECTION 23 57 00 – HEAT EXCHANGERS FOR HVAC

Part 1: General 1.01

Summary

A. Types of heat exchangers specified in this section include the following:

- 1. Water-to-Water Plate and Frame Heat Exchanger.

1.02 Related Sections

1.03 Definitions

1.04 Submittals Required: Product Data, Shop Drawings, Record Drawings, and Maintenance Data.

1.05 Quality Assurance

A. Manufacturer's Qualifications. To be evaluated and approved by PSD HVAC Department..

1.06 Scheduling

1.07 Delivery, Storage, and Handling

1.08 Regulatory Requirements

Part 2: Products

2.01 Manufactures

2.02 Products

A. WATER-TO-WATER PLATE AND FRAME HEAT EXCHANGER:

1. Units shall be ASME rated for 125 psig operating pressure, 300 deg. F. (149 deg. C) maximum temperature. **Part 3: Execution**

3.01 Preparation

3.02 Installation

3.03 Cleaning and Protection

END OF SECTION 23 57 00

SECTION 23 60 00 – CENTRAL COOLING EQUIPMENT

Part 1: General

1.01 Summary

DESCRIPTION

Air cooled condensing units.
Refrigerant piping and specialties.
Cooling Towers.
Chillers.

For new buildings or those receiving a major replacement of mechanical equipment or others authorized for refrigeration cooling:

About 50,000 square feet or larger, use chilled water and cooling towers or evaporative condensers.

20,000 square feet and less, use DX equipment.

Others use either type of equipment or air cooled chillers depending on the building's use and the Engineer's analysis.

Design a separate DX unit for the administration area to be used during extended hours when the rest of the school is unoccupied. This option may not be required if the school cooling plant has a chiller which may be turned down far enough to match the Admin. area load.

Direct expansion (DX) systems should be RTU's

Major remodels of existing buildings without air conditioning will have that capacity added in the remodel. Confer with the District at the time of design. Add-on units must be split systems with low speed fans to reduce noise to a minimum.

Special design considerations shall be given for server room cooling installations. Systems shall be right sized according to the application and consider outdoor air use. Special considerations include:

Setpoints are different than those set for thermal comfort. IT equipment and server room setpoints shall be 80°F.

Design shall consider exhaust and heat removal from server rooms.

Design shall consider point-specific airflow for racks.

Equipment closets shall be considered different than server room closets in design.

Related Sections

Definitions

Submittals Required

Quality Assurance

Scheduling

Delivery, Storage, and Handling

Regulatory Requirements

Part 2: Products

Manufactures

Products

REFRIGERATION SPECIALTIES

Filter-dryers

AIR COOLED CONDENSING UNIT All to have hail guards (RTU, and split systems)

AUTHORIZED TYPES: CHILLER

Less than 100 tons: Reciprocating or screw.

140 tons and larger: Centrifugal.

Between 100 and 140 tons: Determined by the consultant and the District.

Minimum efficiency of Chillers. All packaged chillers shall have a minimum ARI rated efficiency meeting or exceeding the Minimum Required Efficiency listed below. (Note: The efficiency levels from the 2011 standards are listed here. Check www.xcelenergy.com for future updates).

Item (Chillers)	Min. Required Efficiency
Scroll or Rotary Screw < 150 tons	0.74 kW/ton
Scroll or Rotary Screw > 150 tons and < 300 tons	0.67 kW/ton
Air Cooled	10.0 EER
Water Cooled Centrifugal	Must improve on IECC 2006 baseline by 0.016 kW/ton

APPLICABLE TO ALL THREE TYPES

The preferred power is 460v, 3ph, 60hz. If 460 volt power is not available, 230 or 208 volt is acceptable. No single phase equipment.

Single Factory Package:

Refrigerant compressor(s). (Minimum of two) ii. Water cooled shell and tube refrigerant condenser. iii. Evaporator. iv. Expansion valve.

Electric drive motors for the compressor(s) and the oil pump.

Controls mounted within a common panel. vii. Water cooled oil cooler and oil circulating pump.

viii. Electric oil preheater.

Applicable Standards and Regulations:

ANSI - American National Standards Institute (Safety Codes for Mechanical

Refrigeration). ii. ARI - Air Conditioning and Refrigeration Institute - (All applicable equipment rating and construction standards). iii. ASME - American Society of Mechanical Engineers - (Boiler and Pressure Vessel Code, Section VIII, Division 1, latest edition).

NEC - National Electrical Code.

NEMA - National Electrical Manufacturer's Association - (Motors for Hermetic Refrigeration Compressors).

ARI factory performance test required for chillers > 100 tons.

ASHRAE - Standard 15, Safety Code for Mechanical Refrigeration.

Design chilled water supply temperature > 47°F.

Design condenser water temperature < 73°F.

The liquid being chilled and the condenser cooling liquid will be strained water containing biocides and anti-scaling compounds.

Self-excited vibration velocity < 0.10 inch/second in any of the three axes.

Heat exchanger fouling factor: 0.0005.

Target efficiency: 0.62 KW/ton (centrifugal), 0.70KW/ton (screw) or 0.82KW/ton

(reciprocating) at full rated load under the service conditions specified. Examine part load efficiency figures and base specify the optimal machine.

Evaporator:

Shell-and-tube design with seamless copper tubes and designed, manufactured, tested and stamped in accordance with Section VIII, Division 1, latest edition of the ASME Boiler and Pressure Vessel Code and its addenda. ii. Shell: Carbon steel plate, incorporate rupture disc conforming to ANSI/ASHRAE 15-1978 Safety Code, and be furnished with a 150 psig cast-iron water box. Factory-applied thermal insulation.

iii. Positive liquid and vapor seal between the refrigerant and water side of the shell.

iv. Copper tube wall thickness: 0.035 inch.

v. Position intermediate tube support sheets along the length of the shell to avoid contact and relative motion between adjacent tubes. vi. Use multiple layers of metal mesh screen or some other device to form an eliminator to be installed over the tube bundle along the entire length of the evaporator to prevent liquid refrigerant carryover into the compressor.

Water Cooled Condenser:

Shell and tube design with seamless copper tubes, integral fins. Stamp in accordance with Section VIII, Division 1, latest edition of the ASME Boiler and Pressure Vessel Code.

Position intermediate tube support sheets along the length of the shell to avoid contact and relative motion between adjacent tubes.

Copper tube wall thickness: 0.035 inch.

Purge system to operate automatically for removing any non condensables and water vapors which may be present in the refrigerant system. Automatic non condensable discharge and refrigerant return. Remove water with a manual blow-off valve.

Controls and Safeties:

i. Completely prewired control panel mounted on the chiller assembly:

120V single phase/60 Hz with its own transformer.

Numbered terminal strip for field interlock wiring.

Individually numbered and color coded panel wires.

Number wires same as the manufacturer's circuit drawings.

ii. Automatic safety shutdown with a pilot light and a manual reset each for low evaporator refrigerant temperature, high condenser pressure, high motor temperature and low oil pressure. iii. Capacity control mechanisms to limit maximum amperage drawn by the compressor. Setpoint of the compressor demand limit adjustable to any value between 40 and 100% of full load. iv. Individual dial-type pressure gauges to indicate purge drum, condenser, evaporator and oil pressures.

Anti-recycle timer to ensure safe intervals between successive compressor starts.

Panel-mounted meters to indicate total number of compressor starts and elapsed running time. A system pilot light to indicate control power "ON" to the panel. vii.

Pilot Lights:

Start-up in progress.

Anti-recycle timer active.

Condenser water pump on.

Chilled water pump on.

Oil pump on.

Chiller on. viii. Adjustable Temperature Controls:

Deadband.

Chilled water supply temperature setpoint between 45°F and 55°F.

ix. Wire safety controls to the starter to stop the chiller if:

Low evaporator temperature.

High condenser pressure.

High compressor motor temperature.

Low oil pressure.

Loss of condenser water flow.

Loss of chilled water flow.

Imminent freezing of chilled water.

Include a device to reset the chilled water supply temperature set point from the return water temperature. Incorporate a minimum of two field adjustable reset schedules into the controls to match any application with the reset schedule.

Permit automatic chiller unloading during periods when the load decreases below the normal operation. Automatically restart upon an increase in load. xii. Provide connections to automatically start and stop or demand limit the chiller from a future remote energy management device.

xiii. Provide the capacity to unload the chiller from a remote signal.

xiv. Compressor motor starter: Factory mounted, wired and tested on the chiller. Free standing starters requiring field wiring are not acceptable unless mounted next to the chiller. Include an electronic motor protection system to monitor and protect against the following conditions:

Overload.

Phase unbalance.

Distribution fault protection to prevent reconnection of the compressor motor while it is out-of-phase with the line voltage. If a distribution fault is detected, the fault trip indicator shall be displayed and manual reset shall be required.

Distribution faults of 1-1/2 electrical cycle durations shall be detected and the compressor motor shall be disconnected within six electrical cycles. xv. Manually reset high and low refrigerant pressure cutout switches.

xvi. Relief valve in compressor discharge circuit. No valves between the compressor discharge and the relief valve. xvii. Interlocks that will permit field connections from these interrupt signals:

The compressor motor power interrupted on loss of cooling or chilled water flow.

The compressor motor cannot start until the chilled water pump and cooling water pump are operating.

xviii. Disconnect switch mounted on the frame near the starter. xix. Furnish with chilled and condenser water flow switches. xx. An ammeter for each electrical power phase.

xxi. Provide for refrigerant recovery.

Vibration Isolators:

i. Free-standing, laterally stable without any housing, and complete with acoustical friction pads between the baseplate and the support.

5 year warranty on all reciprocating compressors.

Comply with the latest CFC regulations. E. SPLIT SYTEMS:

1. Minimum efficiency of split systems. All packaged split systems shall have a minimum ARI rated efficiency meeting or exceeding the Minimum Required Efficiency listed below. (Note: The efficiency levels from the 2011 standards are listed here. Check www.xcelenergy.com for future updates).

Item (Split systems)	Minimum Required Efficiency
Split System < 65,000 Btuh and < 5.4 tons	14.0 SEER

Part 3: Execution

Preparation

Installation

A. START-UP

1. Provide factory start up services for the chiller and the tower.

3.03 Cleaning and Protection

END OF SECTION 23 60 00

SECTION 23 65 13 – FORCED-DRAFT COOLING TOWERS

Part 1: General

1.01 Summary

- A. This section includes factory-assembled and -tested, open-circuit, induced-draft, cross-flow cooling towers.

1.02 Related Sections

1.03 Definitions

1.04 Submittals Required: Product Data, Shop Drawings, Wiring Diagrams, Coordination Drawings, Product Certificates, Field Quality Control Test Reports, Operation and Maintenance Data, Warranties.

1.05 Quality Assurance

- A. Warranty Period: Five years from date of Substantial Completion.

1.06 Scheduling

1.07 Delivery, Storage, and Handling

1.08 Regulatory Requirements

Part 2: Products

2.01 Manufactures

2.02 Products

A. HANDRAILS, LADDERS, AND PLATFORMS

1. Platforms: Galvanized steel with a bar grating floor.

Part 3: Execution

3.01 Preparation

3.02 Installation

CONNECTIONS

1. Install flexible pipe connectors at final connections of towers.

STARTUP SERVICE

- Engage a factory-authorized service representative to perform startup service.
- Verify operation of tower basin automatic blowdown, and controlling device.
- Prepare a written startup report that records the results of tests and inspections.

ADJUSTING

- Set and balance water flow to each tower inlet.
- Adjust water-level control for proper operating level.
- Occupancy Adjustment: MAY BE REQUIRED – TBD PER PROJECT.

DEMONSTRATION

1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cooling towers.

3.03 Cleaning and Protection

END OF SECTION 23 62 13
SECTION 23 71 20 – GLYCOL

SYSTEMS

Part 1: General 1.01

Summary

- A. Types of glycol system specialties specified in this section include the following:
 - Propylene glycol
 - Feed Pump
 - Provide glycol feeder for all new construction and anytime a boiler room is being upgraded. Engineer to size the feeder. Axiom Industries LTD or equal.
 - Provide a combination pot feeder and filter system with filter socks unless previously installed by owner. Typical of an Eaton unit.

1.02 Related Sections

1.03 Definitions

1.04 Submittals Required: Product Data, Maintenance Data, Test Results.

1.05 Quality Assurance

1.06 Scheduling

1.07 Delivery, Storage, and Handling

1.08 Regulatory Requirements

Part 2: Products

2.01 Manufactures

- A. Inhibited Propylene Glycol Solution:
 - Chillsafe
 - Dow

2.02 Products

GLYCOL SYSTEM

1. GLYCOL TRANSFER PUMP

- i. Provide a Hand-Operated Rotary Transfer Pump with 8 feet of 1 inch hose and a non sparking 3/4" nozzle for the transferring of glycol from the glycol container to the glycol feed tank. The pump shall have a 1 inch telescoping suction pipe, and bung adapter with 2 inch thread.

GLYCOL SOLUTION

1. Heating Water System:

Provide 30% glycol solution suitable to a temperature of -20°F.

Provide on extra 55 gallon drum of propylene glycol.

2. Chilled Water System:

Provide 30% propylene glycol solution.

Provide one extra 55 gallon drum of propylene glycol.

3. Approved glycol: 100% Propylene Virgin Dowfrost glycol with inhibitor (or equal) added so the final result has 30% glycol throughout the system. Any "or equal" approvals should be confirmed prior to CDs going out to bid if design team wants to suggest an alternative. A substitution from a GC would have to be approved per PSD front ends/procedure.

Part 3: Execution

Preparation

Installation

- A. Thoroughly clean and flush system before adding propylene glycol solution. Notify PSD Plumbing Department 24 hours in advance, to verify clean and flush.
- B. Feed propylene glycol to system through make-up line with pressure regulator. Do not use glycol feeder to fill system. Set to fill at 12 psi (69 kPa).
- C. Perform tests determining strength of propylene glycol solution before system is turned over to the Owner. Provide test prior to end of the first year of operation and replenish as required. PSD to confirm 30% solution maintained at end of the year.

3.03 Cleaning and Protection

END OF SECTION 23 71 20

SECTION 23 72 00 – OUTDOOR AIR VENTILATION (AIR TO AIR SYSTEMS)

Part 1: General

- 1.01 Summary
- 1.02 Related Sections
- 1.03 Definitions
- 1.04 Submittals Required
- 1.05 Quality Assurance
- 1.06 Scheduling
- 1.07 Delivery, Storage, and Handling
- 1.08 Regulatory Requirements

Part 2: Products

- 2.01 Manufactures
- 2.02 Products
 - A. Ventilation Outdoor Air Control
 - 1. Minimum ventilation outdoor air control.
 - i. Variable air volume systems shall have a positive means to maintain minimum outdoor air rates regardless of supply air volume. Setting a fixed minimum outdoor air damper position shall not be acceptable. Acceptable means include:
 - Separate minimum damper setpoints for design supply air volume and minimum supply air volume, as indicated by fan speed or other supply air duct static pressure controller. [Note to designer: this is the least accurate method, but least expensive and available as standard on some packaged units.]
 - Outdoor airflow measuring station designed to be $\pm 10\%$ accurate at minimum airflow rates, used to modulate outdoor air and/or return air dampers to maintain minimum outdoor air flow rates.
 - Differential pressure sensor across fixed minimum outdoor air damper with setpoint calibrated to correspond to minimum outdoor air rate, used to modulate return air dampers to maintain minimum outdoor airflow rates.

Part 3: Execution

- 3.01 Preparation
- 3.02 Installation
- 3.03 Cleaning and Protection

END OF SECTION 23 72 00

SECTION 23 74 00 – PACKAGED OUTDOOR HVAC EQUIPMENT

Part 1: General 1.01

Summary

- A. Outdoor air handling units.
- 1.02 Related Sections
- 1.03 Definitions
- 1.04 Submittals Required: Product Data, Wiring Diagrams, Record Drawings, Maintenance Data
- 1.05 Quality Assurance
 - A. Manufacturer's Qualifications: not less than 5 years.
- 1.06 Scheduling
- 1.07 Delivery, Storage, and Handling
- 1.08 Regulatory Requirements

Part 2: Products

2.01 Manufactures

- A. Outdoor Air Handling Units – All must be approved by PSD

2.02 Products

OUTDOOR AIR HANDLING UNITS

1. Disposable Type: Provide disposable type air filters 2" thick, consisting of viscous coated fibers with filtering media encased in fiberboard cell sides having perforated metal grids on each side to provide media support.

Part 3: Execution

Preparation

Installation A. EXTRA STOCK

1. Obtain receipt from Owner that new filters have been installed AT THE END OF THE CONSTRUCTION BEFORE OWNER TAKE OVER.

TRAINING – REQUIRED

3.03 Cleaning and Protection

END OF SECTION 23 74 00

SECTION 23 81 43 – HEAT PUMPS

Part 1: General

- 1.01 Summary
- 1.02 Related Sections
- 1.03 Definitions
- 1.04 Submittals Required: Shop Drawings, Product Data, Manufacturer's Certificate, Operation and Maintenance Data.
- 1.05 Quality Assurance
- 1.06 Scheduling
- 1.07 Delivery, Storage, and Handling
- 1.08 Regulatory Requirements

Part 2: Products

2.01 Manufactures

- AAON (PREFERRED)
- WaterFurnace International, Inc.
- ClimateMaster, Inc.

2.02 Products

1. UNITARY HEAT PUMP UNITS: Minimum efficiency of Heat Pumps. All packaged heat pumps shall have a minimum ARI rated efficiency meeting or exceeding the Minimum Required Efficiency listed below. (Note: The efficiency levels from the 2011 standards are listed here. Check www.xcelenergy.com for future updates).

Item (Heat Pumps)	Minimum Required Efficiency
Ground Source Heat Pump	ENERGY STAR® qualified, closed-loop systems, with a minimum 3.3 COP and 14.1 EER rating
Air Source* < 65 mbtu/h	12.0 EER or 7.7 HSPF
Air Source* 65 – 135 mbtu/h	10.1 EER, 3.2 COP
Air Source* 136 – 240 mbtu/h	9.3 EER, 3.1 COP
Water Source Heat Pump	14.0 EER
*Value listed are from the Federal Energy Management Program (FEMP); check the “Whole Building Design Guide” for future updates.	

B. ELECTRICAL CHARACTERISTICS AND COMPONENTS 1.

Disconnect Switch: Factory mount on equipment.

Part 3: Execution

3.01 Preparation

3.02 Installation

Provide a self-regulating balance valve for each heat pump. Balance valve are not permitted to be used as isolation valves.

Provide a remote reset on heat pumps.

3.03 Cleaning and Protection

END OF SECTION 23 81 43

SECTION 23 82 00 – CONVECTION HEATING AND COOLING UNITS

Part 1: General

1.01 Summary

Preferred system: Hot water baseboard radiation along perimeter walls and in-duct hot water coils to zones with high ventilation loads or excessive heat losses. No radiators or other heating units on walls of student restrooms.

Radiant ceiling panels are NOT ALLOWED. Permitted as replacement items for similar existing equipment or where an existing floor plan makes baseboard radiation impractical.

Unit ventilators NOT permitted

Locate any equipment or duct mounted devices, which may require maintenance or replacement, outside classrooms and in locations where maintenance activities will have minimal disruption to the function of the school.

Related Sections

Definitions

Submittals Required

Quality Assurance

Scheduling

Delivery, Storage, and Handling

Regulatory Requirements

Part 2: Products

Manufactures

Products

BASEBOARD RADIATION

Cabinets or enclosures: 16-gauge or maximum security steel with closed ends to resist abuse and vandalism. Slope the top to discourage the storage of materials.

Design perforations to discourage vandalizing the fin tube or controls with sharp instruments.

Cabinet paint: Baked on enamel or prime coating.

Fin tubes: 3/4", 1", or 1-1/4" copper with a safe working pressure of 200 psi at 250°F and 0.016" thick or heavier aluminum fins spaced no closer than 48 per foot.

Approved manufacturers are Dunham-Bush, Standard, Sterling, or Vulcan. Consult the District for others.

UNIT VENTILATORS OR CABINET HEATERS (NO STANDARD UNIVENTS)

Part 3: Execution

Preparation

Installation

Cleaning and Protection

END OF SECTION 23 82 00

