Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Use of mechanical systems during construction.

1.2 USE OF SYSTEMS

.1 Use of new heating and ventilating systems for supplying temporary heat or ventilation is permitted only under following conditions:.

.1 Entire system is complete, pressure tested, cleaned, flushed out.

.2 Specified water treatment system has been commissioned, water treatment is being continuously monitored.

.3 Building has been closed in, areas to be heated/ventilated are clean and will not thereafter be subjected to dust-producing processes.

.4 There is no possibility of damage.

.5 Supply ventilation systems are protected by 30% filters, inspected daily, changed every 2 weeks or more frequently as required.

.6 Return systems have approved filters over openings, inlets, outlets.

.7 Systems will be:

.1 Operated as per manufacturer's recommendations and instructions.

.2 Operated by Contractor.

.3 Monitored continuously by Contractor.

.8 Warranties and guarantees are not relaxed.

.9 Regular preventive and other manufacturers recommended maintenance routines are performed by Contractor at own expense and under supervision of City’s Representative.

.10 Refurbish entire system before static completion; clean internally and externally, restore to "as- new" condition, replace filters in air systems.

.2 Filters specified in this Section are over and above those specified in other Sections of this project.

.3 Exhaust systems are not included in approvals for temporary heating ventilation.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 74 00 - Cleaning.

.2 Section 07 84 00 - Firestopping.

.3 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

1.2 REFERENCES

.1 Canadian General Standards Board (CGSB)

  .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 00 - Cleaning.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 CONNECTIONS TO EQUIPMENT

.1 In accordance with manufacturer's instructions unless otherwise indicated.

.2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.

.3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

3.2 CLEARANCES

.1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.

.2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated (whichever is greater) without interrupting operation of other system, equipment, components.

3.3 DRAINS

.1 Install piping with grade in direction of flow except as indicated.

.2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.

.3 Pipe each drain valve discharge separately to above floor drain. Discharge to be visible.

.4 Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.4 AIR VENTS

.1 Install manual or automatic air vents where indicated at high points in piping systems.

.2 Install isolating valve at each automatic air valve.

.3 Install drain piping to approved location and terminate where discharge is visible.

3.5 DIELECTRIC COUPLINGS

.1 General: Compatible with system, to suit pressure rating of system.

.2 Locations: Where dissimilar metals are joined.

.3 NPS 2 and under: isolating unions or bronze valves.

.4 Over NPS 2: Isolating flanges.

3.6 PIPEWORK INSTALLATION

.1 Screwed fittings jointed with Teflon tape.

.2 Protect openings against entry of foreign material.

.3 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.

.4 Assemble piping using fittings manufactured to ANSI standards.

.5 Saddle type branch fittings may be used on mains if branch line is no larger than half the size of main.

    .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.

.6 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.

.7 Install concealed pipework to minimize furring space, maximize headroom, conserve space.

.8 Slope piping, except where indicated, in direction of flow for positive drainage and venting.

.9 Install, except where indicated, to permit separate thermal insulation of each pipe.

.10 Group piping wherever possible and as indicated.

.11 Ream pipes, remove scale and other foreign material before assembly.

.12 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.

.13 Provide for thermal expansion as indicated.

.14 Valves:

- .1 Install in accessible locations.
- .2 Remove interior parts before soldering.
- .3 Install with stems above horizontal position unless otherwise indicated.
- .4 Valves accessible for maintenance without removing adjacent piping.
- .5 Install globe valves in bypass around control valves.
- .6 Use gate ball or butterfly valves at branch take-offs for isolating purposes except where otherwise specified.
- .7 Butterfly valves shall be considered equal to gate valves for chilled water, condenser water, glycol and hot water heating installations.
- .8 Install butterfly valves between weld neck flanges to ensure full compression of liner.
- .9 Install plug cocks or ball valves for glycol service.
- .10 Use chain operators on valves NPS 2-1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.

.15 Check Valves:

- .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and elsewhere as indicated.
- .2 Install swing check valves in horizontal lines on discharge of pumps and elsewhere as indicated.

3.7 SLEEVES

.1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.

.2 Material: Schedule 40 black steel pipe.

.3 Construction: Foundation walls and where sleeves extend above finished floors to have annular fins continuously welded on at mid-point.

.4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.

.5 Installation:

- .1 Concrete, masonry walls, concrete floors on grade: Terminate flush with finished surface.
- .2 Other floors: Terminate 25 mm above finished floor.

.3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.

.6 Sealing:

.1 Foundation walls and below grade floors: Fire retardant, waterproof non-hardening mastic.

.2 Elsewhere: Provide space for firestopping. Maintain fire rating integrity.

.3 Sleeves installed for future use: Fill with lime plaster or other easily removable filler.

.4 Ensure no contact between copper pipe or tube and sleeve.

3.8 ESCUTCHEONS

.1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.

.2 Construction: One piece type with set screws. Chrome or nickel plated brass or type 302 stainless steel.

.3 Sizes: Outside diameter to cover opening or sleeve. Inside diameter to fit around pipe or outside of insulation if so provided.

3.9 PREPARATION FOR FIRESTOPPING

.1 Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation to Section 07 84 00 - Firestopping.

.2 Uninsulated unheated pipes not subject to movement: No special preparation.

.3 Uninsulated heated pipes subject to movement: Wrap with non-combustible smooth material to permit pipe movement without damaging firestopping material or installation.

.4 Insulated pipes and ducts: Ensure integrity of insulation and vapour barriers.

3.10 FLUSHING OUT OF PIPING SYSTEMS

.1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

.2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 00 - Cleaning supplemented as specified in relevant sections of Mechanical Division.

.3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.11 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

.1 Advise Contract Administrator 48 hours minimum prior to performance of pressure tests.

.2 Pipework: Test as specified in relevant sections of Mechanical Division.

.3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant sections of Mechanical Division.

.4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.

.5 Conduct tests in presence of City’s Representative or Contract Administrator.

.6 Pay costs for repairs or replacement, retesting, and making good. Contract Administrator to determine whether repair or replacement is appropriate.

.7 Insulate or conceal work only after approval and certification of tests by Contract Administrator.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Electrical motors, drives and guards for mechanical equipment and systems.

.2 Supplier and installer responsibility indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.

.3 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 22 and 23. Refer to Division 26 for quality of materials and workmanship.

1.2 REFERENCES

.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)

.1 ASHRAE 90.1-01, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).

.2 Electrical Equipment Manufacturers' Association Council (EEMAC)

1.3 SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.3 Closeout Submittals

.1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00 - Product Requirements.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

.1 Construction Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 00 - Cleaning.

Part 2 Products

2.1 GENERAL

.1 Motors: high efficiency, in accordance with local Hydro company standards and to ASHRAE 90.1.

2.2 MOTORS

.1 Provide motors for mechanical equipment as specified.

.2 Motors under 373 W (1/2 HP) : speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.

.3 Motors 373 W (1/2 HP) and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40 degrees C, 3 phase, 230/600 V, unless otherwise indicated.

2.3 TEMPORARY MOTORS

.1 If delivery of specified motor will delay completion or commissioning work, install motor approved by Contract Administrator for temporary use. Work will only be accepted when specified motor is installed.

2.4 BELT DRIVES

.1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.

.2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise indicated.

.3 For motors under 7.5 kW (10 HP): standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.

.4 For motors 7.5 kW (10 HP) and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.

.5 Correct size of sheave determined during commissioning.

.6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.

.7 Motor slide rail adjustment plates to allow for centre line adjustment.

.8 Supply one set of spare belts for each set installed in accordance with Section 01 78 10 - Closeout Submittals.

2.5 DRIVE GUARDS

.1 Provide guards for unprotected drives.

.2 Guards for belt drives;

.1 Expanded metal screen welded to steel frame.
.2 Minimum 1.2 mm thick sheet metal tops and bottoms.
.3 38 mm dia holes on both shaft centres for insertion of tachometer.
.4 Removable for servicing.

.3 Provide means to permit lubrication and use of test instruments with guards in place.

.4 Install belt guards to allow movement of motors for adjusting belt tension.-

.5 Guard for flexible coupling:

.1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
.2 Securely fasten in place.
.3 Removable for servicing.

.6 Unprotected fan inlets or outlets:

.1 Wire or expanded metal screen, galvanized, 19 mm mesh.
.2 Net free area of guard: not less than 80% of fan openings.
.3 Securely fasten in place.
.4 Removable for servicing.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Fasten securely in place.

.2 Make removable for servicing, easily returned into, and positively in position.

3.3 CLEANING

.1 Proceed in accordance with Section 01 74 00 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation for flexible connections, expansion joints, anchors and guides for building services piping.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 74 0 - Cleaning.

.3 Section 01 78 10 - Closeout Submittals.

.4 Section 03 20 00 - Concrete Reinforcing.

.5 Section 03 30 00 - Cast-in-Place Concrete .

.6 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

1.3 REFERENCES

.1 American Society for Testing and Materials International, (ASTM).

- .1 ASTM A53/A53M-02, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
- .2 ASTM A105/A105M-03, Standard Specification for Carbon Steel Forgings, for Piping Applications.

1.4 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit product data and indicate for items as applicable:

- .1 Manufacturer, model number, line contents, pressure and temperature rating.
- .2 Movement handled, axial, lateral, angular and the amounts of each.
- .3 Nominal size and dimensions including details of construction and assembly.

.3 Submit maintenance data in accordance with Section 01 78 10 - Closeout Submittals.

.4 Data to include:

- .1 Servicing requirements, including special requirements, stuffing box packing, lubrication and recommended procedures.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for recycling in accordance with Section 01 74 00 - Cleaning.

Part 2 Products

2.1 BELLOWS TYPE EXPANSION JOINTS

.1 For axial, lateral or angular movements, as indicated.

.2 Maximum operating pressure: To suit operating conditions as indicated.

.3 Maximum operating temperature: To suit operating conditions as indicated.

  .1 Hot water heating - 100 deg. C temp. rise.

.4 Type A: controlled free flexing, factory tested to 1 1/2 times maximum working pressure. Furnish test certificates.

.5 Type B: externally pressurized, constant volume, pressure balanced, designed to eliminate pressure thrust, factory tested to 1 1/2 times maximum working pressure. Furnish test certificates.

.6 Bellows:

  .1 Multiple bellows, hydraulically formed, two ply, austenitic stainless steel for specified fluid, pressure and temperature, water treatment and pipeline cleaning procedures.

.7 Reinforcing or control rings:

  .1 2 piece nickel iron.

.8 Ends:

  .1 Weld neck flanges to match pipe.

.9 Liner:

  .1 Austenitic stainless steel in direction of flow.

.10 Shroud:

  .1 Carbon steel, painted.

2.2 FLEXIBLE CONNECTION

.1 Application: to suit motion as indicated.

.2 Minimum length in accordance with manufacturer's recommendations to suit offset 450 mm.

.3 Inner hose: stainless steel corrugated.

.4 Braided wire mesh stainless steel outer jacket.

.5 Diameter and type of end connection: as indicated.

.6 Operating conditions:

  .1 Working pressure: 1476 kPa.

.2 Working temperature: 82 to 115°C.

.3 To match system requirements.

.7 Location

.1 Chilled and condenser water connections to water chiller.

.2 Connections to cooling tower.

.3 Fuel oil supply and return for connections to outdoor fuel oil tank.

2.3 ANCHORS AND GUIDES

.1 Anchors:

.1 Provide as indicated.

.2 Concrete: to Section 03 30 00 - Cast-in-Place Concrete.

.3 Reinforcement: to Section 03 20 00 - Concrete Reinforcing.

.2 Alignment guides:

.1 By conduit manufacturer.

.2 To accommodate specified thickness of insulation.

.3 Vapour barriers, jackets to remain uninterrupted.

Part 3 Execution

3.1 INSTALLATION

.1 Install expansion joints with cold setting. Make record of cold settings.

.2 Install expansion joints and flexible connections in accordance with manufacturer's instructions.

.3 Install pipe anchors and guides as indicated. Anchors to withstand 150 % of axial thrust.

3.2 CLEANING AND START-UP

.1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

□ END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 74 00 - Cleaning.

1.2 REFERENCES

.1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)

- .1 ANSI/ASME B31.1-1998, Power Piping.
- .2 ANSI/ASME B31.3-2000, Process Piping Addenda A.
- .3 ANSI/ASME B31.3-2001, Process Piping Addenda B.
- .4 ANSI/ASME Boiler and Pressure Vessel Code-1998:
  - .1 Section I: Power Boilers.
  - .2 Section V: Nondestructive Examination.
  - .3 Section IX: Welding and Brazing Qualifications.

.2 American National Standards Institute/American Water Works Association (ANSI/AWWA)

- .1 ANSI/AWWA C206-97, Field Welding of Steel Water Pipe.

.3 American Welding Society (AWS)

- .1 AWS C1.1-2000, Recommended Practices for Resistance Welding.
- .2 AWS Z49.1-1999, Safety Welding, Cutting and Allied Process.
- .3 AWS W1-2000, Welding Inspection Handbook..

.4 Canadian General Standards Board (CGSB)

- .1 CAN/CGSB-48.2-92, Spot Radiography of Welded Butt Joints in Ferrous Materials.

.5 Canadian Standards Association (CSA International)

- .1 CSA W47.2-M1987(R1998), Certification of Companies for Fusion Welding of Aluminum.
- .2 CSA W48 series-01, Filler Metals and Allied Materials for Metal Arc Welding.
- .3 CSA B51-97, Boiler, Pressure Vessel and Pressure Piping Code.
- .4 CSA-W117.2-01, Safety in Welding, Cutting and Allied Processes.
- .5 CSA W178.1-02, Certification of Welding Inspection Organizations.
- .6 CSA W178.2-01, Certification of Welding Inspectors.

.6 Comply with Fire Protection Standard #302 (latest revision) Issued by Dominion Fire Commission.

1.3 QUALIFICATIONS

.1 Welders

.1 Welding qualifications in accordance with CSA B51.

.2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.

.3 Each welder to possess identification symbol issued by authority having jurisdiction.

.4 Certification of companies for fusion welding of aluminum in accordance with CSA W47.2.

.2 Inspectors

.1 Inspectors qualified to CSA W178.2.

1.4 QUALITY ASSURANCE

.1 Registration of welding procedures in accordance with CSA B51.

.2 Copy of welding procedures available for inspection.

.3 Safety in welding, cutting and allied processes in accordance with CSA-W117.2.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 00 - Cleaning.

Part 2 Products

2.1 ELECTRODES

.1 Electrodes: in accordance with CSA W48 Series.

Part 3 Execution

3.1 WORKMANSHIP

.1 Welding: in accordance with ANSI/ASME B31.1 B31.3, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, and applicable requirements of provincial authority having jurisdiction.

3.2 INSTALLATION REQUIREMENTS

.1 Identify each weld with welder's identification symbol.

.2 Backing rings:

.1 Where used, fit to minimize gaps between ring and pipe bore.

.2 Do not install at orifice flanges.

.3 Fittings:

.1 NPS 2 and smaller: install welding type sockets.

.2 Branch connections: install welding tees or forged branch outlet fittings.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation for thermometers and pressure gauges in piping systems.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 74 00 - Cleaning.

.3 Section 23 05 54 - Mechanical Identification.

1.3 REFERENCES

.1 American Society of Mechanical Engineers (ASME).

- .1 ASME B40.100-01, Pressure Gauges and Gauge Attachments.
- .2 ASME B40.200-01, Thermometers, Direct Reading and Remote Reading.

.2 Canadian General Standards Board (CGSB).

- .1 CAN/CGSB-14.4-M88, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.
- .2 CAN/CGSB-14.5-M88, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.

1.4 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit shop drawings and product data.

.3 Submit manufacturer's product data for following items:

- .1 Thermometers.
- .2 Pressure gauges.
- .3 Stop cocks.
- .4 Syphons.
- .5 Wells.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for recycling in accordance with Section 01 74 00 - Cleaning.

Part 2 Products

2.1 GENERAL

.1 Design point to be at mid point of scale or range.

.2 Ranges (Accuracy to be 1% of full span):

.1 Hot water heating systems - plus 10 deg.C to 150 deg. C.
.2 Chilled water systems - minus five deg. C to 50 deg. C.
.3 Glycol heat recovery systems - nimus 40 deg. C to 70 deg. C.
.4 Glycol heating system - plus 10 deg. C to 150 deg. C.
.5 Condenser water systems - 0 deg. C to 50 deg. C.

2.2 DIRECT READING THERMOMETERS

.1 Industrial, variable angle type, liquid filled, 150 mm scale length: to CAN/CGSB14.4.

.1 Ensure length of dials are clear of insulation.

2.3 THERMOMETER WELLS

.1 Copper pipe: copper or bronze.

.2 Steel pipe: stainless steel.

2.4 PRESSURE GAUGES

.1 150 mm over 3 m from floor, otherwise 112 mm , dial type: to ASME B40.100, Grade 2A, bronze bourdon tube having 1% accuracy full scale unless otherwise specified.

.2 Provide:

.1 Snubber for pulsating operation.
.2 Diaphragm assembly for corrosive service.
.3 Gasketted pressure relief back with solid front.
.4 Bronze stop cock.
.5 Oil filled at pumps and chillers.

Part 3 Execution

3.1 GENERAL

.1 Install so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading units.

.2 Install between equipment and first fitting or valve.

3.2 THERMOMETERS

.1 Install in wells on piping. Provide heat conductive material inside well.

.2 Install in locations as indicated in drawings and on inlet and outlet of:

.1 Heat exchangers.
.2 Water heating and cooling coils.
.3 Chiller.

.4 Cooling tower.

.5 DHW tanks.

.3 Stems and wells to be immersed in liquid flow. Where a separable well is mounted in pipe 37mm (1 ½”) diam. or less, enlarge pipe to 50mm (2”) diam. for well length plus 75mm (3”).

.4 Use extensions where thermometers are installed through insulation.

3.3 PRESSURE GAUGES

.1 Install in following locations:

.1 Suction and discharge of pumps and strainers.

.2 Inlet and outlet of coils.

.3 Inlet and outlet of liquid side of heat exchangers.

.4 In other locations as indicated, on drawings.

.2 Install gauge cocks for balancing purposes.

.3 Use extensions where pressure gauges are installed through insulation and subject to vibration.

3.4 NAMEPLATES

.1 Install engraved lamicoid nameplates as specified in Section 23 05 54 - Mechanical Identification, identifying medium.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Bronze - valves.

.2 Sustainable requirements for construction and verification.

.3 Related Sections:

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 74 00 - Cleaning.

.3 Section 01 78 10 - Closeout Submittals.

.4 Section 23 05 01 - Installation of Pipework.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME).

.1 ANSI/ASME B1.20.1-1983(R2001), Pipe Threads, General Purpose (Inch).

.2 ANSI/ASME B16.18-2001, Cast Copper Alloy Solder Joint Pressure Fittings.

.2 American Society for Testing and Materials International, (ASTM).

.1 ASTM A276-04, Specification for Stainless Steel Bars and Shapes.

.2 ASTM B62-02, Specification for Composition Bronze or Ounce Metal Castings.

.3 ASTM B283-99a, Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).

.4 ASTM B505/B505M-02, Specification for Copper-Base Alloy Continuous Castings.

.3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).

.1 MSS-SP-25-1998, Standard Marking System for Valves, Fittings, Flanges and Unions.

.2 MSS-SP-80-2003, Bronze Gate Globe, Angle and Check Valves.

.3 MSS-SP-110-1996, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Closeout Submittals:

.1 Submit maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.4 DELIVERY STORAGE AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 00 - Cleaning.

Part 2 Products

2.1 MATERIALS

.1 Valves:

- .1 Except for specialty valves, to be single manufacturer.
- .2 All products to have CRN registration numbers.

.2 End Connections:

- .1 Connection into adjacent piping/tubing:
  - .1 Steel pipe systems: Screwed ends to ANSI/ASME B1.20.1.
  - .2 Copper tube systems: Solder ends to ANSI/ASME B16.18.

.3 Lockshield Keys:

- .1 Where lockshield valves are specified, provide 10 keys of each size: malleable iron cadmium plated.

.4 Gate Valves:

- .1 Requirements common to gate valves, unless specified otherwise:
  - .1 Standard specification: MSS SP-80.
  - .2 Bonnet: union with hexagonal shoulders.
  - .3 Connections: screwed with hexagonal shoulders.
  - .4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
  - .5 Packing: non-asbestos.
  - .6 Handwheel: non-ferrous.
  - .7 Handwheel Nut: bronze to ASTM B62.
- .2 NPS 2 and under, non-rising stem, solid wedge disc, Class 125
  - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
  - .2 Operator: Handwheel.
- .3 NPS 2 and under, non-rising stem, solid wedge disc, Class 150:
  - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
  - .2 Operator: Handwheel.
- .4 NPS 2 and under, rising stem, split wedge disc, Class 125:
  - .1 Body: with long disc guides, screwed bonnet.
  - .2 Disc: split wedge, bronze to ASTM B283, loosely secured to stem.
  - .3 Operator: Handwheel.
- .5 NPS 2 and under, rising stem, solid wedge disc, Class 125:
  - .1 Body: with long disc guides, screwed bonnet.
  - .2 Operator: Handwheel.
- .6 NPS 2 and under, rising stem, solid wedge disc, Class 150:

.1 Body: with long disc guides, screwed union bonnet.

.2 Operator: Handwheel.

.5 Globe Valves:

.1 Requirements common to globe valves, unless specified otherwise:

.1 Standard specification: MSS SP-80.

.2 Bonnet: union with hexagonal shoulders.

.3 Connections: screwed with hexagonal shoulders.

.4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.

.5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.

.6 Handwheel: non-ferrous.

.7 Handwheel Nut: bronze to ASTM B62.

.2 NPS 2 and under, composition disc, Class 125:

.1 Body and bonnet: screwed bonnet.

.2 Disc and seat: renewable rotating PTFE disc composition to suit service conditions, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.

.3 Operator: Handwheel.

.3 NPS 2 and under, composition disc, Class 150:

.1 Body and bonnet: union bonnet.

.2 Disc and seat: renewable rotating PTFE disc in easily removable disc holder, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.

.3 Operator: Handwheel.

.4 NPS 2 and under, plug disc, Class 150, screwed ends:

.1 Body and bonnet: union bonnet.

.2 Disc and seat ring: tapered plug type with disc stem ring of AISI S420 stainless steel to ASTM A276, loosely secured to stem.

.3 Operator: Handwheel.

.5 Angle valve, NPS 2 and under, composition disc, Class 150:

.1 Body and bonnet: union bonnet.

.2 Disc and seat: renewable rotating PTFE disc in slip-on easily removable disc holder having integral guides, regrindable bronze seat, loosely secured to stem.

.3 Operator: Handwheel.

.6 Check Valves:

.1 Requirements common to check valves, unless specified otherwise:

.1 Standard specification: MSS SP-80.

.2 Connections: screwed with hexagonal shoulders.

.2 NPS 2 and under, swing type, bronze disc, Class 125:

.1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.

.2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.

.3 NPS 2 and under, swing type, bronze disc:

.1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.

.2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.

.4 NPS 2 and under, swing type, composition disc, Class 200:

.1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.

.2 Disc: renewable rotating disc of number 6 composition to suit service conditions, bronze two-piece hinge disc construction.

.5 NPS 2 and under, horizontal lift type, composition disc, Class 150:

.1 Body: with integral seat, union bonnet ring with hex shoulders, cap.

.2 Disc: renewable no. 6 composition rotating disc in disc holder having guides top and bottom, of bronze to ASTM B62.

.6 NPS 2 and under, vertical lift type, bronze disc, Class 125:

.1 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.

.7 Silent Check Valves:

.1 NPS 2 and under:

.1 Body: cast high tensile bronze to ASTM B62 with integral seat.

.2 Pressure rating: Class 125.

.3 Connections: screwed ends to ANSI B1.20.1 and with hex. shoulders.

.4 Disc and seat: renewable rotating disc.

.5 Stainless steel spring, heavy duty.

.6 Seat: regrindable.

.8 Ball Valves:

.1 NPS 2 and under:

.1 Body and cap: cast high tensile bronze to ASTM B62.

.2 Pressure rating: Class125, 860 kPa steam.

.3 Connections: Screwed ends to ANSI B1.20.1 and with hexagonal shoulders solder ends to ANSI.

.4 Stem: tamperproof ball drive.

.5 Stem packing nut: external to body.

.6 Ball and seat: replaceable stainless steel hard chrome solid ball and teflon seats.

.7 Stem seal: TFE with external packing nut.

.8 Operator: removable lever handle.

Part 3 Execution

3.1 INSTALLATION

.1 Install rising stem valves in upright position with stem above horizontal.

.2 Remove internal parts before soldering.

.3 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Valves, gate, globe, and check.

.2 Related Sections:

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 74 00 - Cleaning.

.3 Section 01 78 10 - Closeout Submittals.

.4 Section 23 05 01 - Installation of Pipework.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME).

.1 ANSI/ASME B16.1-1998, Cast Iron Pipe Flanges and Flanged Fittings.

.2 American Society for Testing and Materials International (ASTM).

.1 ASTM A49-01, Specification for Heat-Treated Carbon Steel Joint Bars.

.2 ASTM A126-95(2001), Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

.3 ASTM B61-93, Specification for Steam or Valve Bronze Castings.

.4 ASTM B62-93, Specification for Composition Bronze or Ounce Metal Castings.

.5 ASTM B85-03, Specification for Aluminum-Alloy Die Castings.

.6 ASTM B209-04, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).

.1 MSS SP-70-1998, Cast Iron Gate Valves, Flanged and Threaded Ends.

.2 MSS SP-71-1997, Grey Iron Swing Check Valves, Flanged and Threaded Ends.

.3 MSS SP-82-1992, Valve Pressure Testing Methods.

.4 MSS SP-85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Closeout Submittals:

.1 Submit maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.4 DELIVERY STORAGE AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 00 - Cleaning.

Part 2 Products

2.1 MATERIAL

.1 Valves:

- .1 Except for specialty valves, to be of single manufacturer.

.2 Standard specifications:

- .1 Gate valves: MSS SP-70.
- .2 Globe valves: MSS SP-85.
- .3 Check valves: MSS SP-71.

.3 Requirements common to valves, unless specified otherwise:

- .1 Body, bonnet: cast iron to ASTM B209 Class B.
- .2 Connections: flanged ends plain face with 2 mm raised face with serrated finish to ANSI B16.1.
- .3 Inspection and pressure testing: to MSS SP-82.
- .4 Bonnet gasket: non-asbestos.
- .5 Stem: to have precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.
- .6 Stuffing box: non-galling two-piece ball-jointed packing gland, gland bolts and nuts.
- .7 Gland packing: non-asbestos.
- .8 Handwheel: Die-cast aluminum alloy to ASTM B85 or malleable iron to ASTM A49. Nut of bronze to ASTM B62.
- .9 Identification tag: with catalogue number, size, other pertinent data.

.4 All products to have CRN registration numbers.

2.2 GATE VALVES

.1 NPS 2 1/2 - 8, non rising stem, inside screw, bronze iron trim, solid wedge disc:

- .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly. Class 125.
- .2 Disc: solid offset taper wedge, bronze to ASTM B62.
- .3 Seat rings: renewable bronze to ASTM B62, screwed into body.
- .4 Stem: bronze to ASTM B62.
- .5 Disc: solid offset taper wedge, cast iron to ASTM A126 Class B, secured to wrought steel stem.
- .6 Seat: Integral with body.
- .7 Stem: wrought steel.
- .8 Operator: Handwheel.

.9 Bypass: complete with union and NPS gate, globe valve as Section 23 05 22 - Valves - Bronze.

.2 NPS 2 1/2-8, outside screw and yoke (OS&Y), bronze iron trim, solid wedge disc:

.1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, yoke, yoke hub, yoke sleeve and nut. Class 125.

.2 Disc: solid offset taper wedge, bronze to ASTM B62 up to NPS 3, cast iron with bronze disc rings on other sizes, secured to stem through integral forged T-head disc-stem connection.

.3 Seat rings: renewable bronze screwed into body.

.4 Stem: nickel-plated steel manganese-bronze.

.5 Disc: solid offset taper all-cast iron, secured to stem through integral forged T-head disc-stem connection.

.6 Seat rings: integral with body.

.7 Stem: nickel-plated steel.

.8 Pressure-lubricated operating mechanism.

.9 Operator: Handwheel.

.10 Bypass: complete with union and NPS gate globe valve as Section 23 05 01 - Installation of Pipework.

2.3 UNDERWRITERS APPROVED GATE VALVE

.1 NPS 2 1/2 - 14, OS&Y:

.1 Approvals: UL and FM approved for fire service.

.2 UL and FM Label: on valve yoke.

.3 Body, Bonnet: cast iron to ASTM A126 Class B. Wall thicknesses to ANSI B16.1 and ULC 262 (B).

.4 Bonnet bushing, yoke sleeve: bronze, to FM requirements.

.5 Packing gland: bronze.

.6 Stem: manganese bronze. Diameter to ULC C-262 (B).

.7 Stuffing box dimensions, gland bolt diameter: to ULC C-262 (B).

.8 Bosses for bypass valve, drain: on NPS 4 and over.

.9 Disc: solid taper wedge. Up to NPS 3: bronze. NPS 4 and over: cast iron with bronze disc rings.

.10 Disc seat ring: self-aligning, Milwood undercut on NPS 3 - 12.

.11 Pressure rating:

.1 NPS 2-1/2 - 12: 1.7 Mpa CWP.

.2 NPS 14-1.2: 1.2 MPa CWP.

.12 Operator: handwheel.

.13 Bypass: complete with union and NPS gate valve as Section 23 05 22 - Valves - Bronze, paragraph.

2.4 GLOBE VALVES

.1 NPS 2 1/2 - 10, OSY:

.1 Body: with multiple-bolted bonnet.

.2 WP: 860 kPa steam, 1.4 MPa CWP.

.3 Bonnet-yoke gasket: non-asbestos.

.4 Disc: bronze to ASTM B62, fully guided from bottom, securely yet freely connected to stem for swivel action and accurate engagement with disc.

.5 Seat ring: renewable, regrindable, screwed into body.

.6 Stem: bronze to ASTM B62.

.7 Operator: Handwheel.

.8 Bypass: complete with union and NPS gate, globe valve as Section 23 05 22 - Valves - Bronze, paragraph.

2.5 CHECK VALVES

.1 Swing check valves, Class 125:

.1 Body and bolted cover: with tapped and plugged opening on each side for hinge pin. Flanged ends: plain faced with smooth finish.

.1 Up to NPS 16: cast iron to ASTM A126 Class B.

.2 Ratings:

.1 NPS 2 1/2 - 12: 1.4 MPa CWP.

.3 Disc: rotating for extended life.

.1 Up to NPS 6: bronze to ASTM B 62.

.4 Seat rings: renewable bronze to ASTM B62 screwed into body.

.5 Hinge pin, bushings: renewable bronze to ASTM B62.

.6 Disc: A126 Class B, secured to stem, rotating for extended life.

.7 Seat: cast iron, integral with body.

.8 Hinge pin: exelloy; bushings: malleable iron.

.9 Identification tag: fastened to cover.

.10 Hinge: galvanized malleable iron.

2.6 SILENT CHECK VALVES

.1 Construction:

.1 Body: malleable or ductile iron with integral seat.

.2 Pressure rating: class 125, WP = 860 kPa.

.3 Connections: grooved ends.

.4 Disc: bronze or stainless steel renewable rotating disc.

.5 Seat: renewable, EPDM.

.6 Stainless steel spring, heavy duty.

Part 3 Execution

3.1 INSTALLATION

.1 Install rising stem valves in upright position with stem above horizontal.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Butterfly Valves.

.2 Related Sections:

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 74 00 - Cleaning.

.3 Section 01 78 10 - Closeout Submittals.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME).

.1 ANSI/ASME B1.20.1-1983(R2001), Pipe Threads, General Purpose (Inch).

.2 ANSI/ASME B16.1-1998, Cast Iron Pipe Flanges and Flanged Fittings.

.3 ANSI/ASME B16.5-03, Pipe Flanges and Flanged Fittings.

.4 ANSI/ASME B16.11-01, Forged Fittings, Socket-Welding and Threaded.

.5 ANSI/ASME B16.25-1997, Buttwelding Ends.

.6 ANSI/ASME B16.34-1996, Valves - Flanged, Threaded and Welding Ends.

.2 American National Standards Institute (ANSI)/American Petroleum Institute (API).

.1 ANSI/API 609-1997, Lug- and Water-Type Butterfly Valves.

.3 American Society for Testing and Materials International, (ASTM).

.1 ASTM A126-95(01), Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

.2 ASTM B62-02, Specification for Composition Bronze or Ounce Metal Castings.

.3 ASTM B209M-04, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).

.1 MSS SP-67-02, Butterfly Valves.

1.3 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Closeout Submittals:

.1 Submit maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.4 DELIVERY STORAGE AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 00 - Cleaning.

Part 2 Products

2.1 BUTTERFLY VALVES - RESILIENT SEAT - 200 PSIG

.1 Except to specialty valves, to be of single manufacturer.

.2 To be suitable for dead-end service.

.3 CRN registration number required for products.

.4 Sizes: Wafer Lug type: NPS 2 to 30.

.5 Pressure rating for tight shut-off at temperatures up to maximum for seat material.

- .1 NPS 2 - 12: 200 psig.

.6 Minimum seat temperature ratings to 135 degrees C.

.7 Application: on-off operation.

.8 Full lug body (threaded).

.9 Operators:

- .1 NPS 2 - 6: Handles capable of locking in any of ten (10) positions - 0 degrees to 90 degrees. Handle and release trigger - ductile iron. Return spring and hinge pin: carbon steel. Latch plate and mounting hardware: cadmium plated carbon steel. Standard coating: black lacquer.

.10 Designed to comply with MSS SP-67 and API 609.

.11 Compatible with ANSI Class 125/Class 150 flanges.

.12 Construction:

- .1 Body ductile iron.
- .2 Disc: aluminum bronze.
- .3 Seat: EPDM.
- .4 Shaft: 316 stainless steel.
- .5 Taper pin: 316 SS.
- .6 Key: carbon steel.
- .7 O-Ring: Buna-N.
- .8 Bushings: Teflon.

2.2 MOUNTING FLANGES

.1 Class 125 cast iron to ANSI B16.1 or Class 150 steel to B16.5 pipe flanges.

Part 3 Execution

3.1 PREPARATION

.1 Valve and mating flange preparation.

  - .1 Inspect adjacent pipeline, remove rust, scale, welding slag, other foreign material.
  - .2 Ensure that valve seats and pipe flange faces are free of dirt or surface irregularities which may disrupt flange seating and cause external leakage.
  - .3 Install butterfly valves with disc in almost closed position.
  - .4 Inspect valve disc seating surfaces and waterway and eliminate dirt or foreign material.

3.2 INSTALLATION OF VALVES

.1 Install in accordance with manufacturer's instructions.

.2 Do not use gaskets between pipe flanges and valves unless instructed otherwise by valve manufacturer.

.3 Verify suitability of valve for application by inspection of identification tag.

.4 Mount actuator on to valve prior to installation.

.5 Handle valve with care so as to prevent damage to disc and seat faces.

.6 Valves in horizontal pipe lines should be installed with stem in horizontal position to minimize liner and seal wear.

.7 Ensure that valves are centered between bolts before bolts are tightened and then opened and closed to ensure unobstructed disc movement. If interference occurs due, for example to pipe wall thickness, taper bore adjacent piping to remove interference.

3.3 ACTUATOR INSTALLATION

.1 Electrical connections to be made by actuator manufacturer.

.2 Cycle valve operation from fully closed to fully open then back to fully closed.

.3 At same time, check travel stop settings for proper disc alignment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Concrete housekeeping pads, hangers and supports for mechanical piping, ducting and equipment.

1.2 REFERENCES

.1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)

.1 ANSI/ASME B31.1-04, Power Piping.

.2 American Society for Testing and Materials International (ASTM)

.1 ASTM A125-1996(R2001), Specification for Steel Springs, Helical, Heat-Treated.

.2 ASTM A307-04, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.3 ASTM A563-04a, Specification for Carbon and Alloy Steel Nuts.

.3 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)

.1 MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.

.2 ANSI/MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.

.3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.

.4 Underwriter's Laboratories of Canada (ULC)

1.3 SYSTEM DESCRIPTION

.1 Design Requirements:

.1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.

.2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP58.

.3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.

.4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.

.5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.

1.4 SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit shop drawings and product data for following items:

.1 Bases, hangers and supports.
.2 Connections to equipment and structure.
.3 Structural assemblies.

.3 Closeout Submittals:

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00 - Product Requirements.
.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

.1 Construction Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 00 - Cleaning.

Part 2 Products

2.1 GENERAL

.1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP58.

.2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

2.2 PIPE HANGERS

.1 Finishes:

.1 Pipe hangers and supports: galvanized painted with zinc-rich paint after manufacture.
.2 Use electro-plating galvanizing process hot dipped galvanizing process.
.3 Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.

.2 Upper attachment structural: suspension from lower flange of I-Beam:

.1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.

.1 Rod: 9 mm UL listed 13 mm FM approved.

.2 Hanger Rod:

.1 Support hangers with mild steel rod. Load on hanger not to exceed capacity indicated in following table:

.2 Rod Diam. Max. Safe Load

.3 9.5mm(3/8") 277 Kg(610 lbs.)

.4 13mm(1/2") 514 Kg(1130 lbs.)

.5 16mm(5/8") 822 Kg(1818 lbs.)

.6 19mm(3/4") 1232 Kg(2710 lbs.)

.3 Rods to have sufficient threaded length to allow for vertical adjustment after pipe is in place. Use two nuts in each rod, one above clevis or angle iron, and one below.

.2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers.

.3 Upper attachment structural: suspension from upper flange of I-Beam:

.1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.

.2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut.

.4 Upper attachment to concrete:

.1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.

.2 Concrete inserts: wedge shaped body with knockout protector plate to MSS SP69.

.5 Shop and field-fabricated assemblies:

.1 Trapeze hanger assemblies.

.2 Steel brackets.

.3 Sway braces for seismic restraint systems: to Section.

.6 Hanger rods: threaded rod material to MSS SP58:

.1 Ensure that hanger rods are subject to tensile loading only.

.2 Provide linkages where lateral or axial movement of pipework is anticipated.

.3 Do not use 22 mm or 28 mm rod.

.7 Pipe attachments: material to MSS SP58:

.1 Attachments for steel piping: carbon steel galvanized.

.2 Attachments for copper piping: copper plated black steel.

.3 Use insulation shields for hot pipework.

.4 Oversize pipe hangers and supports.

.8 Adjustable clevis: material to MSS SP69, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.

.1 Ensure "U" has hole in bottom for rivetting to insulation shields.

.9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.

.10 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.

.1 Finishes for steel pipework: galvanized.

.2 Finishes for copper, glass, brass or aluminum pipework: galvanized, with formed portion plastic coated epoxy coated.

.11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

2.3 RISER CLAMPS

.1 Steel or cast iron pipe: black carbon steel to MSS SP58, type 42.

.2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.

.3 Bolts: to ASTM A307.

.4 Nuts: to ASTM A563.

2.4 INSULATION PROTECTION SHIELDS

.1 Insulated cold piping:

.1 64 kg/m^3 density insulation plus insulation protection shield to: MSS SP69, galvanized sheet carbon steel. Length designed for maximum 3 m span.

.2 Insulated hot piping:

.1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP69.

2.5 CONSTANT SUPPORT SPRING HANGERS

.1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).

.2 Load adjustability: 10 % minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.

.3 Provide upper and lower factory set travel stops.

.4 Provide load adjustment scale for field adjustments.

.5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.

.6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.6 VARIABLE SUPPORT SPRING HANGERS

.1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.

.2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.

.3 Variable spring hanger complete with factory calibrated travel stops.

.4 Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/-5 % spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

2.7 EQUIPMENT SUPPORTS

.1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings. Submit calculations with shop drawings.

2.8 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

.1 Provide templates to ensure accurate location of anchor bolts.

2.9 HOUSE-KEEPING PADS

.1 Provide 100 or 150 mm high, unless noted larger on drawings, concrete housekeeping pads for base-mounted equipment; size pads 50 mm larger than equipment; chamfer pad edges.

.2 Concrete: to Section 03 30 00 - Cast-in-place Concrete.

2.10 OTHER EQUIPMENT SUPPORTS

.1 Fabricate equipment supports from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings.

.2 Submit structural calculations with shop drawings.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Install in accordance with:

.1 manufacturer's instructions and recommendations.

.2 Vibration Control Devices:

.1 Install on piping systems at pumps, chillers, cooling towers, and as indicated.

.3 Clamps on riser piping:

.1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.

.2 Bolt-tightening torques to industry standards.

.3 Steel pipes: install below coupling or shear lugs welded to pipe.

.4 Cast iron pipes: install below joint.

.4 Clevis plates:

.1 Attach to concrete with 4 minimum concrete inserts, one at each corner.

.5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

.6 Use approved constant support type hangers where:

.1 vertical movement of pipework is 13 mm or more,

.2 transfer of load to adjacent hangers or connected equipment is not permitted.

.7 Use variable support spring hangers where:

.1 transfer of load to adjacent piping or to connected equipment is not critical.

.2 variation in supporting effect does not exceed 25 % of total load.

3.3 HANGER SPACING

.1 Plumbing piping: to Canadian Plumbing Code Provincial Code and authority having jurisdiction.

.2 Fire protection: to applicable fire code.

.3 Fuel oil piping: up to NPS 1/2: every 1.8 m.

.4 Copper piping: up to NPS 1/2: every 1.5 m.

.5 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.

.6 Within 300 mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.1 m	1.8 m
1-1/2	2.7 m	2.4 m
2	3.0 m	2.7 m
2-1/2	3.6 m	3.0 m
3	3.6 m	3.0 m
3-1/2	3.9 m	3.3 m
4	4.2 m	3.6 m
5	4.8 m	
6	5.1 m	

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
8	5.7 m	
10	6.6 m	
12	6.9 m	

.7 Pipework greater than NPS 12: to MSS SP69.

3.4 HANGER INSTALLATION

.1 Install hanger so that rod is vertical under operating conditions.

.2 Adjust hangers to equalize load.

.3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

3.5 HORIZONTAL MOVEMENT

.1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.

.2 Where horizontal pipe movement is less than 13 mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

3.6 FINAL ADJUSTMENT

.1 Adjust hangers and supports:

- .1 Ensure that rod is vertical under operating conditions.
- .2 Equalize loads.

.2 Adjustable clevis:

- .1 Tighten hanger load nut securely to ensure proper hanger performance.
- .2 Tighten upper nut after adjustment.

.3 C-clamps:

- .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.

.4 Beam clamps:

- .1 Hammer jaw firmly against underside of beam.

□ END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Vibration isolation materials and components, measures and their installation.

1.2 REFERENCES

.1 National Fire Protection Association (NFPA)

.1 NFPA 13-2002, Standard for the Installation of Sprinkler Systems.

.2 National Building Code of Canada (NBC) - 1995

1.3 SUBMITTALS

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00 - Product Requirements.

.2 Waste Management and Disposal:

.1 Construction Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 00 - Cleaning.

Part 2 Products

2.1 GENERAL

.1 Size and shape of bases type and performance of vibration isolation as indicated.

2.2 ELASTOMERIC PADS

.1 Type EP1 - neoprene waffle or ribbed; 9 mm minimum thick; 50 durometer; maximum loading 350 kPa.

.2 Type EP2 - rubber waffle or ribbed; 9 mm minimum thick; 30 durometer natural rubber; maximum loading 415 kPa.

.3 Type EP3 - neoprene-steel-neoprene; 9 mm minimum thick neoprene bonded to 1.71 mm steel plate; 50 durometer neoprene, waffle or ribbed; holes sleeved with isolation washers; maximum loading 350 kPa.

.4 Type EP4 - rubber-steel-rubber; 9 mm minimum thick rubber bonded to 1.71 mm steel plate; 30 durometer natural rubber, waffle or ribbed; holes sleeved with isolation washers; maximum loading 415 kPa.

2.3 ELASTOMERIC MOUNTS

.1 Type M1 - colour coded; neoprene in shear; maximum durometer of 60; threaded insert and two bolt-down holes; ribbed top and bottom surfaces.

2.4 SPRINGS

.1 Design stable springs: ratio of lateral to axial stiffness is equal to or greater than 1.2 times ratio of static deflection to working height. Select for 50% travel beyond rated load. Units complete with levelling devices.

.2 Ratio of height when loaded to diameter of spring between 0.8 to 1.0.

.3 Cadmium plate for outdoor installations.

.4 Colour code springs.

2.5 SPRING MOUNT

.1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.

.2 Type M2 - stable open spring: support on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad.

.3 Type M3 - stable open spring: 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; levelling bolt for rigidly mounting to equipment.

.4 Type M4 - restrained stable open spring: supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.

.5 Type M5 - enclosed spring mounts with snubbers for isolation up to 950 kg maximum.

2.6 HANGERS

.1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30 degrees arc without metal to metal contact.

.2 Type H1 - neoprene - in-shear, moulded with rod isolation bushing which passes through hanger box.

.3 Type H2 - stable spring, elastomeric washer, cup with moulded isolation bushing which passes through hanger box.

.4 Type H3 - stable spring, elastomeric element, cup with moulded isolation bushing which passes through hanger box.

.5 Type H4 - stable spring, elastomeric element with precompression washer and nut.

2.7 ROOF CURB ISOLATION RAILS

.1 General: complete factory assembled.

.2 Lower member: continuous rectangular steel tube or extruded aluminum channel.

.3 Upper member: continuous rectangular steel tube to provide continuous support for equipment, complete with all-directional neoprene snubber bushings 6 mm thick to resist wind.

.4 Springs: steel, adjustable, removable, selected for 25 mm maximum static deflection plus 50% additional travel to solid, cadmium plated, sized and positioned to ensure uniform deflection.

.5 High frequency isolation: 6 mm minimum thick continuous gasket on top and bottom of complete assembly or pads on top and bottom of each spring. Material: closed cell neoprene.

.6 Weatherproofing: continuous flexible counterflashing to curb and providing access to springs. Material: aluminum neoprene.

.7 Hardware: cadmium plated or galvanized.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.

.2 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.

.3 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:

   .1 Up to NPS4: first 3 points of support. NPS5 to NPS8: first 4 points of support. NPS10 and Over: first 6 points of support.

   .2 First point of support: static deflection of twice deflection of isolated equipment, but not more than 50 mm.

.4 Where isolation is bolted to floor use vibration isolation rubber washers.

.5 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

3.3 CLEANING

.1 Proceed in accordance with Section 01 74 00 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and requirements for the identification of piping systems, duct work, valves and controllers, including the installation and location of identification systems.

1.2 REFERENCES

.1 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.

.2 CAN/CGSB-24.3-92, Identification of Piping Systems.

.2 National Fire Protection Association (NFPA)

.1 NFPA 13-2002, Standard for the Installation of Sprinkler Systems.

.2 NFPA 14-2003, Standard for the Installation of Standpipe and Hose Systems.

1.3 SUBMITTALS

.1 Product Data:

.2 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.3 Product data to include paint colour chips, other products specified in this section.

.4 Samples:

.1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.

.2 Samples to include nameplates, labels, tags, lists of proposed legends.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00 - Product Requirements.

.2 Waste Management and Disposal:

.1 Construction Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 00 - Cleaning.

Part 2 Products

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

.1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.

.2 Lettering and numbers raised or recessed.

.3 Information to include, as appropriate:

.1 Equipment: manufacturer's name, model, size, serial number, capacity.

.2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 SYSTEM NAMEPLATES

.1 Colours:

.1 Hazardous: red letters, white background.

.2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).

.2 Construction:

.1 3 mm thick laminated plastic or white anodized aluminum, matte finish, with square corners, letters accurately aligned and machine engraved into core.

.3 Sizes:

.1 Conform to following table:

Size # mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5
6	20 x 200	1	8
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20

.2 Use maximum of 25 letters/numbers per line.

.4 Locations:

.1 Terminal cabinets, control panels: use size # 5.

.2 Equipment in Mechanical Rooms: use size # 9.

2.3 PIPING SYSTEMS GOVERNED BY CODES

.1 Identification:

.1 Natural gas: to CSA/CGA B149.1 authority having jurisdiction.

.2 Propane gas: to CSA/CGA B149.1 authority having jurisdiction.

.3 Sprinklers: to NFPA 13.

.4 Standpipe and hose systems: to NFPA 14.

2.4 IDENTIFICATION OF PIPING SYSTEMS

.1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.

.2 Legend:

.1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.

.3 Arrows showing direction of flow:

.1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.

.2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.

.3 Use double-headed arrows where flow is reversible.

.4 Extent of background colour marking:

.1 To full circumference of pipe or insulation.

.2 Length to accommodate pictogram, full length of legend and arrows.

.5 Materials for background colour marking, legend, arrows:

.1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.

.2 Other pipes: pressure sensitive plastic-coated cloth vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.

.6 Colours and Legends:

.1 Where not listed, obtain direction from City's Representative and Contract Administrator.

.2 Colours for legends, arrows: to following table:

Background colour:	Legend, arrows:
Yellow	BLACK
Green	WHITE
Red	WHITE

.3 Background colour marking and legends for piping systems:

Contents	Background colour marking	Legend
City water	Green	CITY WATER
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Waste water	Green	WASTE WATER
Storm water	Green	STORM

Contents	Background colour marking	Legend
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
Fire protection water	Red	FIRE PROT. WTR
Sprinklers	Red	SPRINKLERS

2.5 IDENTIFICATION DUCTWORK SYSTEMS

.1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.

.2 Colours: back, or co-ordinated with base colour to ensure strong contrast.

2.6 VALVES, CONTROLLERS

.1 Lamacoid tags with 12 mm stamped identification data filled with black paint.

.2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

2.7 CONTROLS COMPONENTS IDENTIFICATION

.1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.

.2 Inscriptions to include function and (where appropriate) fail-safe position.

2.8 LANGUAGE

.1 Identification in English.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 TIMING

.1 Provide identification only after painting specified Section 09 91 23 - Interior Painting has been completed.

3.3 INSTALLATION

.1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.

.2 Provide ULC and or CSA registration plates as required by respective agency.

3.4 NAMEPLATES

.1 Locations:

.1 In conspicuous location to facilitate easy reading and identification from operating floor.

.2 Standoffs:

.1 Provide for nameplates on hot and/or insulated surfaces.

.3 Protection:

.1 Do not paint, insulate or cover.

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

.1 On long straight runs in open areas in equipment rooms, tunnels: at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.

.2 Adjacent to each change in direction.

.3 At least once in each small room through which piping or ductwork passes.

.4 On both sides of visual obstruction or where run is difficult to follow.

.5 On both sides of separations such as walls, floors, partitions.

.6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.

.7 At beginning and end points of each run and at each piece of equipment in run.

.8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.

.9 Identification easily and accurately readable from usual operating areas and from access points.

.1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.6 VALVES, CONTROLLERS

.1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.

.2 Number valves in each system consecutively.

3.7 CLEANING

.1 Proceed in accordance with Section 01 74 00 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

□ END OF SECTION

Part 1 General

1.1 SUMMARY

.1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.

.2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

1.2 QUALIFICATIONS OF TAB PERSONNEL

.1 Submit names of personnel to perform TAB to Contract Administrator within 90 days of award of contract.

.2 Provide documentation confirming qualifications, successful experience.

.3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:

   .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
   .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998.
   .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.

.4 Recommendations and suggested practices contained in the TAB Standard: mandatory.

.5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.

.6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.

.7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.

.8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.

   .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.
   .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC), requirements and recommendations contained in these procedures and requirements are mandatory.

1.3 PURPOSE OF TAB

.1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads

.2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.

.3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.4 EXCEPTIONS

.1 TAB of systems and equipment regulated by codes, standards to satisfaction of authority having jurisdiction.

1.5 CO-ORDINATION

.1 Schedule time required for TAB including repairs, re-testing into project construction and completion schedule to ensure completion before acceptance of project.

.2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

1.6 PRE-TAB REVIEW

.1 Review contract documents before project construction is started and confirm in writing to Contract Administrator adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.

.2 Review specified standards and report to Contract Administrator in writing proposed procedures which vary from standard.

.3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.7 START-UP

.1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.

.2 Follow special start-up procedures specified elsewhere in Division 23.

1.8 OPERATION OF SYSTEMS DURING TAB

.1 Operate systems for length of time required for TAB and as required by Contract Administrator for verification of TAB reports.

1.9 START OF TAB

.1 Notify City’s Representative, Contract Administrator 7 days prior to start of TAB.

.2 Start TAB when building is essentially completed, including:

.3 Installation of ceilings, doors, windows, other construction affecting TAB.

.4 Application of weatherstripping, sealing, and caulking.

.5 Pressure, leakage, other tests specified elsewhere Division 23.

.6 Provisions for TAB installed and operational.

.7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:

- .1 Proper thermal overload protection in place for electrical equipment.
- .2 Air systems:
  - .1 Filters in place, clean.
  - .2 Duct systems clean.
  - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
  - .4 Correct fan rotation.
  - .5 Fire, smoke, volume control dampers installed and open.
  - .6 Coil fins combed, clean.
  - .7 Access doors, installed, closed.
  - .8 Outlets installed, volume control dampers open.
- .3 Liquid systems:
  - .1 Flushed, filled, vented.
  - .2 Correct pump rotation.
  - .3 Strainers in place, baskets clean.
  - .4 Isolating and balancing valves installed, open.
  - .5 Calibrated balancing valves installed, at factory settings.
  - .6 Chemical treatment systems complete, operational.

1.10 APPLICATION TOLERANCES

.1 Do TAB to following tolerances of design values:

- .1 HVAC systems: plus 5 %, minus 5 %.
- .2 Hydronic systems: plus or minus 10 %.

1.11 ACCURACY TOLERANCES

.1 Measured values accurate to within plus or minus 2 % of actual values.

1.12 INSTRUMENTS

.1 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.

1.13 SUBMITTALS

.1 Submit, prior to commencement of TAB:

.2 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.14 PRELIMINARY TAB REPORT

.1 Submit for checking and approval of City's Representative Contract Administrator, prior to submission of formal TAB report, sample of rough TAB sheets. Include:

- .1 Details of instruments used.
- .2 Details of TAB procedures employed.
- .3 Calculations procedures.
- .4 Summaries.

1.15 TAB REPORT

.1 TAB report to show results in SI units and to include:

- .1 Project record drawings.
- .2 System schematics.

.2 Submit two copies of tab report to Contract Administrator for initial review. Do changes and comments thru resubmit. 6 copies of TAB Report to Contract Administrator for verification and approval, in English in D-ring binders, complete with index tabs.

1.16 VERIFICATION

.1 Reported results subject to verification by City's Representative Contract Administrator.

.2 Number and location of verified results as directed by Contract Administrator.

.3 Pay costs to repeat TAB as required to satisfaction of Contract Administrator.

1.17 SETTINGS

.1 After TAB is completed to satisfaction of Contract Administrator, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.

.2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

1.18 COMPLETION OF TAB

.1 TAB considered complete when final TAB Report received and approved by Contract Administrator.

1.19 AIR SYSTEMS

.1 Standard: TAB to most stringent of TAB standards of AABC.

.2 Do TAB of exhaust, supply air and return air systems, equipment, components, controls specified Division 23.

.3 Qualifications: personnel performing TAB current member in good standing of AABC.

.4 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.

.5 Locations of equipment measurements: to include as appropriate:

.1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.

.2 At controllers, controlled device.

.6 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.20 OTHER TAB REQUIREMENTS

.1 General requirements applicable to work specified this paragraph:

.1 Qualifications of TAB personnel: as for air systems specified this section.

.2 Quality assurance: as for air systems specified this section.

.2 Building pressure conditions:

.1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions at all times.

.2 TAB procedures:

.1 Kitchen service area (AHU-4) negative to AHU-3 served area.

.3 Zone pressure differences:

.1 Adjust HVAC systems, equipment, controls to establish specified air pressure differentials, with systems in every possible combinations of normal operating modes.

.4 Smoke management systems:

.1 Test for proper operation of all smoke and fire dampers, sensors, detectors, installed as component parts of air systems specified Division 23.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

  .1 Materials and methods for pressure testing ducts over 5 m in length, forming part of a supply, return or exhaust ductwork system directly or indirectly connected to air handling equipment.

1.2 REFERENCES

.1 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)

  .1 SMACNA HVAC Air Duct Leakage Test Manual, 1985.

1.3 SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.

Part 2 Products

2.1 TEST INSTRUMENTS

.1 Test apparatus to include:

  .1 Fan capable of producing required static pressure.
  .2 Duct section with calibrated orifice plate mounted and accurately located pressure taps.
  .3 Flow measuring instrument compatible with the orifice plate.
  .4 Calibration curves for orifice plates used.
  .5 Flexible duct for connecting to ductwork under test.
  .6 Smoke bombs for visual inspections.

.2 Test apparatus: accurate to within +/- 3 % of flow rate and pressure.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 TEST PROCEDURES

.1 Maximum lengths of ducts to be tested consistent with capacity of test equipment.

.2 Section of duct to be tested to include:

.1 Fittings, branch ducts, tap-ins.

.3 Repeat tests until specified pressures are attained. Bear costs for repairs and repetition to tests.

.4 Base partial system leakage calculations on SMACNA HVAC Air Duct Leakage Test Manual.

.5 Seal leaks that can be heard or felt, regardless of their contribution to total leakage.

3.3 SITE TOLERANCES

.1 System leakage tolerances specified are stated as percentage of total flow rate handled by system. Pro-rate specified system leakage tolerances. Leakage for sections of duct systems: not to exceed total allowable leakage.

.2 Leakage tests on following systems not to exceed specified leakage rates.

.1 Small duct systems up to 250 Pa: leakage 2 %.

.2 VAV box and duct on downstream side of VAV box: leakage 2 %.

.3 Large low pressure duct systems up to 500 Pa: leakage 2 %.

.3 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

3.4 TESTING

.1 Test ducts before installation of insulation or other forms of concealment.

.2 Test after seals have cured.

.3 Test when ambient temperature will not affect effectiveness of seals, and gaskets.

3.5 CLEANING

.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 74 00 - Cleaning.

.3 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

1.2 REFERENCES

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

- .1 ANSI/ASHRAE/IESNA 90.1-01, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 American Society for Testing and Materials International, (ASTM)

- .1 ASTM B209M-02, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
- .2 ASTM C335-95, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
- .3 ASTM C411-97, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
- .4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
- .5 ASTM C547-00, Specification for Mineral Fiber Pipe Insulation.
- .6 ASTM C553-00, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- .7 ASTM C612-00a, Specification for Mineral Fiber Block and Board Thermal Insulation.
- .8 ASTM C795-92, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
- .9 ASTM C921-92(1998)e1, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.3 Canadian General Standards Board (CGSB)

- .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.4 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (R1999).

.5 Underwriters Laboratories of Canada (ULC)

- .1 CAN/ULC-S102-M88(R2000), Surface Burning Characteristics of Building Materials and Assemblies.
- .2 CAN/ULC-S701-01, Thermal Insulation Polystyrene, Boards and Pipe Covering.

1.3 DEFINITIONS

.1 For purposes of this section:

.1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.

.2 "EXPOSED" - will mean "not concealed" as defined herein.

.3 Insulation systems - insulation material, fasteners, jackets, and other accessories.

.2 TIAC Codes:

.1 CRD: Code Round Ductwork,

.2 CRF: Code Rectangular Finish.

1.4 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit for approval manufacturer's catalogue literature related to installation, fabrication for duct jointing recommendations.

1.5 MANUFACTURERS' INSTRUCTIONS

.1 Submit manufacturer's installation instructions in accordance with Section 01 33 00 - Submittal Procedures.

.2 Installation instructions to include procedures used, and installation standards achieved.

1.6 QUALIFICATIONS

.1 Installer: specialist in performing work of this section, and have at least 5 years successful experience in this size and type of project, qualified to standards.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.2 Protect from weather and construction traffic.

.3 Protect against damage from any source.

.4 Store at temperatures and conditions recommended by manufacturer.

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 In accordance with CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C335.

.3 TIAC Code C-1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).

.4 TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).

  .1 Mineral fibre: to ASTM C553.
  .2 Jacket: to CGSB 51-GP-52Ma.
  .3 Maximum "k" factor: to ASTM C553.

2.3 JACKETS

.1 Canvas:

  .1 220 gm/m^2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.

.2 Lagging adhesive: Compatible with insulation.

.3 Aluminum:

  .1 To ASTM B209 with and without moisture barrier as scheduled in PART 3 of this section.
  .2 Thickness: 0.50 mm sheet.
  .3 Finish: Smooth.
  .4 Jacket banding and mechanical seals: 12 mm wide, 0.5 mm thick stainless steel.

2.4 ACCESSORIES

.1 Vapour retarder lap adhesive:

  .1 Water based, fire retardant type, compatible with insulation.

.2 Indoor Vapour Retarder Finish:

  .1 Vinyl emulsion type acrylic, compatible with insulation.

.3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.

.4 ULC Listed Canvas Jacket:

  .1 220 gm/m^2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.

.5 Outdoor Vapour Retarder Mastic:

  .1 Vinyl emulsion type acrylic, compatible with insulation.
  .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m^2.

.6 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.

.7 Contact adhesive: quick-setting

.8 Canvas adhesive: washable.

.9 Tie wire: 1.5 mm stainless steel.

.10 Banding: 12 mm wide, 0.5 mm thick stainless steel.

.11 Facing: 25 mm galvanized steel hexagonal wire mesh stitched on one face of insulation one face of insulation with expanded metal lath on other face.

.12 Fasteners: 2 mm diameter pins with 35 mm diameter clips, length to suit thickness of insulation.

Part 3 Execution

3.1 PRE-INSTALLATION REQUIREMENTS

.1 Pressure testing of ductwork systems complete, witnessed and certified.

.2 Surfaces clean, dry, free from foreign material.

3.2 INSTALLATION

.1 Install in accordance with TIAC National Standards.

.2 Apply materials in accordance with manufacturers instructions and as indicated.

.3 Use two layers with staggered joints when required nominal thickness exceeds 75 mm.

.4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

  .1 Hangers, supports to be outside vapour retarder jacket.

.5 Supports, Hangers in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

  .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.

.6 Fasteners: At 300 mm o/c in horizontal and vertical directions, minimum two rows each side.

3.3 DUCTWORK INSULATION SCHEDULE

.1 Insulation types and thicknesses: Conform to following table:

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts	C-1	yes	50
Round cold and dual temperature supply air	C-2	yes	50

	TIAC Code	Vapour Retarder	Thickness (mm)
ducts			
Combustion cold air to condensing boilers	C-2	yes	50
Rectangular warm air ducts			none
Round warm air ducts			
Supply, return and exhaust ducts exposed in space being served			none
Outside air ducts to mixing plenum	C-1	yes	25
Combustion air ductwork	C-1	yes	25
Mixing plenums	C-1	yes	25
Exhaust duct between dampers and louvres	C-1	no	25
Rectangular ducts outside	C-1	special	50
Round ducts outside	C-1	special	50
Acoustically lined ducts	none		

.2 HERE Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:

.1 Use TIAC code C-1 insulation, scored to suit diameter of duct.

.1 Finishes: Conform to following table:

	TIAC Code Rectangular	Round
Indoor, concealed	none	none
Indoor, exposed within mechanical room	CRF/1	CRD/2
Indoor, exposed elsewhere	CRF/2	CRD/3
Outdoor, exposed to precipitation	CRF/3	CRD/4
Outdoor, elsewhere	CRF/4	CRD/5

□ END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Related Sections:

- .1 Section 21 13 13 – Wet Sprinkler Systems.
- .2 Section 21 13 16 – Dry Pipe Sprinkler Systems
- .3 Section 22 11 18 – Domestic Water Piping Copper
- .4 Section 22 13 17 – Drainage Waste & Vent Piping, Cast Iron and Copper
- .5 Section 23 05 05 – Installation of Pipework

1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM)

1.3 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

.1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

1.4 POTABLE WATER SYSTEMS

.1 When cleaning is completed and system filled:

- .1 Verify performance of equipment and systems as specified elsewhere in Division 23.
- .2 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or recharge air chambers. Repeat for each outlet and flush valve.
- .3 Confirm water quality consistent with supply standards, verifying that no residuals remain resulting from flushing and/or cleaning.

1.5 WET SPRINKLER SYSTEM

.1 Cleaning, testing, start-up, performance verification of equipment, systems, components, and devices is specified elsewhere in Division 23 and Section 21 13 13 – Wet Sprinkler System.

.2 Verification of controls, detection devices, alarm devices is specified Division 26.

.3 Verify operation of interlocks between HVAC systems and fire alarm systems.

1.6 DRY PIPE SPRINKLER SYSTEM

.1 Cleaning, testing, start-up, performance verification of equipment, systems, components, and devices is specified elsewhere in Division 23 and Section 21 13 16 – Dry Pipe Sprinkler System.

.2 Verification of controls, detection devices, alarm devices is specified Division 26.

.3 Verify operation of interlocks between HVAC systems and fire alarm systems.

1.7 SANITARY AND STORM DRAINAGE SYSTEMS

.1 Buried systems: perform tests prior to back-filling. Perform hydraulic tests to verify grades and freedom from obstructions.

.2 Ensure that traps are fully and permanently primed.

.3 Ensure that fixtures are properly anchored, connected to system.

.4 Operate flush valves, tank and operate each fixture to verify drainage and no leakage.

.5 Cleanouts: refer to Section 22 42 02 - Plumbing Fixtures.

.6 Roof drains:

.1 Refer to Section 22 42 02 - Plumbing Fixtures.
.2 Remove caps as required.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Procedures and cleaning solutions for cleaning mechanical piping systems.

1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM)

1.3 SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures . Include product characteristics, performance criteria, and limitations.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Product Requirements .

Part 2 Products

2.1 CLEANING SOLUTIONS

.1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.

.2 Sodium carbonate: 0.40 kg per 100 L water in system.

.3 Low-foaming detergent: 0.01 kg per 100 L water in system.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 CLEANING HYDRONIC SYSTEMS

.1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.

.2 Cleaning Agency:

.1 Retain qualified water treatment specialist to perform system cleaning.

.3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist .

.4 Cleaning procedures:

.1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:

.1 Cleaning procedures, flow rates, elapsed time.

.2 Chemicals and concentrations used.

.3 Inhibitors and concentrations.

.4 Specific requirements for completion of work.

.5 Special precautions for protecting piping system materials and components.

.6 Complete analysis of water used to ensure water will not damage systems or equipment.

.5 Conditions at time of cleaning of systems:

.1 Systems: free from construction debris, dirt and other foreign material.

.2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.

.3 Strainers: clean prior to initial fill.

.4 Install temporary filters on pumps not equipped with permanent filters.

.5 Install pressure gauges on strainers to detect plugging.

.6 Report on Completion of Cleaning:

.1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.

.7 Hydronic Systems:

.1 Fill system with water, ensure air is vented from system.

.2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).

.3 Use water metre to record volume of water in system to +/- 0.5%.

.4 Add chemicals under direct supervision of chemical treatment supplier.

.5 Closed loop systems: circulate system cleaner at 60 degrees C for at least 36 h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.

.6 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.

.7 Add chemical solution to system.

.8 Establish circulation, raise temperature slowly to 82 degrees C minimum. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 h at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite test for residual sulphite.

3.3 START-UP OF HYDRONIC SYSTEMS

.1 After cleaning is completed and system is filled:

.1 Establish circulation and expansion tank level, set pressure controls.

.2 Ensure air is removed.

.3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.

.4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.

.5 Clean out strainers repeatedly until system is clean.

.6 Commission water treatment systems as specified in Section 23 25 00 - HVAC Water Treatment Systems.

.7 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.

.8 Repeat with water at design temperature.

.9 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.

.10 Bring system up to design temperature and pressure slowly over a 48-hour period.

.11 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.12 Adjust pipe supports, hangers, springs as necessary.

.13 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.

.14 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.

.15 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.

.16 Check operation of drain valves.

.17 Adjust valve stem packings as systems settle down.

.18 Fully open balancing valves (except those that are factory-set).

.19 Check operation of over-temperature protection devices on circulating pumps.

.20 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

3.4 CLEANING

.1 Proceed in accordance with Section 01 74 00 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

.1 Sensors and Transmitters:

- .1 Airflow stations
- .2 Flowmeters
- .3 Flow switches
- .4 Press and temp sensor wells & sockets
- .5 Temp sensor wells and sockets

.2 Control Valves:

.3 Automatic - Control Dampers:

- .1 Automated Dampers

.4 Decentralized HVAC Equipment:

- .1 Terminal unit controls

1.2 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

.1 Sensors and Transmitters:

- .1 Duct static pressure sensors
- .2 H2O Pressure Differential/Flow Switches

.2 Fire Detection and Alarm:

- .1 Smoke Detectors/Fire Stats

1.3 PRODUCTS NOT FURNISHED OR INSTALLED BUT INTEGRATED WITH THE WORK OF THIS SECTION

.1 General:

- .1 Coordination Meeting: The Installer furnishing the DDC network shall meet with the Installer(s) furnishing each of the following products to coordinate details of the interface between these products and the DDC network. The City or his designated representative shall be present at this meeting. Each Installer shall provide the City and all other Installers with details of the proposed interface including PICS for BACnet equipment, hardware and software identifiers for the interface points, network identifiers, wiring requirements, communication speeds, and required network accessories. The purpose of this meeting shall be to insure there are no unresolved issues regarding the integration of these products into the DDC network. Submittals for these products shall not be approved prior to the completion of this meeting.

.2 Section 23 52 00 - Heating Boilers:

.1 Boiler controls: The boiler vendor shall furnish boilers with an interface to the control and monitoring points specified in Section 23 09 93. These specified points shall be the minimum acceptable interface to the boiler. The connection to these points shall be by one of the following methods: (a) Hardwired connection such as relay, 0-10VDC, or 4-20mA. (b) BACnet/IP network connection. (c) BACnet over ARCNET network connection. (d) BACnet MS/TP network connection.

.3 Section 23 73 11 - Air Handling Units:

.1 Packaged AHU: Unit shall be furnished configured to accept control inputs from an external building automation system controller as specified in Section 23 09 93. Factory mounted safeties and other controls shall not interfere with this controller.

.4 Communications with Third Party Equipment:

.1 Any additional integral control systems included with the products integrated with the work of this section shall be furnished with a BACnet interface for integration into the Direct Digital Control System described in this section.

1.4 RELATED SECTIONS

.1 The General Conditions of the Contract, Supplementary Conditions, and General Requirements are part of this specification and shall be used in conjunction with this section as part of the contract documents.

.2 The following Divisions constitute related work:

.1 Division 1.
.2 Division 23.
.3 Division 26.
.4 Division 28.

1.5 DESCRIPTION

.1 General: The control system shall consist of a high-speed, peer-to-peer network of DDC controllers and an operator workstation. The operator workstation shall be a personal computer (PC) with a color monitor, mouse, keyboard, and printer. The PC shall allow operators to interface with system via dynamic color graphics. Depict each mechanical system and building floor plan by a point-and-click graphic. Furnish a modem or network interface card for remote access to the network and for paging operators when an alarm occurs.

.1 Web-based Option: Furnish and install a web server instead of a PC operator workstation. Operators shall be able to access the system through a conventional web browser on each PC connected to the network.

.2 The system shall directly control HVAC equipment as specified in Section 23 09 93 – Sequence of Operations for HVAC Controls. Each zone controller shall provide occupied and unoccupied modes of operation by individual zone. Furnish energy conservation features such as optimal start and stop, night setback, request-based logic, and demand level adjustment of setpoints as specified in the sequence.

.3 Provide for future system expansion to include monitoring of occupant card access, fire alarm, and lighting control systems.

.4 System shall use the BACnet protocol for communication to the operator workstation or web server and for communication between control modules. I/O points, schedules, setpoints, trends, and alarms specified in Section 23 09 93 – "Sequence of Operations for HVAC Controls" shall be BACnet objects.

1.6 APPROVED CONTROL SYSTEMS

.1 Johnson Controls Metasys is the approved control system.

- .1 Other products specified herein (such as sensors, valves, dampers, and actuators) need not be manufactured by the above manufacturers.

1.7 QUALITY ASSURANCE

.1 Installer and Manufacturer Qualifications

- .1 Installer shall have an established working relationship with Control System Manufacturer.
- .2 Installer shall have successfully completed Control System Manufacturer's control system training. Upon request, Installer shall present record of completed training including course outlines.

1.8 CODES AND STANDARDS

.1 Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with current editions in effect 30 days prior to receipt of bids of the following codes:

- .1 National Electric Code (NEC)
- .2 International Building Code (IBC)
  - .1 Section 719 Ducts and Air Transfer Openings
  - .2 Section 907 Fire Alarm and Detection Systems
  - .3 Section 909 Smoke Control Systems
  - .4 Chapter 28 Mechanical

.2 International Mechanical Code (IMC)

.3 ANSI/ASHRAE 135-2004: Data Communication Protocol for Building Automation and Control Systems (BACNET)

1.9 SYSTEM PERFORMANCE

.1 Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation (server and browser for web-based systems).

- .1 Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 sec.

.2 Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.

.3 Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.

.4 Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.

.5 Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 15 sec.

.6 Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 sec. Select execution times consistent with the mechanical process under control.

.7 Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.

.8 Multiple Alarm Annunciation. Each workstation on the network shall receive alarms within 5 sec of other workstations.

.9 Reporting Accuracy. System shall report values with minimum end-to-end accuracy listed in Table 1.

.10 Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2.

Table 1
Reporting Accuracy

Measured Variable	**Reported Accuracy**
Space Temperature	±0.5ºC (±1ºF)
Ducted Air	±0.5ºC (±1ºF)
Outside Air	±1.0ºC (±2ºF)
Dew Point	±1.5ºC (±3ºF)
Water Temperature	±0.5ºC (±1ºF)
Delta-T	±0.15ºC (±0.25ºF)
Relative Humidity	±5% RH
Water Flow	±2% of full scale
Airflow (terminal)	±10% of full scale (see Note 1)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
Air Pressure (ducts)	±25 Pa (±0.1 in. w.g.)
Air Pressure (space)	±3 Pa (±0.01 in. w.g.)
Water Pressure	±2% of full scale (see Note 2)
Electrical (A, V, W, Power Factor)	±1% of reading (see Note 3)
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO_2)	±50 ppm

Note 1: Accuracy applies to 10% - 100% of scale
Note 2: For both absolute and differential pressure
Note 3: Not including utility-supplied meters

Table 2
Control Stability and Accuracy

Controlled Variable	**Control Accuracy**	**Range of Medium**
Air Pressure	±50 Pa (±0.2 in. w.g.) ±3 Pa (±0.01 in. w.g.)	0-1.5 kPa (0-6 in. w.g.) -25 to 25 Pa (-0.1 to 0.1 in. w.g.)
Airflow	±10% of full scale	
Space Temperature	±1.0ºC (±2.0ºF)	
Duct Temperature	±1.5ºC (±3ºF)	
Humidity	±5% RH	
Fluid Pressure	±10 kPa (±1.5 psi) ±250 Pa (±1.0 in. w.g.)	MPa (1-150 psi) 0-12.5 kPa (0-50 in. w.g.) differential

1.10 SUBMITTALS

.1 Product Submittal Requirements: Meet requirements of Section 01 30 00 on Shop Drawings, Product Data, and Samples. Provide six copies of shop drawings and other submittals on hardware, software, and equipment to be installed or furnished. Begin no work until submittals have been approved for conformity with design intent. Provide drawings as AutoCAD 2006 (or newer) compatible files on magnetic or optical disk (file format: .DWG, .DXF, .VSD, or comparable) and 3 prints of each drawing on 11" x 17" paper. When manufacturer's cutsheets apply to a product series rather than a specific product, clearly indicate applicable data by highlighting or by other means. Clearly reference covered specification and drawing on each submittal. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Submittal approval does not relieve Contractor of responsibility to supply sufficient quantities to complete work. Provide submittals within 12 weeks of contract award on the following:

- .1 Direct Digital Control System Hardware
  - .1 Complete bill of materials indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.
  - .2 Manufacturer's description and technical data such as performance curves, product specifications, and installation and maintenance instructions for items listed below and for relevant items not listed below:
    - .1 Direct digital controllers (controller panels)
    - .2 Transducers and transmitters
    - .3 Sensors (include accuracy data)
    - .4 Actuators
    - .5 Valves
    - .6 Relays and switches
    - .7 Control panels

.8 Power supplies

.9 Batteries

.10 Operator interface equipment

.11 Wiring

.3 Wiring diagrams and layouts for each control panel. Show termination numbers.

.4 Floor plan schematic diagrams indicating field sensor and controller locations.

.5 Riser diagrams showing control network layout, communication protocol, and wire types.

.2 Central System Hardware and Software

.1 Complete bill of material indicating quantity, manufacturer, model number, and relevant technical data of equipment used.

.2 Manufacturer's description and technical data such as product specifications and installation and maintenance instructions for items listed below and for relevant items furnished under this contract not listed below:

.1 Central Processing Unit (CPU) or web server

.2 Monitors

.3 Keyboards

.4 Power supplies

.5 Battery backups

.6 Interface equipment between CPU or server and control panels

.7 Operating System software

.8 Operator interface software

.9 Color graphic software

.10 Third-party software

.3 Schematic diagrams of control, communication, and power wiring for central system installation. Show interface wiring to control system.

.4 Network riser diagrams of wiring between central control unit and control panels.

.3 Controlled Systems

.1 Riser diagrams showing control network layout, communication protocol, and wire types.

.2 Schematic diagram of each controlled system. Label control points with point names. Graphically show locations of control elements.

.3 Schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.

.4 Instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.

.5 Complete description of control system operation including sequences of operation. Include and reference schematic diagram of controlled system.

List I/O points and software points specified in Section 23 09 93. Indicate alarmed and trended points.

.4 Description of process, report formats, and checklists to be used in Section 23 09 23 Article 3.16 (Control System Demonstration and Acceptance).

.5 BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of controller and operator interface.

.2 Schedules

.1 Schedule of work provided within one month of contract award, indicating:

.1 Intended sequence of work items

.2 Start date of each work item

.3 Duration of each work item

.4 Planned delivery dates for ordered material and equipment and expected lead times

.5 Milestones indicating possible restraints on work by other trades or situations

.2 Monthly written status reports indicating work completed and revisions to expected delivery dates. Include updated schedule of work.

.3 Project Record Documents. Submit three copies of record (as-built) documents upon completion of installation for approval prior to final completion. Submittal shall consist of:

.1 Project Record Drawings. As-built versions of submittal shop drawings provided as AutoCAD 2006 (or newer) compatible files on magnetic or optical disk (file format: .DWG, .DXF, .VSD, or comparable) and 6 prints of each drawing on 11" x 17" paper.

.2 Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Section 23 09 23 Article 3.16 (Control System Demonstration and Acceptance).

.3 Operation and Maintenance (O&M) Manual. Printed, electronic, or online help documentation of the following:

.1 As-built versions of submittal product data.

.2 Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.

.3 Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.

.4 Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.

.5 Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.

.6 Documentation of programs created using custom programming language including setpoints, tuning parameters, and object database.

Electronic copies of programs shall meet this requirement if control logic, setpoints, tuning parameters, and objects can be viewed using furnished programming tools.

.7 Graphic files, programs, and database on magnetic or optical media.

.8 List of recommended spare parts with part numbers and suppliers.

.9 Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.

.10 Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation or web server software, and graphics software.

.11 Licenses, guarantees, and warranty documents for equipment and systems.

.12 Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

.4 Training Materials: Provide course outline and materials for each class at least six weeks before first class. Training shall be furnished via instructor-led sessions, computer-based training, or web-based training. Contract Administrator will modify course outlines and materials if necessary to meet City's needs. Contract Administrator will review and approve course outlines and materials at least three weeks before first class.

1.11 WARRANTY

.1 Warrant work as follows:

.1 Warrant labour and materials for specified control system free from defects for a period of 12 months after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to City. Respond during normal business hours within 24 hours of City's warranty service request.

.2 Work shall have a single warranty date, even if City receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.

.3 If Contract Administrator determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, Contract Administrator will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.

.4 Provide updates to operator workstation or web server software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. If available, City can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without City's written authorization.

.5 Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired. Installation labour and materials shall be warranted. Demonstrate operable condition of reused devices at time of Contract Administrator 's acceptance.

1.12 OWNERSHIP OF PROPRIETARY MATERIAL

.1 Project-specific software and documentation shall become City's property. This includes, but is not limited to:

.1 Graphics

.2 Record drawings

.3 Database

.4 Application programming code

.5 Documentation

Part 2 Products

2.1 MATERIALS

.1 Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by City. Spare parts shall be available for at least five years after completion of this contract.

2.2 COMMUNICATION

.1 Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135-2004, BACnet.

.2 Install new wiring and network devices as required to provide a complete and workable control network.

.3 Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.

.4 Internetwork operator interface and value passing shall be transparent to internetwork architecture.

  .1 An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.

  .2 Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified in Section 23 09 93. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.

.5 Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated controller via the internetwork. If applicable, system shall automatically adjust for daylight saving and standard time.

.6 System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.

.7 System shall support Web services data exchange with any other system that complies with XML (extensible markup language) and SOAP (simple object access protocol) standards specified by the Web Services Interoperability Organization (WS-I) Basic Profile 1.0 or higher. Web services support shall as a minimum be provided at the workstation or web server level and shall enable data to be read from or written to the system.

.1 System shall support Web services read data requests by retrieving requested trend data or point values (I/O hardware points, analog value software points, or binary value software points) from any system controller or from the trend history database.

.2 System shall support Web services write data request to each analog and binary object that can be edited through the system operator interface by downloading a numeric value to the specified object.

.3 For read or write requests, the system shall require user name and password authentication and shall support SSL (Secure Socket Layer) or equivalent data encryption.

.4 System shall support discovery through a Web services connection or shall provide a tool available through the Operator Interface that will reveal the path/identifier needed to allow a third party Web services device to read data from or write data to any object in the system which supports this service.

2.3 OPERATOR INTERFACE

.1 Operator Interface. Web server or 1 PC-based workstations shall reside on high-speed network with building controllers. Each workstation or each standard browser connected to server shall be able to access all system information.

.2 Communication. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135-2004, BACnet Annex J.

.3 Hardware. Each workstation or web server shall consist of the following:

.1 Hardware Base. Industry-standard hardware shall meet or exceed DDC system manufacturer's recommended specifications and shall meet response times specified in Section 23 09 23 Paragraph 1.9. Hard disk shall have sufficient memory to store system software, one year of data for trended points specified in Section 23 09 93, and a system database at least twice the size of the existing database at system acceptance. Configure computers and network connections if multiple computers are required to meet specified memory and performance. Web server or workstations shall be IBM-compatible PCs with a minimum of:

.1 Intel Pentium 2.66 GHz processor

.2 1 GB RAM

.3 40 GB hard disk providing data at 100 MB/sec

.4 48x CD-ROM drive

.5 Keyboard

.6 Mouse

.7 17-inch 24-bit color monitor with at least 1024 x 768 resolution

.8 Serial, parallel, and network communication ports and cables required for proper system operation

.4 Operator Functions. Operator interface shall allow each authorized operator to execute the following functions as a minimum:

.1 Log In and Log Out. System shall require user name and password to log in to operator interface.

.2 Point-and-click Navigation. Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.

.3 View and Adjust Equipment Properties. Operators shall be able to view controlled equipment status and to adjust operating parameters such as setpoints, PID gains, on and off controls, and sensor calibration.

.4 View and Adjust Operating Schedules. Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display.

.5 View and Respond to Alarms. Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms.

.6 View and Configure Trends. Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points.

.7 View and Configure Reports. Operators shall be able to run preconfigured reports, to view report results, and to customize report configuration to show data of interest.

.8 Manage Control System Hardware. Operators shall be able to view controller status, to restart (reboot) each controller, and to download new control software to each controller.

.9 Manage Operator Access. Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, and to edit operator function authorization. Operator shall be able to authorize each operator function separately.

.5 System Software.

.1 Operating System. Web server or workstation shall have an industry-standard professional-grade operating system. Acceptable systems include Microsoft Windows XP Pro, Red Hat Linux, or Sun Solaris.

.2 System Graphics. Operator interface shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint.

.1 Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.

.2 Animation. Graphics shall be able to animate by displaying different image files for changed object status.

.3 Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.

.4 Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).

.6 System Tools. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard IBM-compatible PCs with no limit on the number of copies that can be installed under the system license.

.1 Automatic System Database Configuration. Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.

.2 Controller Memory Download. Operators shall be able to download memory from the system database to each controller.

.3 System Configuration. Operators shall be able to configure the system.

.4 Online Help. Context-sensitive online help for each tool shall assist operators in operating and editing the system.

.5 Security. System shall require a user name and password to view, edit, add, or delete data.

.1 Operator Access. Each user name and password combination shall define accessible viewing, editing, adding, and deleting functions in each system application, editor, and object. Authorized operators shall be able to vary and deny each operator's accessible functions based on equipment or geographic location.

.2 Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. Operators shall be able to adjust automatic log out delay.

.3 Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.

.6 System Diagnostics. System shall automatically monitor controller and I/O point operation. System shall annunciate controller failure and I/O point locking (manual overriding to a fixed value).

.7 Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Section 23 09 93 – Sequence of

Operations for HVAC Controls. Alarms shall be BACnet alarm objects and shall use BACnet alarm services.

.8 Alarm Messages. Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location, and nature.

.9 Alarm Reactions. Operator shall be able to configure (by object) actions workstation or web server shall initiate on receipt of each alarm. As a minimum, workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.

.10 Alarm Maintenance. Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms, and to archive closed alarms to the workstation or web server hard disk from each workstation or web browser interface.

.11 Trend Configuration. Operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified in Section 23 09 93 – Sequence of Operations for HVAC Controls. Trends shall be BACnet trend objects.

.12 Object and Property Status and Control. Operator shall be able to view, and to edit if applicable, the status of each system object and property by menu, on graphics, or through custom programs.

.13 Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.

.14 Standard Reports. Furnish the following standard system reports:

- .1 Objects. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
- .2 Alarm Summary. Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
- .3 Logs. System shall log the following to a database or text file and shall retain data for an adjustable period:
  - .1 Alarm History.
  - .2 Trend Data. Operator shall be able to select trends to be logged.
  - .3 Operator Activity. At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.

.15 Custom Reports. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. Reports shall be launched from the operator interface.

.16 Graphics Generation. Graphically based tools and documentation shall allow Operator to edit system graphics, to create graphics, and to integrate graphics into the system. Operator shall be able to add analog and binary values, dynamic text, static text, and animation files to a background graphic using a mouse.

.17 Graphics Library. Complete library of standard HVAC equipment graphics shall include equipment such as boilers, air handlers, terminals, fan coils, and unit heaters. Library shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. Library graphic file format shall be compatible with graphics generation tools.

.18 Custom Application Programming. Operator shall be able to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language shall have the following features:

.1 Language. Language shall be graphically based and shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and operators shall be able to create custom or compound function blocks.

.2 Programming Environment. Tool shall provide a full-screen, cursor-and-mouse-driven programming environment that incorporates word processing features such as cut and paste. Operators shall be able to insert, add, modify, and delete custom programming code, and to copy blocks of code to a file library for reuse in other control programs.

.3 Independent Program Modules. Operator shall be able to develop independently executing program modules that can disable, enable and exchange data with other program modules.

.4 Debugging and Simulation. Operator shall be able to step through the program observing intermediate values and results. Operator shall be able to adjust input variables to simulate actual operating conditions. Operator shall be able to adjust each step's time increment to observe operation of delays, integrators, and other time-sensitive control logic. Debugger shall provide error messages for syntax and for execution errors.

.5 Conditional Statements. Operator shall be able to program conditional logic using compound Boolean (AND, OR, and NOT) and relational (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

.6 Mathematical Functions. Language shall support floating-point addition, subtraction, multiplication, division, and square root operations, as well as absolute value calculation and programmatic selection of minimum and maximum values from a list of values.

.7 Variables: Operator shall be able to use variable values in program conditional statements and mathematical functions.

.1 Time Variables. Operator shall be able to use predefined variables to represent time of day, day of the week, month of the year, and date. Other predefined variables or simple control logic shall provide elapsed time in seconds, minutes, hours, and days. Operator shall be able to start, stop, and reset elapsed time variables using the program language.

.2 System Variables. Operator shall be able to use predefined variables to represent status and results of Controller Software and shall be able to enable, disable, and change setpoints of Controller Software as described in Controller Software section.

.7 Portable Operator's Terminal. Provide all necessary software to configure an IBM-compatible laptop computer for use as a Portable Operator's Terminal. Operator shall be able to connect configured Terminal to the system network or directly to each controller for programming, setting up, and troubleshooting.

.8 BACnet. Web server or workstation shall have demonstrated interoperability during at least one BMA Interoperability Workshop and shall substantially conform to BACnet Operator Workstation (B-OWS) device profile as specified in ASHRAE/ANSI 135-2001, BACnet Annex L.

2.4 CONTROLLER SOFTWARE

.1 Building and energy management application software shall reside and operate in system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.

.2 System Security. See Paragraph 2.3.F.5 (Security) and Paragraph 2.3.F.15.c (Operator Activity).

.3 Scheduling. See Paragraph 2.3.D.4 (View and Adjust Operating Schedules). System shall provide the following schedule options as a minimum:

- .1 Weekly. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
- .2 Exception. Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule has executed, system shall discard and replace exception schedule with standard schedule for that day of the week.
- .3 Holiday. Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.

.4 System Coordination. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.

.5 Binary and Analog Alarms. See Paragraph 2.3.F.7 (Alarm Processing).

.6 Alarm Reporting. See Paragraph 2.3.F.9 (Alarm Reactions).

.7 Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.

.8 Demand Limiting.

- .1 System shall monitor building power consumption from building power meter pulse generator signals or from building feeder line watt transducer or current transformer.
- .2 When power consumption exceeds adjustable levels, system shall automatically adjust setpoints, de-energize low-priority equipment, and take other programmatic actions to reduce demand as specified in Section 23 09 93 – Sequence of Operations for HVAC Controls. When demand drops below adjustable levels, system shall restore loads as specified.

.9 Maintenance Management. System shall generate maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance alarms as specified in Section 23 09 93 – Sequence of Operations for HVAC Controls.

.10 Sequencing. Application software shall sequence boilers, and pumps as specified in Section 23 09 93 – Sequence of Operations for HVAC Controls.

.11 PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.

.12 Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.

.13 Energy Calculations.

.1 System shall accumulate and convert instantaneous power (kW) or flow rates (L/s [gpm]) to energy usage data.

.2 System shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.

.14 Anti-Short Cycling. Binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.

.15 On and Off Control with Differential. System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.

.16 Runtime Totalization. System shall provide an algorithm that can totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as specified in Section 23 09 93 – Sequence of Operations for HVAC Controls.

2.5 CONTROLLERS

.1 General. Provide Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA), and Smart Sensors (SS) as required to achieve performance specified in Section 23 09 23 Article 1.9 (System Performance). Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of BACnet Smart Actuators and Smart Sensors.

.2 BACnet.

.1 Building Controllers (BCs). Each BC shall conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-BC in the BACnet Testing Labouratories (BTL) Product Listing.

.2 Advanced Application Controllers (AACs). Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Labouratories (BTL) Product Listing.

.3 Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Labouratories (BTL) Product Listing.

.4 Smart Actuators (SAs). Each SA shall conform to BACnet Smart Actuator (B-SA) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-SA in the BACnet Testing Labouratories (BTL) Product Listing.

.5 Smart Sensors (SSs). Each SS shall conform to BACnet Smart Sensor (B-SS) device profile as specified in ANSI/ASHRAE 135-2004, BACnet Annex L and shall be listed as a certified B-SS in the BACnet Testing Labouratories (BTL) Product Listing.

.6 BACnet Communication.

.1 Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.

.2 BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.

.3 Each AAC shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.

.4 Each ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.

.5 Each SA shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.

.6 Each SS shall reside on a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol with BACnet/IP addressing, or it shall reside on a BACnet network using ARCNET or MS/TP Data Link/Physical layer protocol.

.3 Communication.

.1 Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.

.2 Signal Management. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.

.3 Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.

.4 Stand-Alone Operation. Each piece of equipment specified in Section 23 09 93 shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.

.4 Environment. Controller hardware shall be suitable for anticipated ambient conditions.

.1 Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -29°C to 60°C (-20°F to 140°F).

.2 Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

.5 Keypad. Provide a local keypad and display for each BC and AAC. Operator shall be able to use keypad to view and edit data. Keypad and display shall require password to prevent unauthorized use. If the manufacturer does not normally provide a keypad and display for each BC and AAC, provide the software and any interface cabling needed to use a laptop computer as a Portable Operator's Terminal for the system.

.6 Real-Time Clock. Controllers that perform scheduling shall have a real-time clock.

.7 Serviceability.

.1 Controllers shall have diagnostic LEDs for power, communication, and processor.

.2 Wires shall be connected to a field-removable modular terminal strip or to a termination card connected by a ribbon cable.

.3 Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.

.8 Memory.

.1 Controller memory shall support operating system, database, and programming requirements.

.2 Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.

.3 Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.

.9 Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

.10 Transformer. ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

2.6 INPUT AND OUTPUT INTERFACE

.1 General. Hard-wire input and output points to BCs, AACs, ASCs, or SAs.

.2 Protection. Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with up to 24 V for any duration shall cause no controller damage.

.3 Binary Inputs. Binary inputs shall monitor the on and off signal from a remote device. Binary inputs shall provide a wetting current of at least 12 mA and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.

.4 Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall accumulate up to 10 pulses per second.

.5 Analog Inputs. Analog inputs shall monitor low-voltage (0-10 Vdc), current (4-20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.

.6 Binary Outputs. Binary outputs shall send an on-or-off signal for on and off control. Building Controller binary outputs shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.

.7 Analog Outputs. Analog outputs shall send a modulating 0-10 Vdc or 4-20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.

.8 Tri-State Outputs. Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.

.9 Universal Inputs and Outputs. Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.

2.7 POWER SUPPLIES AND LINE FILTERING

.1 Power Supplies. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.

   .1 DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.

      .1 Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.

.2 Line voltage units shall be UL recognized and CSA listed.

.2 Power Line Filtering.

.1 Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:

.1 Dielectric strength of 1000 V minimum

.2 Response time of 10 nanoseconds or less

.3 Transverse mode noise attenuation of 65 dB or greater

.4 Common mode noise attenuation of 150 dB or greater at 40-100 Hz

2.8 AUXILIARY CONTROL DEVICES

.1 Motorized Control Dampers.

.1 Type. Control dampers shall have linear flow characteristics and shall be parallel- or opposed-blade type as specified below or as scheduled on drawings.

.1 Outdoor and return air mixing dampers and face-and-bypass dampers shall be parallel-blade and shall direct airstreams toward each other.

.2 Other modulating dampers shall be opposed-blade.

.3 Two-position shutoff dampers shall be parallel- or opposed-blade with blade and side seals.

.2 Frame. Damper frames shall be 2.38 mm (13 gauge) galvanized steel channel or 3.175 mm (1/8 in.) extruded aluminum with reinforced corner bracing.

.3 Blades. Damper blades shall not exceed 20 cm (8 in.) in width or 125 cm (48 in.) in length. Blades shall be suitable for medium velocity (10 m/s [2000 fpm]) performance. Blades shall be not less than 1.5875 mm (16 gauge).

.4 Shaft Bearings. Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze, or better.

.5 Seals. Blade edges and frame top and bottom shall have replaceable seals of butyl rubber or neoprene. Side seals shall be spring-loaded stainless steel. Blade seals shall leak no more than 50 $L/s \cdot m^2$ (10 cfm per ft^2) at 1000 Pa (4 in. w.g.) differential pressure. Blades shall be airfoil type suitable for wide-open face velocity of 7.5 m/s (1500 fpm).

.6 Sections. Damper sections shall not exceed 125 cm - 150 cm (48 in. - 60 in.). Each section shall have at least one damper actuator.

.7 Linkages. Dampers shall have exposed linkages.

.2 Electric Damper and Valve Actuators.

.1 Stall Protection. Mechanical or electronic stall protection shall prevent actuator damage throughout the actuator's rotation.

.2 Spring-return Mechanism. Actuators used for power-failure and safety applications shall have an internal mechanical spring-return mechanism or an uninterruptible power supply (UPS).

.3 Signal and Range. Proportional actuators shall accept a 0-10 Vdc or a 0-20 mA control signal and shall have a 2-10 Vdc or 4-20 mA operating range. (Floating motor actuators may be substituted for proportional actuators in terminal unit applications as described in paragraph 2.6H.)

.4 Wiring. 24 Vac and 24 Vdc actuators shall operate on Class 2 wiring.

.5 Manual Positioning. Operators shall be able to manually position each actuator when the actuator is not powered. Non-spring-return actuators shall have an external manual gear release. Spring-return actuators with more than 7 N·m (60 in.-lb) torque capacity shall have a manual crank.

.3 Control Valves.

.1 General. Select body and trim materials in accordance with manufacturer's recommendations for design conditions and service shown.

.2 Type. Provide two- or three-way control valves for two-position or modulating service as shown.

.3 Water Valves.

.1 Valves providing two-position service shall be quick opening. Two-way valves shall have replaceable disc or ball.

.2 Close-off (Differential) Pressure Rating. Valve actuator and trim shall provide the following minimum close-off pressure ratings.

.1 Two-way: 150% of total system (pump) head.

.2 Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.

.3 Ports. Valves providing modulating service shall have equal percentage ports.

.4 Sizing.

.1 Two-position service: line size.

.2 Two-way modulating service: select pressure drop equal to the greatest of twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 35 kPa (5 psi).

.3 Three-way modulating service: select pressure drop equal to the smaller of twice the pressure drop through the coil exchanger (load) or 35 kPa (5 psi).

.5 Fail Position. Water valves shall fail normally open or closed as follows unless otherwise specified.

.1 Water zone valves: normally open.

.2 Heating coils in air handlers: normally open.

.3 Other applications: as scheduled or as required by sequences of operation

.4 Binary Temperature Devices.

.1 Low-Voltage Space Thermostats. Low-voltage space thermostats shall be 24 V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

.2 Line-Voltage Space Thermostats. Line-voltage space thermostats shall be bimetal-actuated, open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listing for electrical rating, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

.3 Low-Limit Thermostats. Low-limit airstream thermostats shall be UL listed, vapour pressure type. Element shall be at least 6 m (20 ft) long. Element shall sense temperature in each 30 cm (1 ft) section and shall respond to lowest sensed temperature. Low-limit thermostat shall be manual reset only.

.5 Temperature Sensors.

.1 Type. Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor.

.2 Duct Sensors. Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 1.5 m (5 ft) in length per 1 m^2(10 ft^2) of duct cross-section.

.3 Immersion Sensors. Provide immersion sensors with a separable stainless steel well. Well pressure rating shall be consistent with system pressure it will be immersed in. Well shall withstand pipe design flow velocities.

.4 Space Sensors. Space sensors shall have setpoint adjustment, override switch, display, and communication port as shown.

.5 Differential Sensors. Provide matched sensors for differential temperature measurement.

.6 Humidity Sensors.

.1 Duct and room sensors shall have a sensing range of 20%-80%.

.2 Duct sensors shall have a sampling chamber.

.3 Outdoor air humidity sensors shall have a sensing range of 20%-95% RH and shall be suitable for ambient conditions of 40°C-75°C (40°F-170°F).

.4 Humidity sensors shall not drift more than 1% of full scale annually.

.7 Carbon Monoxide Sensors.

.1 Space sensors shall have a sensing range of 0 to 250 PPM

.2 Accurate in conditions from 15-90% RH

.3 Operating temperature range -20 to 50°C

.4 Space sensors to be of the electrochemical type.

.5 Sensor to be equivalent to Vulcain 301M

.8 Nitrous Oxide Sensors.

.1 Space sensors shall have a sensing range of 0 to 10 PPM

.2 Accurate in conditions from 15-90% RH

.3 Operating temperature range 0 to 40°C

.4 Space sensors to be of the electrochemical type.

.5 Sensor to be equivalent to Vulcain 301M.

.9 Flow Switches. Flow-proving switches shall be paddle (water service only) or differential pressure type (air or water service) as shown. Switches shall be UL listed, SPDT snap-acting, and pilot duty rated (125 VA minimum).

.1 Paddle switches shall have adjustable sensitivity and NEMA 1 enclosure unless otherwise specified.

.2 Differential pressure switches shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

.10 Relays.

.1 Control Relays. Control relays shall be plug-in type, UL listed, and shall have dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.

.2 Time Delay Relays. Time delay relays shall be solid-state plug-in type, UL listed, and shall have adjustable time delay. Delay shall be adjustable ±100% from setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.

.11 Override Timers.

.1 Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0-6 hour calibrated dial unless otherwise specified. Flush mount timer on local control panel face or where shown.

.12 Current Transmitters.

.1 AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4-20 mA two-wire output. Full-scale unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be ±1% full-scale at 500 ohm maximum burden.

.2 Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.

.3 Unit shall be split-core type for clamp-on installation on existing wiring.

.13 Current Transformers.

.1 AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.

.2 Transformers shall be available in various current ratios and shall be selected for ±1% accuracy at 5 A full-scale output.

.3 Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.

.14 Voltage Transmitters.

.1 AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4-20 mA output with zero and span adjustment.

.2 Adjustable full-scale unit ranges shall be 100-130 Vac, 200-250 Vac, 250-330 Vac, and 400-600 Vac. Unit accuracy shall be ±1% full-scale at 500 ohm maximum burden.

.3 Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating.

.15 Voltage Transformers.

.1 AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.

.2 Transformers shall be suitable for ambient temperatures of 4°C-55°C (40°F-130°F) and shall provide ±0.5% accuracy at 24 Vac and 5 VA load.

.3 Windings (except for terminals) shall be completely enclosed with metal or plastic.

.16 Power Monitors.

.1 Power monitors shall be three-phase type and shall have three-phase disconnect and shorting switch assembly, UL listed voltage transformers, and UL listed split-core current transformers.

.2 Power monitors shall provide selectable output: rate pulse for kWh reading or 4-20 mA for kW reading. Power monitors shall operate with 5 A current inputs and maximum error of ±2% at 1.0 power factor or ±2.5% at 0.5 power factor.

.17 Current Switches.

.1 Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.

.18 Pressure Transducers.

.1 Transducers shall have linear output signal and field-adjustable zero and span.

.2 Continuous operating conditions of positive or negative pressure 50% greater than calibrated span shall not damage transducer sensing elements.

.3 Water pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Transducer shall have 4-20 mA output, suitable mounting provisions, and block and bleed valves.

.4 Water differential pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Over-range limit (differential pressure) and maximum static pressure shall be 2000 kPa (300 psi.) Transducer shall have 4-20 mA output, suitable mounting provisions, and 5-valve manifold.

.19 Differential Pressure Switches. Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

.20 Pressure-Electric (PE) Switches. PE switches shall be UL listed, pilot duty rated (125 VA minimum) or motor control rated, metal or neoprene diaphragm actuated, operating pressure rated for 0-175 kPa (0-25 psig), with calibrated scale minimum setpoint range of 14-125 kPa (2-18 psig).

.1 Provide one- or two-stage switch action (SPDT, DPST, or DPDT) as required by application.

.2 Switches shall be open type (panel-mounted). Exception: Switches shall be enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified.

.3 Each pneumatic signal line to PE switches shall have permanent indicating gauge.

.21 Local Control Panels.

.1 Indoor control panels shall be fully enclosed NEMA 1 construction with hinged door key-lock latch and removable sub-panels. A common key shall open each control panel and sub-panel.

.2 Prewire internal and face-mounted device connections with color-coded stranded conductors tie-wrapped or neatly installed in plastic troughs. Field connection terminals shall be UL listed for 600 V service, individually identified per control and interlock drawings, with adequate clearance for field wiring.

.3 Each local panel shall have a control power source power switch (on-off) with overcurrent protection.

.22 Variable Frequency Drives

.1 Description of System

.1 This specification provides requirements for the supply and installation of Variable Frequency Drives (VFD's) for fans and pumps as specified in other sections of the specification. The VFD's shall be capable of variable or constant torque as required by the specifications and schedules. The selection of the VFD shall be coordinated with the manufacturer of the fan, pumps, etc. to ensure that the optimum supply and installation of each VFD is achieved. The VFD shall include all alarms and functions as specified in this section and other related sections and schedules. The VFD and its peripheral devices, as required by specifications are to be located in a sprinkler proof enclosure to suit the environment in which it is located.

.2 Integral bypass as required by other sections of this specification. The bypass shall be automatic or manual as specified in other sections. Bypass and all components are to be NEMA rated. Refer to Division 16 Specifications for additional details and requirements on bypass switch components.

.2 References and Regulations

.1 NEMA ICS 3.1 - Safety standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.

.2 UL 508C - Underwriter's Laboratory

.3 CAN/CSA-C22 No. 14 - Canadian Standards Association.

.4 CSA 22.2 No. 100-95.

.5 CSA 22.1 Canadian Electrical Code.

.6 Other applicable Industry Canada Standards and Regulations.

.7 C-UL marking to provide an approved listing for both United States and Canadian users. The Manufacturer will furnish the product as listed and classified by Underwriter's Laboratories as suitable for the purpose specified and indicated.

.8 IEEE 519 - 1992: Conforming but not limited to the following values from the Standard for General Systems, non-hospital and airports.

.1 For the type of environment that is applicable.

.1 THD for Voltage 5%.

.2 THD for Current as per IEEE 519-92

.3 Harmonic levels for each individual voltage and current harmonic to meet IEEE 519-92.

.4 Individual and total voltage and current distortion as per IEEE 519-92.

.5 Voltage notching as per IEEE 519-92. (Notch Area and Depth as per Table 10.2 for General System applications, notch depth 20%, notch area 22,800

.6 Levels shall be limited to the requirements set by IEEE 519-92 for General Systems.

.3 Training

.1 Provide 8 hours of training for each type of VFD in addition to the site specific training supplied by Division 15 for the fan or pump with which the VFD has been supplied.

.2 Ensure that manuals and drawings are available for the training.

.3 The training shall include specific information relating to the application as specified in other sections of the specifications as well as general operation and maintenance of the VFD.

.1 Include procedures for the setting of parameters within the VFD for the particular application(s) specified as well as an explanation of the purpose of each parameter that is accessible to the maintenance personnel and the specific instructions required to alter the parameters.

.2 The instructions will include a written record of the final parameter settings after set-up and commissioning, for each VFD supplied as part of the project. General or generic values are not permitted. Record and turn over the values set in each VFD.

.4 Shop Drawings and Product Data

.1 Shop drawings are to be submitted for each VFD. Shop Drawings shall include but not be limited to the following submissions:

.1 Catalogue and technical data.

.2 A "comply/non-comply" list of the shop drawing submissions, addressing each item of the specification indicating that it complies with the specification, or else stating the deviation.

.3 Outline dimensions, weights etc. including any special locating/installation instructions.

.4 Control drawings and schematic diagrams including all connections to external equipment and devices. Include single line and impedance diagrams. Include internal circuit schematics and the layout of all electronic and electrical components.

.5 Line harmonic calculations, including filter calculations required to comply with the voltage and current distortion levels required by IEEE 519 (IEEE 519-92). Include the voltage distortion level at the electrical distribution equipment. The intent is to reduce the harmonic content to a level that will not create damage to the City's equipment, and to reduce harmonic content at the point of common coupling.

.6 Instruction manuals for programming and installation.

.7 Include a list of all initial values of parameter settings. Optimize the parameter settings for this application.

.8 Manufacturer's installation instructions for the VFD, line and load reactors, control cabling, filters, VFD shielded cabling, motor etc. as required by Industry Canada Regulations.

.5 Maintenance Data

.1 Provide maintenance data as per Section 15010.

.2 Include as-built shop drawings with the O&M manuals.

.3 Provide all schematics, diagrams, and as-built drawings including interconnections to other equipment.

.4 Provide programming manuals c/w the actual setting of all parameters. Provide all site-specific programming etc.

.6 Products

.1 The Variable Frequency Drive (VFD) shall include, but not be limited to, the supply and installation of the following: pulse width modulated VFD, with IGBT inverter section, NEMA enclosure, filtering, wiring, grounding, line reactors, load reactors and/or dv/dt filter, relays, motor starters, protective devices, programming, software etc. required by this section and all other sections to make a complete working system.

.2 Voltage is to be as described in Division 16 specifications and schedules.

.3 VFD size is to be as per Division 15 and Division 16

.4 The VFD shall conform to the European Electromagnetic Compatibility Directive, a requirement for CE marking. The VFD shall meet with the first Environment restricted label of EN61800-3 through the use of EMI/RFI filters. Filtration shall enable the VFD to be CE marked (CE marking is not required).

.1 The manufacturer's installation and grounding instructions are to be included with each VFD.

.2 Output cables to motors for mechanical assemblies provided in other sections of this specification are to be shielded and are to be specifically manufactured for variable frequency drives. Installation is to be as specified by the manufacturer. Refer to Division 16 Specifications and Drawings.

.3 Provide instructions to the Division 16 contractor for termination of shielded cables (Teck Drive RX cables are provided) from the output of the VFD to the motor and input feeder to the VFD from its point of supply.

.4 Provide grounding instructions to the Division 16 contractor. All equipment including, filters, reactors, variable frequency drive, motor, enclosure, control cabling are to be grounded according to manufacturer's requirements. Grounding instructions are to be included in installation manuals included with each drive. The VFD manufacturer or his representative are to examine grounding once the cabling has been installed and terminated to ensure that it meets the manufacturer's written instructions.

.5 The VFD manufacturer or his representative is to examine the installation of the VFD to ensure that the installation complies current codes and regulations.

.7 System includes:

.1 The VFD and its peripheral devices are to be fully enclosed in an approved enclosure to suit the environment in which it is located (e.g. weatherproof if located in wet environments). Enclosures are to be sprinkler proof even if the drive is located in a location without sprinklers. Sprinklers may be installed in the future.

.2 Disconnecting means for the drive is to be located in the VFD enclosure and interlocked to the door of the enclosure. An input circuit breaker is an acceptable disconnecting device).

.3 Thermal overloads suitable for use with the motor.

.4 Thermistor input for motor over-temperature shutdowns.

.5 Control power transformer rated for drive power. The power supply shall be fused.

.6 Diode or fully gated bridge on the input.

.7 DC Bus inductor on all VFD's with ratings of 7.5HP (5.5KW) or greater.

.8 Switching logic power supply operating from the DC bus.

.9 Microprocessor based inverter logic isolated from power circuits.

.10 Latest generation IGBT inverter section.

.11 Phase to phase and phase to ground MOV protection.

.12 Auxiliary contacts - 2 form C contacts for each of the following signals:

.1 Drive Alarm

.2 At Speed

.3 Control power on

.4 Drive fault

.5 Drive run

.6 Reversing

.7 Jogging

.8 Peripheral Interface to enable attaching common options.

.9 Others as provided with the VFD of as described in other Sections of the Specifications.

.13 Line reactors are to include but not be limited to the following, as required to meet IEEE 519-92. The intent is to reduce the following harmonic indices to an acceptable level as per IEEE 519-92 at all points in the electrical distribution system, in the building at the time of installation of the VFD. The recommended harmonic indices are, but not limited to:

.1 Depth of notches, total notch area and distortion of bus voltage by commutation notches (low voltage notches)

.2 To comply with IEEE 519-92 for General Systems.

.3 For the type of environment that is applicable.

.4 THD for Voltage 5%

.5 THD for Current as per IEEE 519-92

.6 Harmonic levels for each individual voltage and current harmonic to meet IEEE 519-92.

.7 Individual and total voltage and current distortion as per IEEE 519-92.

.8 Voltage notching as per IEEE 519-92 (Notch Area and Depth as per Table 10.2 for general systems).

.14 Output line reactors and or dv/dt filters. Provide additional filters where necessary due to cable lengths.

.15 Output filtering for RFI and EMI emissions caused by high speed switching. Sinusoidal filters are preferable.

.16 Filters shall be constructed and installed so that they will not supply any existing or future loads.

.17 Common mode choke sized to the amperage of the drive.

.18 Copper ground bus.

.19 Operator interface to the drive shall be provided by a module with integral display.

.1 The display shall be a 2 line, 16 character alphanumeric, backlit LCD that is used to show drive operating conditions, fault indications and programming information. The display shall be customer programmable to show faults, operating temperatures and pressures, etc and programming information. The module shall provide programming information plus an operation keypad with Start, Stop, Speed Reference (analog pot or digital keys), direction control / indication and Jog. The module shall be connected to the drive via a cable and installed in the main door of the VFD enclosure. The units shall be capable of allowing the operator to change set points, temperature and pressures, lead/lag pumps etc. as required by other sections of this specification and the manufacturer of the pumps and fans.

.2 The keypad is to be accessible without opening the door of the VFD enclosure.

.8 Operation

.1 The drive is programmable or self-adjusting for operation under the following conditions.

.1 Controlled shut down with no component failure in the event of an output phase to phase or phase to ground short circuit and annunciation of the fault condition.

.2 Selectable Sensorless Vector or V/Hz mode.

.3 The VFD shall include, but not be limited to the following protective parameters that are to be displayed at the LCD interface: overcurrent, overvoltage, inverter fault, undervoltage, overtemperature, motor overtemperaturre, phase loss - input and output etc.

.4 As described in other Sections of this Specification.

.2 Selectable for variable or constant torque loads. Selection of variable torque provides 115% of rated VT current for up to one minute.

Selection of constant torque provides 150% of rated CT current for up to one minute.

.3 Multiple programmable stop modes including - Ramp, Coast, DC-Brake, Ramp-to-Hold and S-curve.

.4 Multiple acceleration and deceleration rates from 0 to 3600 seconds.

.5 Adjustable output frequency up to 400Hz.

.6 Inputs and outputs

.1 Two analogue Inputs shall consist of single ended inputs, isolated inputs, and bipolar inputs that can be configured as 0-10 VDC or 0-20 ma. The analogue inputs shall be able to be programmed to process control, trim pre-set speeds and frequency control, etc. Provide three single ended inputs and other types as described and as required by other sections of this specification.

.1 Refer to other sections of this specification for additional requirements.

.2 Digital Inputs and Outputs shall consist of the following:

.1 Six digital inputs, positive or negative logic; nominal voltage to be 24VDC.

.2 A minimum of two programmable Form C relay outputs.

.3 One digital outputs open collector 50mv/48V

.4 Refer to other sections of this specification for additional requirements.

.3 Analogue Outputs

.1 0(4) to 20ma: RL 50 ohm max. 10 bit accuracy.

.2 Refer to other sections of this specification for additional requirements.

.7 Adjustable minimum and maximum motor speeds set in consultation with the motor and equipment manufacturers to prevent damage to the motor. The motor selection shall be coordinated with the selection of the VFD by the fan or pump supplier.

.8 Communications to include but not be limited to RS232/422/485 and industry standard communication protocols e.g. DeviceNet, Modbus RTU, LonWorks, Bacnet, Johnson Controls N2L. The use of 3rd party boards is acceptable to connect LonWorks for example to the VFD, providing the supplier of the VFD has tested and certified the use of the 3rd party product with the VFD, partnering is preferable.

.1 Other protocols may be requested. Refer to other sections of this specification for additional requirements.

.9 Manufacturers

.1 ABB, AC Tech, Allen-Bradley, Cutler-Hammer, Siemens.

.9 Installation

.1 The drive is to be installed to CSA 22.1, current codes, standards, and other sections of this specification. The drive is to be installed to manufacturer's recommendations.

.2 The drive is to be wired to achieve the following functions:

.1 Remote start and stop (isolated input at 24 VDC or 120 VAC)

.2 Speed to be adjusted by a remote analogue input i.e. 4-20ma.

.3 Wire and connect control wiring to pre-set speed control equipment. Set and adjust as pre-set speeds as indicated in other sections of this specification. Configure trimming of pre-set speeds by analogue inputs to the VFD from remote equipment as indicated in other sections.

.4 Those as required by other sections of the specification.

.3 Install the VFD drive securely on a flat wall surface, as close to the motor as possible, within the distance allowed by the maximum conductor length specified by the drive manufacturer.

.4 Install the VFD as far as practical from telecommunications equipment, control equipment and wiring. Maintain a minimum of distance of three meters between the VFD and its feeders from telecommunication and control cables. VFD input and output cables are to cross communication and control cables at 90 degrees.

.5 Division 16 to provide Teck Drive RX cable from the VFD to the motor. Division 16 is to provide Teck Drive RX to the input of the VFD from the circuit breaker feeding the VFD. The Teck Drive RX cable is specifically manufactured for use with variable frequency drives. Connectors for the Drive RX cables are to be specifically designed for use with this type of cable, as per the cable manufacturer's instructions. The cable is to be bonded as per the VFD manufacturer's instructions. Division 15 is to coordinate with Division 16.

.1 Grounding is to be as per the manufacturer of the VFD's instructions, CSA requirements for safety and to reduce RFI and EMI.

.2 All control conductors are to be shielded of a type specified by the manufacturer. The shields are to be grounded as per the manufacturer's instructions. All control wiring shall be in conduit. All conduits used for control wiring shall include a separate insulated ground conductor, #12 AWG minimum.

.3 The conduit for the control conductors shall not be installed within 600mm of the power conductors for the VFD. The shields of the cables shall be grounded according to the manufacturer's instructions for:

.1 Analogue signals

.2 Digital signals

.4 The control cables shall be terminated in terminals (supplied with the VFD enclosure). Shielded cables shall be grounded according to the VFD manufacturer's instructions.

.5 The VFD shall be programmed, commissioned, set-up and tested by the manufacturer's representative. The drive shall be set-up to optimize the operation with the specific equipment that the drive has been specified with, in other Sections of this Specification.

.6 The contractor shall examine the Division 15 shop drawings for the motor that is supplied by the fan supplier. The motor must be suitable for the intended use and shall be labelled as such, as required by CSA C22.2 No. 100-95. Ensure that the labels are on the motor before connecting. If the motor is not suitable for use with the VFD and/or is not labelled, notify the Division 15 contractor immediately.

.7 Division 16 to provide a three pole disconnect switch with an auxiliary contact at the motor. The auxiliary contact is to open prior to the main switch blades. Division 16 is to provide a 2/C #14 Teck cable from the VFD to the disconnect switch. Connect the switch in the VFD to stop the output to the motor prior to the opening of the disconnect switch.

2.9 WIRING AND RACEWAYS

.1 General. Provide copper wiring, plenum cable, and raceways as specified in applicable sections of Division 26.

.2 Insulated wire shall use copper conductors and shall be UL listed for 90°C (200°F) minimum service.

2.10 FIBER OPTIC CABLE SYSTEM

.1 Optical Cable. Optical cables shall be duplex 900 mm tight-buffer construction designed for intra-building environments. Sheath shall be UL listed OFNP in accordance with NEC Article 770. Optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125mm.

.2 Connectors. Field terminate optical fibers with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.

Part 3 Execution

3.1 EXAMINATION

.1 Thoroughly examine project plans for control device and equipment locations. Report discrepancies, conflicts, or omissions to Contract Administrator for resolution before starting rough-in work.

.2 Inspect site to verify that equipment can be installed as shown. Report discrepancies, conflicts, or omissions to Contract Administrator for resolution before starting rough-in work.

.3 Examine drawings and specifications for work of others. Report inadequate headroom or space conditions or other discrepancies to Contract Administrator and obtain written instructions for changes necessary to accommodate Section 23 09 23 work with work of others. Controls Contractor shall perform at his expense necessary changes in specified work caused by failure or neglect to report discrepancies.

3.2 PROTECTION

.1 Controls Contractor shall protect against and be liable for damage to work and to material caused by Contractor's work or employees.

.2 Controls Contractor shall be responsible for work and equipment until inspected, tested, and accepted. Protect material not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3 COORDINATION

.1 Site.

  .1 Assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will interfere with work of other trades. If installation without coordination causes interference with work of other trades, Contractor shall correct conditions without extra charge.
  .2 Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.

.2 Submittals. See Section 23 09 23 Article 1.10 (Submittals).

.3 Test and Balance.

  .1 Provide Test and Balance Contractor a single set of necessary tools to interface to control system for testing and balancing.
  .2 Train Test and Balance Contractor to use control system interface tools.
  .3 Provide a qualified technician to assist with testing and balancing the first 20 terminal units.

.4 Test and Balance Contractor shall return tools undamaged and in working condition at completion of testing and balancing.

.4 Life Safety.

.1 Duct smoke detectors required for air handler shutdown are provided under Division 28. Interlock smoke detectors to air handlers for shutdown as specified in Section 23 09 93 – Sequence of Operations for HVAC Controls.

.2 Smoke dampers and actuators required for duct smoke isolation are provided under Division 23. Interlock smoke dampers to air handlers as specified in Section 23 09 93 – Sequence of Operations for HVAC Controls.

.3 Fire and smoke dampers and actuators required for fire-rated walls are provided under Division 23. Fire and smoke damper control is provided under Division 28.

.5 Coordination with Other Controls. Integrate with and coordinate controls and control devices furnished or installed by others as follows.

.1 Communication media and equipment shall be provided as specified in Section 23 09 23 Article 2.2 (Communication).

.2 Each supplier of a controls product shall configure, program, start up, and test that product to meet the sequences of operation described in Section 23 09 93 Appendix A regardless of where within the contract documents those products are described.

.3 Coordinate and resolve incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.

.4 Controls Contractor shall be responsible for integration of control products provided by multiple suppliers regardless of where integration is described within the contract documents.

3.4 GENERAL WORKMANSHIP

.1 Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.

.2 Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.

.3 Install equipment in readily accessible locations as defined by National Electrical Code (NEC) Chapter 1 Article 100 Part A.

.4 Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.

.5 Equipment, installation, and wiring shall comply with industry specifications and standards and local codes for performance, reliability, and compatibility.

3.5 FIELD QUALITY CONTROL

.1 Work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances as identified in Section 23 09 23 Article 1.8 (Codes and Standards).

.2 Continually monitor field installation for code compliance and workmanship quality.

.3 Contractor shall arrange for work inspection by local or state authorities having jurisdiction over the work.

3.6 WIRING

.1 Control and interlock wiring and installation shall comply with national and local electrical codes, Division 26, and manufacturer's recommendations. Where the requirements of Section 23 09 23 differ from Division 26, Division 26 shall take precedence.

.2 NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway as specified by NEC and Division 26.

.3 Low-voltage wiring shall meet NEC Class 2 requirements. Subfuse low-voltage power circuits as required to meet Class 2 current limit.

.4 NEC Class 2 (current-limited) wires not in raceway but in concealed and accessible locations such as return air plenums shall be UL listed for the intended application.

.5 Install wiring in raceway where subject to mechanical damage and at levels below 3 m (10ft) in mechanical, electrical, or service rooms.

.6 Install Class 1 and Class 2 wiring in separate raceways. Boxes and panels containing high-voltage wiring and equipment shall not be used for low-voltage wiring except for the purpose of interfacing the two through relays and transformers.

.7 Do not install wiring in raceway containing tubing.

.8 Run exposed Class 2 wiring parallel to a surface or perpendicular to it and tie neatly at 3 m (10 ft) intervals.

.9 Use structural members to support or anchor plenum cables without raceway. Do not use ductwork, electrical raceways, piping, or ceiling suspension systems to support or anchor cables.

.10 Secure raceways with raceway clamps fastened to structure and spaced according to code requirements. Raceways and pull boxes shall not be hung on or attached to ductwork, electrical raceways, piping, or ceiling suspension systems.

.11 Size raceway and select wire size and type in accordance with manufacturer's recommendations and NEC requirements.

.12 Include one pull string in each raceway 2.5 cm (1 in.) or larger.

.13 Use color-coded conductors throughout.

.14 Locate control and status relays in designated enclosures only. Do not install control and status relays in packaged equipment control panel enclosures containing Class 1 starters.

.15 Conceal raceways except within mechanical, electrical, or service rooms. Maintain minimum clearance of 15 cm (6 in.) between raceway and high-temperature equipment such as flues.

.16 Adhere to requirements in Division 26 where raceway crosses building expansion joints.

.17 Install insulated bushings on raceway ends and enclosure openings. Seal top ends of vertical raceways.

.18 Terminate control and interlock wiring related to the work of this section. Maintain at the job site updated (as-built) wiring diagrams that identify terminations.

.19 Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Do not use flexible metal raceway less than ½ in. electrical trade size. Use liquid-tight flexible metal raceways in areas exposed to moisture including boiler rooms.

.20 Install raceway rigidly, support adequately, ream at both ends, and leave clean and free of obstructions. Join raceway sections with couplings and according to code. Make terminations in boxes with fittings. Make terminations not in boxes with bushings.

3.7 COMMUNICATION WIRING

.1 Communication wiring shall be low-voltage Class 2 wiring and shall comply with Article 3.7 (Wiring).

.2 Install communication wiring in separate raceways and enclosures from other Class 2 wiring.

.3 During installation do not exceed maximum cable pulling, tension, or bend radius specified by the cable manufacturer.

.4 Verify entire network's integrity following cable installation using appropriate tests for each cable.

.5 Install lightning arrestor according to manufacturer's recommendations between cable and ground where a cable enters or exits a building.

.6 Each run of communication wiring shall be a continuous length without splices when that length is commercially available. Runs longer than commercially available lengths shall have as few splices as possible using commercially available lengths.

.7 Label communication wiring to indicate origination and destination.

.8 Ground coaxial cable according to NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

3.8 FIBER OPTIC CABLE

.1 During installation do not exceed maximum pulling tensions specified by cable manufacturer. Post-installation residual cable tension shall be within cable manufacturer's specifications.

.2 Install cabling and associated components according to manufacturers' instructions. Do not exceed minimum cable and unjacketed fiber bend radii specified by cable manufacturer.

3.9 INSTALLATION OF SENSORS

.1 Install sensors according to manufacturer's recommendations.

.2 Mount sensors rigidly and adequately for operating environment.

.3 Install room temperature sensors on concealed junction boxes properly supported by wall framing.

.4 Air seal wires attached to sensors in their raceways or in the wall to prevent sensor readings from being affected by air transmitted from other areas.

.5 Use averaging sensors in mixing plenums and hot and cold decks. Install averaging sensors in a serpentine manner vertically across duct. Support each bend with a capillary clip.

.6 Install mixing plenum low-limit sensors in a serpentine manner horizontally across duct. Support each bend with a capillary clip. Provide 3 m (1 ft) of sensing element for each 1 m^2 (1 ft^2) of coil area.

.7 Install pipe-mounted temperature sensors in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.

.8 Install outdoor air temperature sensors on north wall at designated location with sun shield.

.9 Differential Air Static Pressure.

.1 Supply Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.

.2 Return Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.

.3 Building Static Pressure. Pipe pressure sensor's low-pressure port to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe high-pressure port to a location behind a thermostat cover.

.4 Piping to pressure transducer pressure ports shall contain a capped test port adjacent to transducer.

.5 Pressure transducers, except those controlling VAV boxes, shall be located in control panels, not on monitored equipment or on ductwork. Mount transducers in a vibration-free location accessible for service without use of ladders or special equipment.

.6 Mount gauge tees adjacent to air and water differential pressure taps. Install shut-off valves before tee for water gauges.

.10 Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.

3.10 FLOW SWITCH INSTALLATION

.1 Use correct paddle for pipe diameter.

.2 Adjust flow switch according to manufacturer's instructions.

3.11 ACTUATORS

.1 General. Mount actuators and adapters according to manufacturer's recommendations.

.2 Electric and Electronic Damper Actuators. Mount actuators directly on damper shaft or jackshaft unless shown as a linkage installation. Link actuators according to manufacturer's recommendations.

- .1 For low-leakage dampers with seals, mount actuator with a minimum 5° travel available for damper seal tightening.
- .2 To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, then tighten linkage.
- .3 Check operation of damper-actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
- .4 Provide necessary mounting hardware and linkages for actuator installation.

.3 Valve Actuators. Connect actuators to valves with adapters approved by actuator manufacturer.

3.12 WARNING LABELS

.1 Affix permanent warning labels to equipment that can be automatically started by the control system.

- .1 Labels shall use white lettering (12-point type or larger) on a red background.
- .2 Warning labels shall read as follows.

C A U T I O N
This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.

.2 Affix permanent warning labels to motor starters and control panels that are connected to multiple power sources utilizing separate disconnects.

- .1 Labels shall use white lettering (12-point type or larger) on a red background.
- .2 Warning labels shall read as follows.

C A U T I O N
This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

3.13 IDENTIFICATION OF HARDWARE AND WIRING

.1 Label wiring and cabling, including that within factory-fabricated panels, with control system address or termination number at each end within 5 cm (2 in.) of termination.

.2 Label pneumatic tubing at each end within 5 cm (2 in.) of termination with a descriptive identifier.

.3 Permanently label or code each point of field terminal strips to show instrument or item served.

.4 Label control panels with minimum 1 cm (½ in.) letters on laminated plastic nameplates.

.5 Label each control component with a permanent label. Label plug-in components such that label remains stationary during component replacement.

.6 Label room sensors related to terminal boxes or valves with nameplates.

.7 Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.

.8 Label identifiers shall match record documents.

3.14 PROGRAMMING

.1 Point Naming. Name points as shown on the equipment points list provided with each sequence of operation. See Section 23 09 93 (Sequences of Operation). If character limitations or space restrictions make it advisable to shorten the name, the abbreviations given in Appendix B to Section 23 09 93 may be used. Where multiple points with the same name reside in the same controller, each point name may be customized with its associated Program Object number. For example, "Zone Temp 1" for Zone 1, "Zone Temp 2" for Zone 2.

.2 Software Programming. Programming shall provide actions for each possible situation. Graphic- or parameter-based programs shall be documented. Text-based programs shall be modular, structured, and commented to clearly describe each section of the program.

  .1 Application Programming. Provide application programming that adheres to sequences of operation specified in Section 23 09 93. Program documentation or comment statements shall reflect language used in sequences of operation.
  .2 System Programming. Provide system programming necessary for system operation.

.3 Operator Interface.

  .1 Standard Graphics. Provide graphics as specified in Section 23 09 23 Article 2.3 Paragraph E.2 (System Graphics). Show on each equipment graphic input and output points and relevant calculated points such as indicated on the applicable Points List in Section 23 09 93. Point information on graphics shall dynamically update.
  .2 Install, initialize, start up, and troubleshoot operator interface software and functions (including operating system software, operator interface database, and third-party software installation and integration required for successful operator interface operation) as described in Section 23 09 23.

3.15 CONTROL SYSTEM CHECKOUT AND TESTING

.1 Startup Testing. Complete startup testing to verify operational control system before notifying City of system demonstration. Provide City with schedule for startup testing. City may have representative present during any or all startup testing.

.1 Calibrate and prepare for service each instrument, control, and accessory equipment furnished under Section 23 09 23.

.2 Verify that control wiring is properly connected and free of shorts and ground faults. Verify that terminations are tight.

.3 Enable control systems and verify each input device's calibration. Calibrate each device according to manufacturer's recommendations.

.4 Verify that binary output devices such as relays, solenoid valves, two-position actuators and control valves, and magnetic starters, operate properly and that normal positions are correct.

.5 Verify that analog output devices such as I/Ps and actuators are functional, that start and span are correct, and that direction and normal positions are correct. Check control valves and automatic dampers to ensure proper action and closure. Make necessary adjustments to valve stem and damper blade travel.

.6 Prepare a log documenting startup testing of each input and output device, with technician's initials certifying each device has been tested and calibrated.

.7 Verify that system operates according to sequences of operation. Simulate and observe each operational mode by overriding and varying inputs and schedules. Tune PID loops and each control routine that requires tuning.

.8 Alarms and Interlocks.

  .1 Check each alarm with an appropriate signal at a value that will trip the alarm.

  .2 Trip interlocks using field contacts to check logic and to ensure that actuators fail in the proper direction.

  .3 Test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.

3.16 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

.1 Demonstration. Prior to acceptance, perform the following performance tests to demonstrate system operation and compliance with specification after and in addition to tests specified in Article 3.17 (Control System Checkout and Testing). Provide Contract Administrator with log documenting completion of startup tests.

  .1 Contract Administrator will be present to observe and review system demonstration. Notify Contract Administrator at least 10 days before system demonstration begins.

  .2 Demonstration shall follow process submitted and approved under Section 23 09 23 Article 1.10 (Submittals). Complete approved checklists and forms for each system as part of system demonstration.

  .3 Demonstrate actual field operation of each sequence of operation as specified in Section 23 09 93. Provide at least two persons equipped with two-way communication. Demonstrate calibration and response of any input and output points requested by Contract Administrator. Provide and operate test equipment required to prove proper system operation.

  .4 Demonstrate compliance with Section 23 09 23 Part 1 (System Performance).

  .5 Demonstrate compliance with sequences of operation through each operational mode.

  .6 Demonstrate complete operation of operator interface.

.7 Demonstrate each of the following.

.1 DDC loop response. Supply graphical trend data output showing each DDC loop's response to a setpoint change representing an actuator position change of at least 25% of full range. Trend sampling rate shall be from 10 seconds to 3 minutes, depending on loop speed. Each sample's trend data shall show setpoint, actuator position, and controlled variable values. Contract Administrator will require further tuning of each loop that displays unreasonably under- or over-damped control.

.2 Demand limiting. Supply trend data output showing demand-limiting algorithm action. Trend data shall document action sampled each minute over at least a 30-minute period and shall show building kW, demand-limiting setpoint, and status of setpoints and other affected equipment parameters.

.3 Building fire alarm system interface.

.4 Trend logs for each system. Trend data shall indicate setpoints, operating points, valve positions, and other data as specified in the points list provided with each sequence of operation in Section 23 09 93. Each log shall cover three 48-hour periods and shall have a sample frequency not less than 10 minutes or as specified on its points list. Logs shall be accessible through system's operator interface and shall be retrievable for use in other software programs as specified in Section 23 09 23 Article 2.3 Paragraph E.11 (Trend Configuration).

.8 Tests that fail to demonstrate proper system operation shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.

.2 Acceptance.

.1 After tests described in this specification are performed to the satisfaction of both Contract Administrator and City, Contract Administrator will accept control system as meeting completion requirements. Contract Administrator may exempt tests from completion requirements that cannot be performed due to circumstances beyond Contractor's control. Contract Administrator will provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.

.2 System shall not be accepted until completed demonstration forms and checklists are submitted and approved as required in Section 23 09 23 Article 1.10 (Submittals).

3.17 CLEANING

.1 Each day clean up debris resulting from work. Remove packaging material as soon as its contents have been removed. Collect waste and place in designated location.

.2 On completion of work in each area, clean work debris and equipment. Keep areas free from dust, dirt, and debris.

.3 On completion of work, check equipment furnished under this section for paint damage. Repair damaged factory-finished paint to match adjacent areas. Replace deformed cabinets and enclosures with new material and repaint to match adjacent areas.

3.18 TRAINING

.1 Provide training for a designated staff of City's representatives. Training shall be provided via self-paced training, web-based or computer-based training, classroom training, or a combination of training methods.

.2 Training shall enable students to accomplish the following objectives.

.1 Proficiently operate system
.2 Understand control system architecture and configuration
.3 Understand DDC system components
.4 Understand system operation, including DDC system control and optimizing routines (algorithms)
.5 Operate workstation and peripherals
.6 Log on and off system
.7 Access graphics, point reports, and logs
.8 Adjust and change system setpoints, time schedules, and holiday schedules
.9 Recognize common HVAC system malfunctions by observing system graphics, trend graphs, and other system tools
.10 Understand system drawings and Operation and Maintenance manual
.11 Understand job layout and location of control components
.12 Access data from DDC controllers
.13 Operate portable operator's terminals
.14 Create and change system graphics
.15 Create, delete, and modify alarms, including configuring alarm reactions
.16 Create, delete, and modify point trend logs (graphs) and multi-point trend graphs
.17 Configure and run reports
.18 Add, remove, and modify system's physical points
.19 Create, modify, and delete application programming
.20 Add operator interface stations
.21 Add a new controller to system
.22 Download firmware and advanced applications programming to a controller
.23 Configure and calibrate I/O points
.24 Maintain software and prepare backups
.25 Interface with job-specific, third-party operator software
.26 Add new users and understand password security procedures

.3 Divide presentation of objectives into three sessions (1-13, 14-23, and 24-26). Participants will attend one or more of sessions, depending on knowledge level required.

.1 Day-to-day Operators (objectives 1-13)
.2 Advanced Operators (objectives 1-13 and 14-23)
.3 System Managers and Administrators (objectives 1-13 and 24-26)

.4 Provide course outline and materials according to Section 23 09 23 Article 1.10 (Submittals). Provide one copy of training material per student.

.5 Instructors shall be factory-trained and experienced in presenting this material.

.6 Perform classroom training using a network of working controllers representative of installed hardware.

End Of Section

Part 1 General

1.1 EXHAUST FAN - ON/OFF (TYPICAL OF 1)

Run Conditions - Interlocked:
The fan(s) EF --- shall be interlocked to run whenever Air Handling Unit ---- runs unless shutdown on safeties.

Fan:
The fan shall have a user definable (adj.) minimum runtime.

Exhaust Air Damper:
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.

Alarms shall be provided as follows:

- Damper Failure: Commanded open, but the status is closed.
- Damper in Hand: Commanded closed, but the status is open.

Fan Status:
The controller shall monitor the fan status.

Alarms shall be provided as follows:

- Fan Failure: Commanded on, but the status is off.
- Fan in Hand: Commanded off, but the status is on.
- Fan Runtime Exceeded: Fan status runtime exceeds a user definable limit (adj.).

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Fan Status			×					×		×
Fan Start/Stop				×				×		×
Exhaust Air Damper				×				×		×
Fan Failure									×	
Fan in Hand									×	
Fan Runtime Exceeded									×	
Totals	**0**	**0**	**1**	**2**	**0**	**0**	**0**	**3**	**3**	**3**

Total Hardware (3) **Total Software (6)**

1.2 MAKEUP AIR UNIT - SUPPLY AIR TEMP (TYPICAL OF 1)

Run Conditions - Interlocked:
The unit MAU --- shall be interlocked to run whenever Exhaust fan---- runs unless shutdown on safeties.

Freeze Protection:
The unit shall shut down and generate an alarm upon receiving a freezestat status.

Outside Air Damper:
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.

Alarms shall be provided as follows:

- Outside Air Damper Failure: Commanded open, but the status is closed.
- Outside Air Damper in Hand: Commanded closed, but the status is open.

Heat Recovery - Run-Around Loop Coils:
The controller shall run the run-around loop pump and modulate the run-around loop mixing valve for energy recovery as follows.

Cooling Recovery Mode:
The run-around loop pump shall run continuously. The controller shall measure the discharge air temperature (downstream of the outside air coil) and modulate the run-around loop mixing valve to maintain a setpoint 2°F (adj.) less than the unit supply air temperature setpoint. The run-around loop shall run for cool recovery whenever:

- Return air temperature is 5°F (adj.) or more below the outside air temperature.
- AND the unit is in a cooling mode.
- AND the supply fan is on.

Heating Recovery Mode:
The run-around loop pump shall run continuously . The controller shall measure the discharge air temperature (downstream of the outside air coil) and modulate the run-around loop mixing valve to maintain a setpoint 2°F (adj.) greater than the unit supply air temperature setpoint. The run-around loop shall run for heat recovery whenever:

Return air temperature is 5°F (adj.) or more above the outside air temperature.
AND the unit is in a heating mode.
AND the supply fan is on.

Frost Protection:
The run-around loop pump shall run and the run-around loop mixing valve shall close to 0% (adj.) in order to circulate water through the exhaust air coil whenever:

- Run-around loop temperature drops below 33°F (adj.)
- OR the exhaust air temperature drops below 30°F (adj.).

Alarms shall be provided as follows:

- Run-Around Loop Pump Failure: Commanded on, but the status is off.
- Run-Around Loop Pump in Hand: Commanded off, but the status is on.
- Run-Around Loop Pump Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).

Supply Fan:
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.

Alarms shall be provided as follows:

- Supply Fan Failure: Commanded on, but the status is off.
- Supply Fan in Hand: Commanded off, but the status is on.
- Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).

Exhaust Fan:
The exhaust fan shall run whenever the supply fan runs, unless shutdown on safeties.

Alarms shall be provided as follows:

- Exhaust Fan Failure: Commanded on, but the status is off.
- Exhaust Fan in Hand: Commanded off, but the status is on.
- Exhaust Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).

Supply Air Temperature Setpoint - Outside Air Reset:
The controller shall monitor the supply air temperature and shall maintain supply air temperature setpoint. The supply air temperature setpoint shall reset for cooling as follows:

As outside air temperature drops from 85°F (adj.) to 20°F (adj.)
the supply air temperature setpoint shall reset upwards from 55°F (adj.) to 95°F (adj.).

Heating Coil Valve:
The controller shall measure the supply air temperature and modulate the heating coil valve to maintain its heating setpoint.

The heating shall be enabled whenever:

- Outside air temperature is less than 65°F (adj.).
- AND the supply air temperature is below heating setpoint.
- AND the fan status is on.

The heating coil valve shall open to 100% (adj.) whenever the freezestat is on.

Prefilter Differential Pressure Monitor:
The controller shall monitor the differential pressure across the prefilter.

Alarms shall be provided as follows:

- Prefilter Change Required: Prefilter differential pressure exceeds a user definable limit (adj.).

Final Filter Differential Pressure Monitor:
The controller shall monitor the differential pressure across the final filter.

Alarms shall be provided as follows:

- Final Filter Change Required: Final filter differential pressure exceeds a user definable limit (adj.).

Supply Air Temperature:
The controller shall monitor the supply air temperature.

Alarms shall be provided as follows:

- High Supply Air Temp: If the supply air temperature is greater than 120°F (adj.).
- Low Supply Air Temp: If the supply air temperature is less than 45°F (adj.).

	Hardware Points				Software Points					
Point Name	AI	AO	BI	BO	AV	BV	Sched	Trend	Alarm	Show On Graphic
Run-Around Loop Coil Discharge Air Temp	×							×		×
Outside Air Temp	×							×		×
Return Air Temp	×							×		×
Exhaust Air Temp	×							×		×
Run-Around Loop Temp	×								×	×
Prefilter Differential Pressure	×							×		
Final Filter Differential Pressure	×							×		
Supply Air Temp	×							×		×
Run-Around Loop Mixing Valve		×						×		×
Heating Valve		×						×		×
Freezestat			×					×	×	×
Outside Air Damper Status			×					×		×
Run-Around Loop Pump Status			×					×		×
Supply Fan Status			×					×		×
Exhaust Fan Status			×					×		×
Outside Air Damper				×				×		×
Run-Around Loop Pump Start/Stop				×				×		×
Supply Fan Start/Stop				×				×		×
Exhaust Fan Start/Stop				×				×		×
Supply Air Temp Setpoint					×			×		×
Outside Air Temp					×					×

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Outside Air Damper Failure									×	
Outside Air Damper in Hand									×	
Run-Around Loop Pump Failure									×	
Run-Around Loop Pump in Hand									×	
Run-Around Loop Pump Runtime Exceeded									×	
Supply Fan Failure									×	
Supply Fan in Hand									×	
Supply Fan Runtime Exceeded									×	
Exhaust Fan Failure									×	
Exhaust Fan in Hand									×	
Exhaust Fan Runtime Exceeded									×	
Prefilter Change Required									×	×
Final Filter Change Required									×	×
High Supply Air Temp									×	
Low Supply Air Temp									×	
Totals	**8**	**2**	**5**	**4**	**2**	**0**	**0**	**19**	**17**	**21**

Total Hardware (19) **Total Software (38)**

1.3 CABINET HEATER (TYPICAL OF 1)

Run Conditions - Continuous:
The unit shall run continuously and shall maintain a heating setpoint of 70°F (adj.).

Alarms shall be provided as follows:

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

Zone Setpoint Adjust:
The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.

Fan:
The fan shall run anytime the zone temperature is below heating setpoint, unless shutdown on safeties.

Heating Coil Valve:
The controller shall measure the zone temperature and modulate the heating coil valve to maintain its heating setpoint.

The heating shall be enabled whenever:

- Outside air temperature is less than 65°F (adj.).
- AND the zone temperature is below heating setpoint.
- AND the fan is on.

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Zone Temp	×							×		×
Zone Setpoint Adjust	×									×
Heating Valve		×						×		×
Fan Start/Stop				×				×		×
Heating Setpoint								×		×
Low Zone Temp									×	
Totals	**2**	**1**	**0**	**1**	**0**	**0**	**0**	**4**	**1**	**5**

Total Hardware (4) **Total Software (5)**

1.4 UNIT HEATER (TYPICAL OF 1)

Run Conditions - Continuous:
The unit shall run continuously and shall maintain a heating setpoint of 70°F (adj.).

Alarms shall be provided as follows:

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

Zone Setpoint Adjust:
The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.

Fan:
The fan shall run anytime the zone temperature drops below heating setpoint, unless shutdown on safeties.

Heating Coil Valve:
The controller shall measure the zone temperature and modulate the heating coil valve to maintain its heating setpoint.

The heating shall be enabled whenever:

- Outside air temperature is less than 65°F (adj.).
- AND the zone temperature is below heating setpoint.
- AND the fan is on.

Fan Status:
The controller shall monitor the fan status.

Alarms shall be provided as follows:

- Fan Failure: Commanded on, but the status is off.
- Fan in Hand: Commanded off, but the status is on.
- Fan Runtime Exceeded: Fan status runtime exceeds a user definable limit (adj.).

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Zone Temp	×							×		×
Zone Setpoint Adjust	×									×
Heating Valve		×						×		×
Fan Status			×					×		×
Fan Start/Stop				×				×		×
Heating Setpoint								×		×
Low Zone Temp									×	
Fan Failure									×	
Fan in Hand									×	
Fan Runtime Exceeded									×	
Totals	**2**	**1**	**1**	**1**	**0**	**0**	**0**	**5**	**4**	**6**

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**

Total Hardware (5) **Total Software (9)**

1.5 VARIABLE AIR VOLUME - AHU (TYPICAL OF 1)

Run Conditions - Requested:
The unit shall run whenever:

- Any zone is occupied.
- OR a definable number of unoccupied zones need heating or cooling.

Freeze Protection:
The unit shall shut down and generate an alarm upon receiving a freezestat status.

High Static Shutdown:
The unit shall shut down and generate an alarm upon receiving an high static shutdown signal.

Supply Air Smoke Detection:
The unit shall shut down and generate an alarm upon receiving a supply air smoke detector status.

Supply Fan:
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.

Alarms shall be provided as follows:

- Supply Fan Failure: Commanded on, but the status is off.
- Supply Fan in Hand: Commanded off, but the status is on.
- Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).

Supply Air Duct Static Pressure Control:
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.).

Alarms shall be provided as follows:

- High Supply Air Static Pressure: If the supply air static pressure is 25% (adj.) greater than setpoint.
- Low Supply Air Static Pressure: If the supply air static pressure is 25% (adj.) less than setpoint.
- Supply Fan VFD Fault.

Return Fan:
The return fan shall run whenever the supply fan runs.

Alarms shall be provided as follows:

- Return Fan Failure: Commanded on, but the status is off.
- Return Fan in Hand: Commanded off, but the status is on.
- Return Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
- Return Fan VFD Fault.

Building Static Pressure Control:
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.).

Alarms shall be provided as follows:

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

Energy Recovery - Run-Around Loop Coils:
The controller shall run the run-around loop pump and modulate the run-around loop mixing valve for energy recovery as follows.

Cooling Recovery Mode:
The run-around loop pump shall run continuously. The controller shall measure the run-around loop coil discharge air temperature (downstream of the outside air coil) and modulate the run-around loop mixing valve to maintain a setpoint 2°F (adj.) less than the unit supply air temperature setpoint. The run-around loop shall run for cool recovery whenever:

- Unit return air temperature is 5°F (adj.) or more below the outside air temperature.
- AND the unit is in a cooling mode.
- AND the economizer (if present) is off.
- AND the supply fan is on.

Heating Recovery Mode:
The run-around loop pump shall run continuously . The controller shall measure the run-around loop coil discharge air temperature (downstream of the outside air coil) and modulate the run-around loop mixing valve to maintain a setpoint 2°F (adj.) greater than the unit supply air temperature setpoint. The run-around loop shall run for heat recovery whenever:

Unit return air temperature is 5°F (adj.) or more above the outside air temperature.
AND the unit is in a heating mode.
AND the economizer (if present) is off.
AND the supply fan is on.

Frost Protection:
The run-around loop pump shall run and the run-around loop mixing valve shall close to 0% (adj.) in order to circulate water through the run-around loop exhaust air coil whenever:

- Run-around loop temperature drops below 33°F (adj.)
- OR the exhaust air temperature drops below 30°F (adj.).

Alarms shall be provided as follows:

- Run-Around Loop Pump Failure: Commanded on, but the status is off.
- Run-Around Loop Pump in Hand: Commanded off, but the status is on.
- Run-Around Loop Pump Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).

Supply Air Temperature Setpoint - Optimized:
The controller shall monitor the supply air temperature and shall maintain a supply air temperature setpoint reset based on zone cooling and heating requirements

The supply air temperature setpoint shall be reset for cooling based on zone cooling requirements as follows:

- The initial supply air temperature setpoint shall be 55°F (adj.).
- As cooling demand increases, the setpoint shall incrementally reset down to a minimum of 53°F (adj.).
- As cooling demand decreases, the setpoint shall incrementally reset up to a maximum of 72°F (adj.) .

If more zones need heating than cooling, then the supply air temperature setpoint shall be reset for heating as follows:

- The initial supply air temperature setpoint shall be 82°F (adj.).
- As heating demand increases, the setpoint shall incrementally reset up to a maximum of 85°F (adj.).
- As heating demand decreases, the setpoint shall incrementally reset down to a minimum of 72°F (adj.).

Cooling Stages:
The controller shall measure the supply air temperature and stage the cooling to maintain its cooling setpoint. 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.

The cooling shall be enabled whenever:

- Outside air temperature is greater than 60°F (adj.).
- AND the economizer (if present) is disabled or fully open.
- AND the supply fan status is on.
- AND the heating (if present) is not active.

Alarms shall be provided as follows:

- High Supply Air Temp: If the supply air temperature is 5°F (adj.) greater than setpoint.

Heating Coil Valve:
The controller shall measure the supply air temperature and modulate the heating coil valve to maintain its heating setpoint.

The heating shall be enabled whenever:

- Outside air temperature is less than 65°F (adj.).
- AND the supply fan status is on.
- AND the cooling (if present) is not active.

The heating coil valve shall open whenever:

- Supply air temperature drops from 40°F to 35°F (adj.).

- OR the freezestat (if present) is on.

Alarms shall be provided as follows:

- Low Supply Air Temp: If the supply air temperature is 5°F (adj.) less than setpoint.

Economizer:
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.

The economizer shall be enabled whenever:

- Outside air temperature is less than 65°F (adj.).
- AND the outside air temperature is less than the return air temperature.
- AND the supply fan status is on.

The economizer shall close whenever:

- Mixed air temperature drops from 40°F to 35°F (adj.).
- OR the freezestat (if present) is on.
- OR on loss of supply fan status.

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.

Minimum Outside Air Ventilation - Carbon Dioxide (CO2) Control:
When in the occupied mode, the controller shall measure the return air CO2 levels and modulate the outside air dampers open on rising CO2 concentrations, overriding normal damper operation to maintain a CO2 setpoint of 750 ppm (adj.).

Alarms shall be provided as follows:

- High Return Air Carbon Dioxide Concentration: If the return air CO2 concentration is greater than 1000 ppm (adj.).

Dehumidification:
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.

Humidifier Control:
The controller shall measure the return air humidity and modulate the humidifier to maintain a setpoint of 50% rh (adj.). The humidifier shall be enabled whenever the supply fan status is on.

The humidifier shall turn off whenever:

- Supply air humidity rises from 90% rh to 95% rh (adj.).
- OR on loss of supply fan status.

Alarms shall be provided as follows:

- High Supply Air Humidity: If the supply air humidity is greater than 90% rh (adj.).

- Low Supply Air Humidity: If the supply air humidity is less than 30% rh (adj.).

Prefilter Differential Pressure Monitor:
The controller shall monitor the differential pressure across the prefilter.

Alarms shall be provided as follows:

- Prefilter Change Required: Prefilter differential pressure exceeds a user definable limit (adj.).

Final Filter Differential Pressure Monitor:
The controller shall monitor the differential pressure across the final filter.

Alarms shall be provided as follows:

- Final Filter Change Required: Final filter differential pressure exceeds a user definable limit (adj.).

Mixed Air Temperature:
The controller shall monitor the mixed air temperature and use as required for economizer control (if present) or preheating control (if present).

Alarms shall be provided as follows:

- High Mixed Air Temp: If the mixed air temperature is greater than 90°F (adj.).

- Low Mixed Air Temp: If the mixed air temperature is less than 45°F (adj.).

Return Air Humidity:
The controller shall monitor the return air humidity and use as required for economizer control (if present) or humidity control (if present).

Alarms shall be provided as follows:

- High Return Air Humidity: If the return air humidity is greater than 70% (adj.).

- Low Return Air Humidity: If the return air humidity is less than 35% (adj.).

Return Air Temperature:
The controller shall monitor the return air temperature and use as required for setpoint control or economizer control (if present).

Alarms shall be provided as follows:

- High Return Air Temp: If the return air temperature is greater than 90°F (adj.).

- Low Return Air Temp: If the return air temperature is less than 45°F (adj.).

Supply Air Temperature:
The controller shall monitor the supply air temperature.

Alarms shall be provided as follows:

- High Supply Air Temp: If the supply air temperature is greater than 120°F (adj.).

- Low Supply Air Temp: If the supply air temperature is less than 45°F (adj.).

	Hardware Points				Software Points					
Point Name	AI	AO	BI	BO	AV	BV	Sched	Trend	Alarm	Show On Graphic
Supply Air Static Pressure	×							×	×	×
Building Static Pressure	×							×		×
Run-Around Loop Coil Discharge Air Temp	×							×		×
Outside Air Temp	×							×		×
Exhaust Air Temp	×							×		×
Run-Around Loop Temp	×							×		×
RA Carbon Dioxide PPM	×							×		×
Supply Air Humidity	×							×		×
Prefilter Differential Pressure	×							×		
Final Filter Differential Pressure	×							×		
Mixed Air Temp	×							×		×
Return Air Humidity	×							×		×
Return Air Temp	×							×		×
Supply Air Temp	×							×		×
Supply Fan VFD Speed		×						×		×
Return Fan VFD Speed		×						×		×
Run-Around Loop Mixing Valve		×						×		×
Heating Valve		×						×		×
Mixed Air Dampers		×						×		×
Humidifier		×						×		×
Freezestat			×					×	×	×
High Static Shutdown			×					×	×	×
Supply Air Smoke Detector			×					×	×	×
Supply Fan VFD Fault			×						×	×
Supply Fan Status			×					×		×
Return Fan VFD Fault			×						×	
Return Fan Status			×					×		×
Run-Around Loop Pump Status			×					×		×
Supply Fan Start/Stop				×				×		×
Return Fan Start/Stop				×				×		×
Run-Around Loop Pump Start/Stop				×				×		×
Cooling Stage 1				×				×		×
Cooling Stage 2				×				×		×
Humidifier Enable				×						×
Supply Air Static Pressure Setpoint					×			×		×
Building Static Pressure Setpoint					×					×

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Supply Air Temp Setpoint					×			×		×
Economizer Mixed Air Temp Setpoint					×			×		×
RA Carbon Dioxide PPM Setpoint					×			×		×
Dehumidification Setpoint					×			×		×
Humidifier Setpoint					×					×
High Supply Air Static Pressure									×	
Low Supply Air Static Pressure									×	
Supply Fan Failure									×	
Supply Fan in Hand									×	
Supply Fan Runtime Exceeded									×	
High Building Static Pressure									×	
Low Building Static Pressure									×	
Return Fan Failure									×	
Return Fan in Hand									×	
Return Fan Runtime Exceeded									×	
Run-Around Loop Pump Failure									×	
Run-Around Loop Pump in Hand									×	
Run-Around Loop Pump Runtime Exceeded									×	
High Supply Air Temp									×	
Compressor Runtime Exceeded									×	
Low Supply Air Temp									×	
High RA Carbon Dioxide Concentration									×	
High Supply Air Humidity									×	
Low Supply Air Humidity									×	
Prefilter Change Required									×	×
Final Filter Change Required									×	×
High Mixed Air Temp									×	
Low Mixed Air Temp									×	
High Return Air Humidity									×	
Low Return Air									×	

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Humidity										
High Return Air Temp									×	
Low Return Air Temp									×	
High Supply Air Temp									×	
Low Supply Air Temp									×	
Totals	**14**	**6**	**8**	**6**	**7**	**0**	**0**	**36**	**35**	**40**

Total Hardware (34) **Total Software (78)**

1.6 TWO BOILER SYSTEM (TYPICAL OF 1)

Boiler System Run Conditions:
The boiler system shall be enabled to run whenever:

- A definable number of hot water coils need heating.
- AND outside air temperature is less than 65°F (adj.).

To prevent short cycling, the boiler system shall run for and be off for minimum adjustable times (both user definable), unless shutdown on safeties or outside air conditions.

The boiler shall run subject to its own internal safeties and controls.

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

Boiler 1 Safeties:
The following safeties shall be monitored:

- Boiler alarm.
- Low water level.

Alarms shall be provided as follows:

- Boiler alarm.
- Low water level alarm.

Boiler 2 Safeties:
The following safeties shall be monitored:

- Boiler alarm.
- Low water level.

Alarms shall be provided as follows:

- Boiler alarm.
- Low water level alarm.

Hot Water Pump Lead/Lag Operation:
The two hot water pumps shall operate in a lead/lag fashion.

- The lead pump shall run first.
- On failure of the lead pump, the lag pump shall run and the lead pump shall turn off.
- On decreasing hot water differential pressure, the lag pump shall stage on and run in unison with the lead pump to maintain hot water differential pressure setpoint.

The designated lead pump shall rotate upon one of the following conditions (user selectable):

- manually through a software switch

- if pump runtime (adj.) is exceeded
- daily
- weekly
- monthly

Alarms shall be provided as follows:

- Hot Water Pump 1
  - Failure: Commanded on, but the status is off.
  - Running in Hand: Commanded off, but the status is on.
  - Runtime Exceeded: Status runtime exceeds a user definable limit.
  - VFD Fault.

- Hot Water Pump 2
  - Failure: Commanded on, but the status is off.
  - Running in Hand: Commanded off, but the status is on.
  - Runtime Exceeded: Status runtime exceeds a user definable limit.
  - VFD Fault.

Hot Water Differential Pressure Control:
The controller shall measure hot water differential pressure and modulate the hot water pump VFDs in sequence to maintain its hot water differential pressure setpoint.

The following setpoints are recommended values. All setpoints shall be field adjusted during the commissioning period to meet the requirements of actual field conditions.

The controller shall modulate hot water pump speeds to maintain a hot water differential pressure of $12lb_f/in^2$ (adj.). The VFDs minimum speed shall not drop below 20% (adj.).

On dropping hot water differential pressure, the VFDs shall stage on and run to maintain setpoint as follows:

- The controller shall modulate the lead VFD to maintain setpoint.
- If the lead VFD speed is greater than a setpoint of 90% (adj.), the lag VFD shall stage on.
- The lag VFD shall ramp up to match the lead VFD speed and then run in unison with the lead VFD to maintain setpoint.

On rising hot water differential pressure, the VFDs shall stage off as follows:

- If the VFDs speeds drops back to 60% (adj.) below setpoint, the lag VFD shall stage off.
- The lead VFD shall continue to run to maintain setpoint.

Alarms shall be provided as follows:

- High Hot Water Differential Pressure: If 25% (adj.) greater than setpoint.
- Low Hot Water Differential Pressure: If 25% (adj.) less than setpoint.

Circulation Pump 1:
The Circulation Pump 1 shall run anytime Boiler 1 is called to run and shall have a user definable delay (adj.) on stop.

Alarms shall be provided as follows:

- Circulation Pump 1 Failure: Commanded on, but the status is off.
- Circulation Pump 1 Running in Hand: Commanded off, but the status is on.
- Circulation Pump 1 Runtime Exceeded: Status runtime exceeds a user-definable limit.

Circulation Pump 2:
The Circulation Pump 2 shall run anytime Boiler 2 is called to run and shall have a user definable delay (adj.) on stop.

Alarms shall be provided as follows:

- Circulation Pump 2 Failure: Commanded on, but the status is off.
- Circulation Pump 2 Running in Hand: Commanded off, but the status is on.
- Circulation Pump 2 Runtime Exceeded: Status runtime exceeds a user-definable limit.

Boiler Lead/Standby Operation:
The two boilers shall operate in a lead/standby fashion when called to run and flow is proven.

- The lead boiler shall run first.
- On failure of the lead boiler, the standby boiler shall run and the lead boiler shall turn off.

The designated lead boiler shall rotate upon one of the following conditions: (user selectable):

- manually through a software switch
- if boiler runtime (adj.) is exceeded
- daily
- weekly
- monthly

Alarms shall be provided as follows:

- Boiler 1
  - Failure: Commanded on but the status is off.
  - Running in Hand: Commanded off but the status is on.

    - Runtime Exceeded: Status runtime exceeds a user definable limit.

- Boiler 2
    - Failure: Commanded on but the status is off.
    - Running in Hand: Commanded off but the status is on.
    - Runtime Exceeded: Status runtime exceeds a user definable limit.

- Lead Boiler Failure: The lead boiler is in failure and the standby boiler is on.

Hot Water Supply Temperature Setpoint:
The boiler shall maintain a hot water supply temperature setpoint as determined by its own internal controls (provided by others).

Primary Hot Water Temperature Monitoring:
The following temperatures shall be monitored:

- Primary hot water supply.
- Primary hot water return.

Alarms shall be provided as follows:

- High Primary Hot Water Supply Temp: If greater than 200°F (adj.).
- Low Primary Hot Water Supply Temp: If less than 100°F (adj.).

Boiler 1 Hot Water Temperature Monitoring:
The following temperatures shall be monitored:

- Boiler 1 hot water supply.
- Boiler 1 hot water return.

Alarms shall be provided as follows:

- High Hot Water Supply Temp: If greater than 200°F (adj.).
- Low Hot Water Supply Temp: If less than 100°F (adj.).

Boiler 2 Hot Water Temperature Monitoring:
The following temperatures shall be monitored:

- Boiler 2 hot water supply.
- Boiler 2 hot water return.

Alarms shall be provided as follows:

- High Hot Water Supply Temp: If greater than 200°F (adj.).
- Low Hot Water Supply Temp: If less than 100°F (adj.).

	Hardware Points				Software Points					
Point Name	AI	AO	BI	BO	AV	BV	Sched	Trend	Alarm	Show On Graphic
Hot Water Differential Pressure	×							×		×
Primary Hot Water Return Temp	×							×		×
Primary Hot Water Supply Temp	×							×		×
Boiler 1 Hot Water Return Temp	×							×		×
Boiler 1 Hot Water Supply Temp	×							×		×
Boiler 2 Hot Water Return Temp	×							×		×
Boiler 2 Hot Water Supply Temp	×							×		×
Hot Water Pump 1 VFD Speed		×						×		×
Hot Water Pump 2 VFD Speed		×						×		×
Boiler 1 Alarm Status			×					×	×	×
Boiler 1 Low Water Level			×					×	×	×
Boiler 2 Alarm Status			×					×	×	×
Boiler 2 Low Water Level			×					×	×	×
Hot Water Pump 1 VFD Fault			×						×	×
Hot Water Pump 2 VFD Fault			×						×	×
Hot Water Pump 1 Status			×					×		×
Hot Water Pump 2 Status			×					×		×
Circulation Pump 1 Status			×					×		×
Circulation Pump 2 Status			×					×		×
Boiler 1 Status			×					×		×
Boiler 2 Status			×					×		×
Hot Water Pump 1 Start/Stop				×						×
Hot Water Pump 2 Start/Stop				×						×
Circulation Pump 1 Start/Stop				×				×		×
Circulation Pump 2 Start/Stop				×				×		×
Boiler 1 Enable				×						×
Boiler 2 Enable				×						×

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Hot Water Differential Pressure Setpoint					×					×
High Hot Water Differential Pressure									×	
Low Hot Water Differential Pressure									×	
Hot Water Pump 1 Failure									×	
Hot Water Pump 1 Running in Hand									×	
Hot Water Pump 1 Runtime Exceeded									×	
Hot Water Pump 2 Failure									×	
Hot Water Pump 2 Running in Hand									×	
Hot Water Pump 2 Runtime Exceeded									×	
Circulation Pump 1 Failure									×	
Circulation Pump 1 Running in Hand									×	
Circulation Pump 1 Runtime Exceeded									×	
Circulation Pump 2 Failure									×	
Circulation Pump 2 Running in Hand									×	
Circulation Pump 2 Runtime Exceeded									×	
Boiler 1 Runtime Exceeded									×	
Boiler 2 Failure									×	
Boiler 2 Running in Hand									×	
Boiler 2 Runtime Exceeded									×	
Lead Boiler Failure									×	×
Boiler 1 Failure									×	
Boiler 1 Running in Hand									×	
High Primary Hot Water Supply Temp									×	
Low Primary Hot Water Supply Temp									×	
Boiler 1 High Hot									×	

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Water Supply Temp										
Boiler 1 Low Hot Water Supply Temp									×	
Boiler 2 High Hot Water Supply Temp									×	
Boiler 2 Low Hot Water Supply Temp									×	
Totals	**7**	**2**	**12**	**6**	**1**	**0**	**0**	**21**	**33**	**29**

Total Hardware (27) **Total Software (55)**

1.7 UNIT HEATER (TYPICAL OF 3)

Run Conditions - Scheduled:
The unit shall run according to a user definable time schedule in the following modes:

- Occupied Mode: The unit shall maintain a heating setpoint of 70°F (adj.).
- Unoccupied Mode (night setback): The unit shall maintain a heating setpoint of 65°F (adj.).

Alarms shall be provided as follows:

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

Zone Setpoint Adjust:
The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.

Fan:
The fan shall run anytime the zone temperature drops below heating setpoint, unless shutdown on safeties.

Heating Coil Valve:
The controller shall measure the zone temperature and modulate the heating coil valve to maintain its heating setpoint.

The heating shall be enabled whenever:

- Outside air temperature is less than 65°F (adj.).
- AND the zone temperature is below heating setpoint.
- AND the fan is on.

Fan Status:
The controller shall monitor the fan status.

Alarms shall be provided as follows:

- Fan Failure: Commanded on, but the status is off.
- Fan in Hand: Commanded off, but the status is on.
- Fan Runtime Exceeded: Fan status runtime exceeds a user definable limit (adj.).

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Zone Temp	×							×		×
Zone Setpoint Adjust	×									×
Heating Valve		×						×		×
Fan Status			×					×		×
Fan Start/Stop				×				×		×
Schedule							×			
Heating Setpoint								×		×

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Low Zone Temp									×	
Fan Failure									×	
Fan in Hand									×	
Fan Runtime Exceeded									×	
Totals	**2**	**1**	**1**	**1**	**0**	**0**	**1**	**5**	**4**	**6**

Total Hardware (5)

Total Software (10)

1.8 FAN COIL UNIT (TYPICAL OF 10)

Run Conditions - Continuous:
The unit shall run continuously and shall maintain:

- A 74°F (adj.) cooling setpoint
- A 70°F (adj.) heating setpoint.

Alarms shall be provided as follows:

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

Zone Setpoint Adjust:
The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.

Smoke Detection:
The unit shall shut down and generate an alarm upon receiving a smoke detector status.

Fan:
The fan shall run anytime the unit is commanded to run, unless shutdown on safeties.

Heating Coil Valve:
The controller shall measure the zone temperature and modulate the heating coil valve to maintain its heating setpoint.

The heating shall be enabled whenever:

- Outside air temperature is less than 65°F (adj.).
- AND the zone temperature is below heating setpoint.
- AND the fan is on.

Fan Status:
The controller shall monitor the fan status.

Alarms shall be provided as follows:

- Fan Failure: Commanded on, but the status is off.
- Fan in Hand: Commanded off, but the status is on.
- Fan Runtime Exceeded: Fan status runtime exceeds a user definable limit (adj.).

	Hardware Points				**Software Points**					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Zone Temp	×							×		×
Zone Setpoint Adjust	×									×

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Heating Valve		×						×		×
Smoke Detector			×					×	×	×
Fan Status			×							×
Fan Start/Stop				×				×		×
Heating Setpoint								×		×
Cooling Setpoint								×		×
High Zone Temp									×	
Low Zone Temp									×	
Fan Failure									×	
Fan in Hand									×	
Fan Runtime Exceeded									×	
Totals	**2**	**1**	**2**	**1**	**0**	**0**	**0**	**6**	**6**	**8**

Total Hardware (6) **Total Software (12)**

1.9 VARIABLE AIR VOLUME - TERMINAL UNIT (TYPICAL OF 48)

Run Conditions - Scheduled:
The unit shall run according to a user definable time schedule in the following modes:

- Occupied Mode: The unit shall maintain
    - A 74°F (adj.) cooling setpoint
    - A 70°F (adj.) heating setpoint.
- Unoccupied Mode (night setback): The unit shall maintain
    - A 80°F (adj.) cooling setpoint.
    - A 65°F (adj.) heating setpoint.

Alarms shall be provided as follows:

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

Zone Setpoint Adjust:
The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.

Zone Optimal Start:
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.

Zone Unoccupied Override:
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.

Reversing Variable Volume Terminal Unit - Flow Control:
The unit shall maintain zone setpoints by controlling the airflow through one of the following:

Occupied:

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

Unoccupied:

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

<u>Reheating Coil Valve:</u>
The controller shall measure the zone temperature and modulate the reheating coil valve open on dropping temperature to maintain its heating setpoint.

<u>Discharge Air Temperature:</u>
The controller shall monitor the discharge air temperature.

Alarms shall be provided as follows:

- High Discharge Air Temp: If the discharge air temperature is greater than 120°F (adj.).
- Low Discharge Air Temp: If the discharge air temperature is less than 40°F (adj.).

	Hardware Points				**Software Points**					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Zone Temp	×							×		×
Zone Setpoint Adjust	×									×
Airflow	×							×		×
Discharge Air Temp	×							×		×
Zone Damper		×								×
Reheating Valve		×						×		×
Zone Override			×					×		×
Airflow Setpoint					×			×		×
Heating Mode						×		×		
Schedule							×			
Heating Setpoint								×		×
Cooling Setpoint								×		×
High Zone Temp									×	
Low Zone Temp									×	
High Discharge Air Temp									×	
Low Discharge Air Temp									×	
Totals	**4**	**2**	**1**	**0**	**1**	**1**	**1**	**9**	**4**	**10**

Total Hardware (7) **Total Software (16)**

1.10 HOT WATER LOOP PUMPS (TYPICAL OF 2)

Hot Water Pump Run Conditions:
The hot water pumps shall be enabled whenever:

- A definable number of hot water coils need heating.
- AND outside air temperature is less than 54°F (adj.).

The pumps shall run for freeze protection anytime outside air temperature is less than 38°F (adj.).

To prevent short cycling, the pump shall run for a minimum time and be off for a minimum time (both user adjustable).

Hot Water Pump Lead/Lag Operation:
The two variable speed hot water pumps shall operate in a lead/lag fashion.

- The lead pump shall run first.
- On failure of the lead pump, the lag pump shall run and the lead pump shall turn off.
- On decreasing hot water differential pressure, the lag pump shall stage on and run in unison with the lead pump to maintain hot water differential pressure setpoint.

The designated lead pump shall rotate upon one of the following conditions (user selectable):

- manually through a software switch
- if pump runtime (adj.) is exceeded
- daily
- weekly
- monthly

Alarms shall be provided as follows:

- Hot Water Pump 1
    - Failure: Commanded on, but the status is off.
    - Running in Hand: Commanded off, but the status is on.
    - Runtime Exceeded: Status runtime exceeds a user definable limit.
    - VFD Fault.

- Hot Water Pump 2
    - Failure: Commanded on, but the status is off.
    - Running in Hand: Commanded off, but the status is on.
    - Runtime Exceeded: Status runtime exceeds a user definable limit.

- VFD Fault.

<u>Hot Water Differential Pressure Control:</u>
The controller shall measure hot water differential pressure and modulate the hot water pump VFDs in sequence to maintain its hot water differential pressure setpoint.

The following setpoints are recommended values. All setpoints shall be field adjusted during the commissioning period to meet the requirements of actual field conditions.

The controller shall modulate hot water pump speeds to maintain a hot water differential pressure of $12lb_f/in^2$ (adj.). The VFDs minimum speed shall not drop below 20% (adj.).

On dropping hot water differential pressure, the VFDs shall stage on and run to maintain setpoint as follows:

- The controller shall modulate the lead VFD to maintain setpoint.
- If the lead VFD speed is greater than a setpoint of 90% (adj.), the lag VFD shall stage on.
- The lag VFD shall ramp up to match the lead VFD speed and then run in unison with the lead VFD to maintain setpoint.

On rising hot water differential pressure, the VFDs shall stage off as follows:

- If the VFDs speeds drops back to 60% (adj.) below setpoint, the lag VFD shall stage off.
- The lead VFD shall continue to run to maintain setpoint.

Alarms shall be provided as follows:

- High Hot Water Differential Pressure: If 25% (adj.) greater than setpoint.
- Low Hot Water Differential Pressure: If 25% (adj.) less than setpoint.

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Hot Water Differential Pressure	×							×		×
Hot Water Pump 1 VFD Speed		×						×		×
Hot Water Pump 2 VFD Speed		×						×		×
Hot Water Pump 2 VFD Fault			×						×	×
Hot Water Pump 1 Status			×					×		×
Hot Water Pump 2 Status			×					×		×
Hot Water Pump 1 VFD Fault			×						×	×
Hot Water Pump 1 Start/Stop				×				×		×
Hot Water Pump 2 Start/Stop				×				×		×
Hot Water Differential					×					×

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Pressure Setpoint										
High Hot Water Differential Pressure									×	
Low Hot Water Differential Pressure									×	
Hot Water Pump 1 Failure									×	
Hot Water Pump 2 Failure									×	
Hot Water Pump 1 Running in Hand									×	
Hot Water Pump 2 Running in Hand									×	
Hot Water Pump 1 Runtime Exceeded									×	
Hot Water Pump 2 Runtime Exceeded									×	
Totals	**1**	**2**	**4**	**2**	**1**	**0**	**0**	**7**	**10**	**10**

Total Hardware (9) **Total Software (18)**

1.11 OUTSIDE AIR CONDITIONS (TYPICAL OF 1)

Outside Air Conditions:
The controller shall monitor the outside air temperature and humidity and calculate the outside air enthalpy on a continual basis. These values shall be made available to the system at all times.

Alarm shall be generated as follows:

- Sensor Failure: Sensor reading indicates shorted or disconnected sensor. In the event of a sensor failure, an alternate outside air conditions sensor shall be made available to the system without interruption in sensor readings.

Outside Air Temperature History:
The controller shall monitor and record the high and low temperature readings for the outside air. These readings shall be recorded on a daily, month-to-date, and year-to-date basis.

Cooling Degree Day:
The controller shall provide a Degree Day history index that reflects the energy consumption for the facilities cooling demand. Computations shall use a mean daily temperature of 65°F (adj.). The Degree Day peak value readings shall be recorded on a daily, month-to-date, and year-to-date basis.

Heating Degree Day:
The controller shall provide a Degree Day history index that reflects the energy consumption for the facilities heating demand. Computations shall use a mean daily temperature of 65°F (adj.). The Degree Day peak value readings shall be recorded on a daily, month-to-date, and year-to-date basis.

	Hardware Points				Software Points					
Point Name	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Outside Air Temp	×							×		×
Outside Air Humidity	×							×		×
Outside Air Enthalpy					×			×		×
High Temp Today								×		×
High Temp Month-to-Date								×		×
High Temp Year-to-Date								×		×
Low Temp Today								×		×
Low Temp Month-to-Date								×		×
Low Temp Year-to-Date								×		×
Sensor Failure									×	
Totals	**2**	**0**	**0**	**0**	**1**	**0**	**0**	**9**	**1**	**9**

Total Hardware (2) **Total Software (11)**

1.12 POINT SUMMARY

		Hardware Points				Software Points					
Equipment Name	**Qty**	**AI**	**AO**	**BI**	**BO**	**AV**	**BV**	**Sched**	**Trend**	**Alarm**	**Show On Graphic**
Exhaust Fan - On/Off (Typical of 1)	Each	0	0	1	2	0	0	0	3	3	3
	Total (x1)	**0**	**0**	**1**	**2**	**0**	**0**	**0**	**3**	**3**	**3**
Makeup Air Unit - Supply Air Temp (Typical of 1)	Each	8	2	5	4	2	0	0	19	17	21
	Total (x1)	**8**	**2**	**5**	**4**	**2**	**0**	**0**	**19**	**17**	**21**
Cabinet Heater (Typical of 1)	Each	2	1	0	1	0	0	0	4	1	5
	Total (x1)	**2**	**1**	**0**	**1**	**0**	**0**	**0**	**4**	**1**	**5**
Unit Heater (Typical of 1)	Each	2	1	1	1	0	0	0	5	4	6
	Total (x1)	**2**	**1**	**1**	**1**	**0**	**0**	**0**	**5**	**4**	**6**
Variable Air Volume - AHU (Typical of 1)	Each	14	6	8	6	7	0	0	36	35	40
	Total (x1)	**14**	**6**	**8**	**6**	**7**	**0**	**0**	**36**	**35**	**40**
Two Boiler System (Typical of 1)	Each	7	2	12	6	1	0	0	21	33	29
	Total (x1)	**7**	**2**	**12**	**6**	**1**	**0**	**0**	**21**	**33**	**29**
Unit Heater (Typical of 3)	Each	2	1	1	1	0	0	1	5	4	6
	Total (x3)	**6**	**3**	**3**	**3**	**0**	**0**	**3**	**15**	**12**	**18**
Fan Coil Unit (Typical of 10)	Each	2	1	2	1	0	0	0	6	6	8
	Total (x10)	**20**	**10**	**20**	**10**	**0**	**0**	**0**	**60**	**60**	**80**
Variable Air Volume - Terminal Unit (Typical of 48)	Each	4	2	1	0	1	1	1	9	4	10
	Total (x48)	**192**	**96**	**48**	**0**	**48**	**48**	**48**	**432**	**192**	**480**
Hot Water Loop Pumps (Typical of 2)	Each	1	2	4	2	1	0	0	7	10	10
	Total (x2)	**2**	**4**	**8**	**4**	**2**	**0**	**0**	**14**	**20**	**20**
Outside Air Conditions (Typical of 1)	Each	2	0	0	0	1	0	0	9	1	9
	Total (x1)	**2**	**0**	**0**	**0**	**1**	**0**	**0**	**9**	**1**	**9**
Project Totals		**255**	**125**	**106**	**37**	**61**	**48**	**51**	**618**	**378**	**711**

Total Hardware (523) **Total Software (1156)**

APPENDIX A: Glossary of Terms

Terms used within the Specification Text:

- **Advanced Application Controller (AAC):**

  A fully programmable control module. This control module may be capable of some of the advanced features found in Building Controllers (storing trends, initiating read and write requests, etc.) but it does not serve as a master controller. Advanced Application Controllers may reside on either the Ethernet/IP backbone or on a subnet.

- **Application Specific Controller (ASC):**

  A pre-programmed control module which is intended for use in a specific application. ASCs may be configurable, in that the user can choose between various pre-programmed options, but it does not support full custom programming. ASCs are often used on terminal equipment such as VAV boxes or fan coil units. In many vendors' architectures ASCs do not store trends or schedules but instead rely upon a Building Controller to provide those functions.

- **BACnet/IP:**

  An approved BACnet network type which uses an Ethernet carrier and IP addressing.

- **BACnet MS/TP:**

  An approved BACnet network type which uses a Master-Slave Token Passing configuration. MS/TP networks are unique to BACnet and utilize EIA485 twisted pair topology running at 9600 to 76,800 bps.

- **BACnet over ARCNET:**

  An approved BACnet network type which uses an ARCNET (attached resource computer network) carrier. ARCNET is an industry standard that can utilize several speeds and wiring standards. The most common configuration used by BACnet controllers is an EIA485 twisted pair topology running at 156,000 bps.

- **Building Controller (BC):**

  A fully programmable control module which is capable of storing trends and schedules, serving as a router to devices on a subnet, and initiating read and write requests to other controllers. Typically this controller is located on the Ethernet/IP backbone of the BAS. In many vendors' architectures a Building Controller will serve as a master controller, storing schedules and trends for controllers on a subnet underneath the Building Controller.

- **Direct Digital Control (DDC):**

  A control system in which a digital computer or microprocessor is directly connected to the valves, dampers, and other actuators which control the system, as opposed to indirectly controlling a system by resetting setpoints on an analog pneumatic or electronic controller.

- **PICS - Protocol Implementation Conformance Statement:**

  A written document, created by the manufacturer of a device, which identifies the particular options specified by BACnet that are implemented in the device.

- **Smart Actuator (SA):**

  An actuator which is controlled by a network connection rather than a binary or analog signal. (0-10v, 4-20mA, relay, etc.)

- **Smart Sensor (SS):**

  A sensor which provides information to the BAS via network connection rather than a binary or analog signal. (0-10000 ohm, 4-20mA, dry contact, etc.)

- **Web services:**

  Web services are a standard method of exchanging data between computer systems using the XML (extensible markup language) and SOAP (simple object access protocol) standards. Web services can be used at any level within a Building Automation System (BAS), but most commonly they are used to transfer data between BAS using different protocols or between a BAS and a non-BAS system such as a tenant billing system or a utility management system.

Terms used within the Sequences of Operation:

- **adj.**

  Adjustable by the end user, through the supplied user interface.

- **AI, AO, etc. (Column Headings on Points List)**

  AI = Analog Input. A physical input to the control module.
  AO = Analog Output. A physical output from the control module.
  AV = Analog Value. An intermediate (software) point that may be editable or read-only. Editable AVs are typically used to allow the user to set a fixed control parameter, such as a setpoint. Read Only AVs are typically used to display the status of a control operation.
  BI = Binary Input. A physical input to the control module.
  BO = Binary Output. A physical output from the control module.
  BV = Binary Value. An intermediate (software) point that may be editable or read-only. Editable BVs are typically used to allow the user to set a fixed control parameter, such as a setpoint. Read Only BVs are typically used to display the status of a control operation.
  Sched = Schedule. The control algorithm for this equipment shall include a user editable schedule.
  Trend. The control system shall be configured to collect and display a trend log of this object. The trending interval shall be no less than one sample every 5 minutes. (Change of Value trending, where a sample is taken every time the value changes by more than a user-defined minimum, is an acceptable alternative.)
  Alarm. The control system shall be configured to generate an alarm when this object exceeds user definable limits, as described in the Sequence of Controls.

  Note: If the specifications require use of the BACnet protocol, all of the above shall be provided as BACnet objects.

- **KW Demand Limiting: ***

  An energy management strategy that reduces energy consumption when a system's electric power meter exceeds an operator-defined threshold.

When power consumption exceeds defined levels, the system automatically adjust setpoints, de-energizes low priority equipment, and takes other pre-programmed actions to avoid peak demand charges. As the demand drops, the system restores loads in a predetermined manner.

- **Occupant Override Switch, or Timed Local Override:**

  A control option that allows building occupants to override the programmed HVAC schedule for a limited period of time.

  When the override time expires, the zone returns to its unoccupied state.

- **Occupant Setpoint Adjustment:**

  A control option that allows building occupants to adjust - within limits set by the HVAC control system - the heating and cooling setpoints of selected zones. Typically the user interface for this function is built into the zone sensor.

- **Optimal Start-Up: ***

  A control strategy that automatically starts an HVAC system at the latest possible time yet ensures comfort conditions by the time the building becomes occupied.

  In a typical implementation, a controller measures the temperature of the zone and the outside air. Then, using design heating or cooling capacity at the design outside air temperature, the system computes how long a unit must run at maximum capacity to bring the zone temperature to its occupied setpoint.

  The optimal start algorithm often includes a self-learning feature to adjust for variations from design capacity.

  A distributed system must use Run on Request with Optimal Start. (See below.)

- **Requested, or Run on Request: ***

  A control strategy that optimizes the runtime of a source piece of equipment that supplies one or more receiving units - such as an air handler unit supplying zone terminal units with heating, cooling, ventilation, or similar service. Source equipment runs only when needed, not on a fixed schedule.

  The source equipment runs when one or more receiving units request its services. An operator determines how many requests are required to start the source equipment.

  For example, if all the zones in a building are unoccupied and the zone terminal units do not need heating or cooling, the AHU will shut down. However, if a zone becomes occupied or needs cooling, the terminal unit will send a run request to the AHU to initiate the start-up sequence. If this AHU depends on a central chiller, it can send a run request to the chiller.

  The run on request algorithm also allows an operator to schedule occupancy for individual zones based on the needs of the occupants without having to adjust the schedules of related AHUs and chillers.

- **Trim and Respond, or Setpoint Optimization: ***

  A control strategy that optimizes the setpoint of a source piece of equipment that supplies one or more receiving units - such as an air handler unit supplying zone terminal units with heating, cooling, ventilation, or similar service.

The source unit communicates with receiving units to determine heating, cooling, and other requirements, and then adjusts its setpoint.

For example, if all zones are comfortable and do not request cooling, the AHU will gradually increase (trim) its supply air setpoint. When a zone requests cooling, the AHU responds by dropping its setpoint. The more zones that request cooling, the more it drops the setpoint. The AHU repeats this process throughout the day to keep zones cool, but with a supply air setpoint that is no cooler than necessary.

Contracting Terms:

- **Furnished or Provided:**

  The act of supplying a device or piece of equipment as required meeting the scope of work specified and making that device or equipment operational. All costs required to furnish the specified device or equipment and make it operational are borne by the division specified to be responsible for providing the device or equipment.

- **Install or Installed:**

  The physical act of mounting, piping or wiring a device or piece of equipment in accordance with the manufacturer's instructions and the scope of work as specified. All costs required to complete the installation are borne by the division specified to include labor and any ancillary materials.

- **Interface:**

  The physical device required to provide integration capabilities from an equipment vendor's product to the control system. The equipment vendor most normally furnishes the interface device. An example of an interface is the chilled water temperature reset interface card provided by the chiller manufacturer in order to allow the control system to integrate the chilled water temperature reset function into the control system.

- **Integrate:**

  The physical connections from a control system to all specified equipment through an interface as required to allow the specified control and monitoring functions of the equipment to be performed via the control system.

APPENDIX B: Abbreviations

The following abbreviations may be used in graphics, schematics, point names, and other UI applications where space is at a premium.

AC - Air Conditioning
ACU - Air Conditioning Unit
AHU - Air Handling Unit
AI - Analog Input
AO - Analog Output
AUTO - Automatic
AUX - Auxiliary
BI - Binary Input
BO - Binary Output
C - Common
CHW - Chilled Water

CHWP - Chilled Water Pump
CHWR - Chilled Water Return
CHWS - Chilled Water Supply
COND - Condenser
CW - Condenser Water
CWP - Condenser Water Pump
CWR - Condenser Water Return
CWS - Condenser Water Supply
DA - Discharge Air
EA - Exhaust Air
EF - Exhaust Fan
EVAP - Evaporators
FCU - Fan Coil Unit
HOA - Hand / Off / Auto
HP - Heat Pump
HRU - Heat Recovery Unit
HTEX - Heat Exchanger
HW - Hot Water
HWP - Hot Water Pump
HWR - Hot Water Return
HWS - Hot Water Supply
MAX - Maximum
MIN - Minimum
MISC - Miscellaneous
NC - Normally Closed
NO - Normally Open
OA - Outdoor Air
PIU - Powered Induction Unit
RA - Return Air
RF - Return Fan
RH - Relative Humidity
RTU - Roof-top Unit
SA - Supply Air
SF - Supply Fan
SP - Static Pressure
TEMP - Temperature
UH - Unit Heater
UV - Unit Ventilator
VAV - Variable Air Volume
VVTU - Variable Volume Terminal Unit
W/ - with
W/O - without
WSHP - Water Source Heat Pump

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and installation for piping, valves and fittings for gas fired equipment.

.2 Related Sections:

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 78 10 - Closeout Submittals.

.3 Section 23 05 01 - Installation of Pipework.

.4 Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems.

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B16.5-03, Pipe Flanges and Flanged Fittings.

.2 ASME B16.18-01, Cast Copper Alloy Solder Joint Pressure Fittings.

.3 ASME B16.22-01, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.

.4 ASME B18.2.1-96, Square and Hex Bolts and Screws Inch Series.

.2 American Society for Testing and Materials International (ASTM)

.1 ASTM A47/A47M-99(2004), Standard Specification for Ferritic Malleable Iron Castings.

.2 ASTM A53/A53M-04, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.

.3 ASTM B75M-99, Standard Specification for Seamless Copper Tube Metric.

.4 ASTM B837-01, Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems.

.3 Canadian Standards Association (CSA International)

.1 CSA W47.1-03, Certification of Companies for Fusion Welding of Steel.

.4 Canadian Standards Association (CSA)/Canadian Gas Association (CGA)

.1 CAN/CSA B149.1HB-00, Natural Gas and Propane Installation Code Handbook.

.2 CAN/CSA B149.2-00, Propane Storage and Handling Code.

1.3 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Instructions: submit manufacturer's installation instructions.

.3 Closeout Submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

Part 2 Products

2.1 PIPE

.1 Steel pipe: to ASTM A53/A53M, Schedule 40, seamless as follows:

 .1 NPS 1/2 to 2, screwed.
 .2 NPS2 1/2 and over, plain end.

.2 Copper tube: to ASTM B837.

2.2 JOINTING MATERIAL

.1 Screwed fittings: pulverized lead paste.

.2 Welded fittings: to CSA W47.1.

.3 Flange gaskets: nonmetallic flat.

.4 Brazing: to ASTM B837.

2.3 FITTINGS

.1 Steel pipe fittings, screwed, flanged or welded:

 .1 Malleable iron: screwed, banded, Class 150.
 .2 Steel pipe flanges and flanged fittings: to ASME B16.5.
 .3 Welding: butt-welding fittings.
 .4 Unions: malleable iron, brass to iron, ground seat, to ASTM A47/A47M.
 .5 Bolts and nuts: to ASME B18.2.1.
 .6 Nipples: schedule 40, to ASTM A53/A53M.

.2 Copper pipe fittings, screwed, flanged or soldered:

 .1 Cast copper fittings: to ASME B16.18.
 .2 Wrought copper fittings: to ASME B16.22.

2.4 VALVES

.1 Provincial Code approved, lubricated plug ball type.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 PIPING

.1 Install in accordance with Section 23 05 01 - Installation of Pipework, applicable Provincial/Territorial Codes, CAN/CSA B149.1, CAN/CSA B149.2, supplemented as specified.

.2 Install drip points:

.1 At low points in piping system.

.2 At connections to equipment.

3.3 VALVES

.1 Install valves with stems upright or horizontal unless otherwise approved by Contract Administrator.

.2 Install valves at branch take-offs to isolate pieces of equipment, and as indicated.

3.4 FIELD QUALITY CONTROL

.1 Site Tests/Inspection:

.1 Test system in accordance with CAN/CSA B149.1 CAN/CSA B149.2 and requirements of authorities having jurisdiction.

3.5 ADJUSTING

.1 Purging: purge after pressure test in accordance with CAN/CSA B149.1 CAN/CSA B149.2.

.2 Pre-Start-Up Inspections:

.1 Check vents from regulators, control valves, terminate outside building in approved location, protected against blockage, damage.

.2 Check gas trains, entire installation is approved by authority having jurisdiction.

3.6 CLEANING

.1 Cleaning: in accordance with Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems CAN/CSA B149.1, CAN/CSA B149.2, supplemented as specified.

.2 Perform cleaning operations in accordance with manufacturer's recommendations.

.3 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

- .1 The supply and installation of Hydronic Specialties Equipment.

.2 Related Sections:

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 00 - Cleaning
- .3 Section 01 78 10 - Closeout Submittals.

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME).

- .1 ASME-04, Boiler and Pressure Vessel Code.

.2 American Society for Testing and Materials, (ASTM).

- .1 ASTM A47/A47M-99, Specification for Ferritic Malleable Iron Castings.
- .2 ASTM A278M-01, Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (345 degrees C).
- .3 ASTM A516/A516M-96(e1), Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
- .4 ASTM A536-84(1999)e1, Specification for Ductile Iron Castings.
- .5 ASTM B62-93, Specification for Composition Bronze or Ounce Metal Castings.

.3 Canadian Standards Association (CSA International).

- .1 CSA B51-03, Boiler, Pressure Vessel, and Pressure Piping Code.

1.3 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures .

.2 Closeout Submittals:

- .1 Submit maintenance data in accordance with Section 01 78 10 - Closeout Submittals .

Part 2 Products

2.1 DIAPHRAGM TYPE EXPANSION TANK

.1 Horizontal, Vertical, galvanized steel, steel, pressurized diaphragm type expansion tank.

.2 Capacity: Refer to schedule.

.3 Size: Refer to schedule.

.4 Diaphragm sealed in EPDM suitable for 115 degrees C operating temperature.

.5 Working pressure: 860 kPa with ASME stamp and certification.

.6 Air precharged to 84 kPa initial fill pressure of system.

.7 Base mount for vertical installation.

.8 Supports: provide supports with hold down bolts and installation templates.

.9 Renewable diaphragm, compatible with liquid

.10 Tanks shall be constructed and stamped in accordance with ASME Boiler and Pressure Vessel Code Section VIII, c/w replaceable heavy-duty (butyl bladder compatible with water and ethylene glycol)(or EPDM bladder compatible with propylene glycol).

.11 Bladder connection to be capable of handling the flow of the corresponding pipe size at 1.83 M/S (6ft/sec) with a maximum pressure drop of 3.45 kPa (0.5 psi).

.12 Piping from the system to the vessel to include a square-head cock and a boiler drain.

.13 In piping adjacent to each tank provide Conbraco 510 Series relief valve c/w packed caps. Relief valves to be ASME Section VIII approved and rated for 10% overpressure. Do not install any valves between relief valve connection and tank..

2.2 AUTOMATIC AIR VENT

.1 Standard float vent: brass body and NPS 1/8 connection and rated at 690 kPa working pressure.

.2 Industrial float vent: cast iron body and NPS 1/2 connection and rated at 1034 kPa working pressure.

.3 Float: solid material suitable for 115 degrees C working temperature.

2.3 AIR PURGER - IN-LINE

.1 Working pressure: 1034 kPa.

.2 Size: NPS 1 1/2 as indicated.

2.4 COMBINATION LOW PRESSURE RELIEF AND REDUCING VALVE

.1 Adjustable pressure setting: 206 kPa relief, 55 to 172 kPa reducing.

.2 Low inlet pressure check valve.

.3 Removable strainer.

2.5 PIPE LINE STRAINER

.1 NPS 1/2 to 2: bronze body to ASTM B62, screwed connections, Y pattern.

.2 NPS 2 1/2 to 12: cast iron body to ASTM, Class 30 flanged connections.

.3 Blowdown connection: NPS 1.

.4 Screen: stainless steel with 1.19 mm perforations.

.5 Working pressure: 860 kPa.

2.6 SUCTION DIFFUSER

.1 Body: cast iron with flanged screwed connections.

.2 Strainer: with built-in, disposable 1.19 mm mesh, low pressure drop screen and NPS blowdown connection.

.3 Permanent magnet particle trap.

.4 Full length straightening vanes.

.5 Pressure gauge tappings.

.6 Adjustable support leg.

Part 3 Execution

3.1 GENERAL

.1 Install as indicated and to manufacturer's recommendations.

.2 Run drain lines and blow off connections to terminate above nearest drain.

.3 Maintain proper clearance to permit service and maintenance.

.4 Should deviations beyond allowable clearances arise, request and follow City’s Representative's or Contract Administrator's directive.

.5 Check shop drawings for conformance of all tappings for ancillaries and for equipment operating weights.

3.2 STRAINERS

.1 Install in horizontal or down flow lines.

.2 Ensure clearance for removal of basket.

.3 Install ahead of each pump.

.4 Install ahead of each automatic control valve except at radiation and as indicated.

3.3 AIR VENTS

.1 Install at high points of systems.

.2 Install gate valve on automatic air vent inlet. Run discharge to nearest drain.

3.4 EXPANSION TANKS

.1 Adjust expansion tank pressure to suit design criteria.

.2 Install lockshield type valve at inlet to tank .

3.5 PRESSURE SAFETY RELIEF VALVES

.1 Run discharge pipe to terminate above nearest drain.

3.6 SUCTION DIFFUSERS

.1 Install on inlet to pumps having suction size greater than 75.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Copper piping valves and fittings for hydronic systems, for hot water heating systems, temperature range 5 degrees C to 120 degrees C and 860 kPa working pressure.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)/American Welding Society (AWS)

.1 ANSI/AWS A5.8/A5.8M-04, Specification Filler Metals for Brazing and Bronze Welding.

.2 American Society of Mechanical Engineers (ASME)

.1 ANSI/ASME B16.4-98, Gray-Iron Threaded Fittings.

.2 ANSI/ASME B16.15-1985(2004), Cast Bronze Threaded Fittings.

.3 ANSI B16.18-2001, Cast Copper Alloy, Solder Joint Pressure Fittings.

.4 ANSI/ASME B16.22-2001, Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.

.3 American Society for Testing and Materials International (ASTM)

.1 ASTM B32-04, Standard Specification for Solder Metal.

.2 ASTM B61-02, Standard Specification for Steam or Valve Bronze Castings.

.3 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.

.4 ASTM B88M-03, Standard Specification for Seamless Copper Water Tube Metric.

.4 Manufacturers Standardization Society (MSS)

.1 MSS SP67-2002a, Butterfly Valves.

.2 MSS SP70-1998, Cast Iron Gate Valves, Flanged and Threaded Ends.

.3 MSS SP71-1997, Grey Iron Swing Check Valves, Flanged and Threaded Ends.

.4 MSS SP80-2003, Bronze Gate, Globe, Angle and Check Valves.

.5 MSS SP85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.2 Shop Drawings:

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Indicate on manufacturers catalogue literature the following: VALVES .

.3 Closeout Submittals:

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Product Requirements.

Part 2 Products

2.1 TUBING

.1 Type M hard drawn copper tubing: to ASTM B88M.

2.2 FITTINGS

.1 Cast bronze threaded fittings: to ANSI/ASME B16.15.

.2 Wrought copper and copper alloy solder joint pressure fittings: to ANSI/ASME B16.22.

.3 Cast iron threaded fittings: to ANSI/ASME B16.4.

.4 Cast copper alloy solder joint pressure fittings: to ANSI B16.18.

2.3 FLANGES

.1 Brass or bronze: threaded.

.2 Cast iron: threaded.

.3 Orifice flanges: slip-on, raised face, 2100 kPa.

2.4 JOINTS

.1 Solder, tin-antimony, 95:5: to ASTM B32.

.2 Silver solder BCUP: to ANSI/AWS A5.8.

.3 Brazing: as indicated.

2.5 VALVES

.1 Connections:

.1 NPS 2 and smaller: ends for soldering.

.2 NPS 2 1/2 and larger: flanged grooved ends.

.2 Gate Valves Application: isolating equipment, control valves:

.1 NPS 2 and under:

.1 Class 125, rising stem wedge disc, as specified Section 23 05 22 - Valves - Bronze .

.2 NPS 2 1/2 and over:

.1 Rising stem, wedge disc, bronze trim, as specified Section 23 05 23 - Valves - Cast Iron.

.3 Butterfly valves: application: isolating each cell or section of multiple component equipment (eg. multi-section coils, multi-cell cooling towers) :

.1 NPS 2 1/2 and over: lug type grooved ends: as specified Section 23 05 17 - Pipe Welding .

.4 Globe valves: application: throttling, flow control, emergency bypass :

.1 NPS 2 and under:

.1 With PFTE disc, as specified Section 23 05 22 - Valves - Bronze .

.2 NPS 2 1/2 and over:

.1 With composition disc, trim, as specified Section 23 05 23 - Valves - Cast Iron .

.5 Drain valves: gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 22 - Valves - Bronze .

.6 Swing check valves:

.1 NPS 2 and under:

.1 Class 125, swing, with composition disc, as specified Section 23 05 22 - Valves - Bronze.

.2 NPS 2 1/2 and over:

.1 Flanged, grooved ends: as specified Section 23 05 23 - Valves - Cast Iron

.7 Silent check valves:

.1 NPS 2 and under:

.1 As specified Section 23 05 22 - Valves - Bronze.

.2 NPS 2 1/2 and over:

.1 Flanged, grooved ends: as specified Section 23 05 23 - Valves - Cast Iron

.8 Ball valves:

.1 NPS 2 and under: as specified Section 23 05 22 - Valves - Bronze.

.9 Lubricated Plug Valves:NPS 2 and under: .

.1 NPS 2 1/2 and over: as specified Section 23 05 23 - Valves - Cast Iron.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 PIPING INSTALLATION

.1 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.

.2 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping where ever practical.

.3 Slope piping in direction of drainage and for positive venting.

.4 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.

.5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.

.6 Assemble piping using fittings manufactured to ANSI standards.

3.3 VALVE INSTALLATION

.1 Install rising stem valves in upright position with stem above horizontal.

.2 Install butterfly valves on chilled water and condenser water lines only.

.3 Install gate, ball or butterfly valves at branch take-offs and to isolate each piece of equipment, and as indicated.

.4 Install globe valves in by-pass around control valves as indicated.

.5 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.

.6 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

.7 Install chain operators on valves NPS 2 1/2 and over where installed more than 2400 mm above floor in Mechanical Equipment Rooms.

.8 Install ball valves for glycol service.

3.4 CIRCUIT BALANCING VALVES

.1 Install flow measuring stations and flow balancing valves as indicated.

.2 Remove handwheel after installation and TAB is complete.

.3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.5 FILLING OF SYSTEM

.1 Refill system with clean water adding water treatment as specified or glycol.

3.6 FIELD QUALITY CONTROL

.1 Balancing:

.1 Balance water systems to within plus or minus 5 % of design output.

.2 Refer to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC, for applicable procedures.

.2 Glycol Charging:

.1 Provide mixing tank and positive displacement pump for glycol charging.

.2 Retest for concentration to ASTM E202 after cleaning.

.3 Provide report to Contract Administrator.

3.7 CLEANING

.1 Proceed in accordance with Section 01 74 00 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes.

.1 Materials and installation for steel piping, valves and fittings for hydronic systems for hot water heating, glycol, condenser and chilled water systems, temperature range 5 degrees C to 120 degrees C and 860 kPa working pressure.

.2 Related Sections.

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 74 00 - Cleaning.

.3 Section 01 78 10 - Closeout Submittals.

.4 Section 21 05 01 - Common Work Results - Mechanical.

.5 Section 23 05 17 - Pipe Welding.

.6 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

.7 Section 23 05 01 - Installation of Pipework.

.8 Section 23 05 22 - Valves - Bronze.

.9 Section 23 05 23 - Valves - Cast Iron.

.10 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME).

.1 ASME B16.1-98, Cast Iron Pipe Flanges and Flanged Fittings.

.2 ASME B16.3-98, Malleable Iron Threaded Fittings.

.3 ASME B16.5-03, Pipe Flanges and Flanged Fittings.

.4 ASME B16.9-01, Factory-Made Wrought Buttwelding Fittings.

.5 ASME B18.2.1-03, Square and Hex Bolts and Screws (Inch Series).

.6 ASME B18.2.2-87(R1999), Square and Hex Nuts (Inch Series).

.2 American Society for Testing and Materials International, (ASTM).

.1 ASTM A47/A47M-99, Standard Specification for Ferritic Malleable Iron Castings.

.2 ASTM A53/A53M-02, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.

.3 ASTM A536-84(1999)e1, Standard Specification for Ductile Iron Castings.

.4 ASTM B61-02, Standard Specification for Steam or Valve Bronze Castings.

.5 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.

.3 Canadian Standards Association (CSA International).

.1 CSA B242-M1980(R1998), Groove and Shoulder Type Mechanical Pipe Couplings.

.2 CAN/CSA W48-01, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).

.4 Manufacturer's Standardization of the Valve and Fittings Industry (MSS).

.1 MSS-SP-67-025, Butterfly Valves.

.2 MSS-SP-70-98, Cast Iron Gate Valves, Flanged and Threaded Ends.

.3 MSS-SP-71-97, Cast Iron Swing Check Valves Flanged and Threaded Ends.

.4 MSS-SP-80-03, Bronze Gate, Globe, Angle and Check Valves.

.5 MSS-SP-85-02, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SUBMITTALS

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Closeout Submittals.

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

Part 2 Products

2.1 PIPE

.1 Steel pipe: to ASTM A53/A53M, Grade B , as follows:

.1 To NPS6: Schedule 40 carbon steel, continuous weld.

.2 NPS8 and over, 10 Schedule 40 carbon-steel, continuous weld.

2.2 PIPE JOINTS

.1 NPS2 and under: screwed fittings with PTFE tape or lead-free pipe dope .

.2 NPS2-1/2 and over: welding fittings and flanges to CAN/CSA W48 .

.3 Roll grooved: standard rigid coupling to CSA B242.

.4 Flanges: plain or raised face.

.5 Orifice flanges: slip-on raised face, 2100 kPa.

.6 Flange gaskets: to AWWA C111 .

.7 Pipe thread: taper.

.8 Bolts and nuts: to ASME B18.2.1 and ASME B18.2.2 .

.9 Roll grooved coupling gaskets: type EPDM .

2.3 FITTINGS

.1 Screwed fittings: malleable iron, to ASME B16.3, Class 150 .

.2 Pipe flanges and flanged fittings:

.1 Cast iron: to ASME B16.1, Class 125 .

.2 Steel: to ASME B16.5.

.3 Butt-welding fittings: steel, to ASME B16.9.

.4 Unions: malleable iron, to ASTM A47/A47M and ASME B16.3 .

.5 Fittings for roll grooved piping: malleable iron to ASTM A47/A47M ductile iron to ASTM A536.

2.4 VALVES

.1 Connections:

.1 NPS2 and smaller: screwed ends.

.2 NPS2.1/2 and larger: Flanged grooved ends.

.2 Gate valves: Application: Isolating equipment, control valves:

.1 NPS2 and under:

.1 Class 125 , rising stem, wedge disc, as specified Section 23 05 22 - Valves - Bronze .

.2 NPS21/2 and over:

.1 Rising stem, wedge disc, bronze trim, as specified Section 23 05 23 - Valves - Cast Iron: Gate, Globe, Check .

.3 Butterfly valves: to MSS-SP-67 Application: Isolating cells or section of multiple component equipment eg. multi-section coils, multi-cell cooling towers:

.1 NPS21/2 and over: Lug type Grooved ends: as specified Section 23 05 17 - Pipe Welding .

.4 Globe valves: Application: Throttling, flow control, emergency bypass :

.1 NPS2 and under:

.1 With PTFE disc, as specified Section 23 05 22 - Valves - Bronze .

.2 NPS21/2 and over:

.1 With composition bronze disc, lead free bronze trim, as specified Section 23 05 23 - Valves - Cast Iron: Gate, Globe, Check .

.5 Balancing, for TAB:

.1 Sizes: Calibrated balancing valves, as specified this section.

.2 NPS2 and under:

.1 Globe, with disc as specified Section 23 05 22 - Valves - Bronze .

.6 Drain valves: Gate, Class 125 , non-rising stem, solid wedge disc, as specified Section 23 05 22 - Valves - Bronze .

.7 Bypass valves on gate glove valves NPS8 and larger: NPS3/4 , Globe, with PTFE disc as specified Section 23 05 22 - Valves - Bronze .

.8 Swing check valves: to MSS-SP-71.

.1 NPS2 and under:

.1 Class 125, swing, with composition disc, as specified Section 23 05 22 - Valves - Bronze .

.2 NPS21/2 and over:

.1 Flanged Grooved ends: as specified Section 23 05 23 - Valves - Cast Iron: Gate, Globe, Check.

.9 Silent check valves:

.1 NPS2 and under:

.1 As specified Section 23 05 22 - Valves - Bronze.

.2 NPS21/2 and over:

.1 Flanged Grooved ends: as specified Section 23 05 23 - Valves - Cast Iron: Gate, Globe, Check.

.10 Ball valves:

.1 NPS2 and under: as specified Section 23 05 22 - Valves - Bronze.

Part 3 Execution

3.1 PIPING INSTALLATION

.1 Install pipework in accordance with Section 23 05 01 - Installation of Pipe Work.

3.2 CIRCUIT BALANCING VALVES

.1 Install flow measuring stations and flow balancing valves as indicated.

.2 Remove handwheel after installation and when TAB is complete.

.3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.3 CLEANING, FLUSHING AND START-UP

.1 In accordance with Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems.

3.4 TESTING

.1 Test system in accordance with Section 23 05 00 - Common Work Results - Mechanical.

3.5 BALANCING

.1 Balance water systems to within plus or minus 5 % of design output.

.2 Refer to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for applicable procedures.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes.

.1 Materials and installation of piping, valves and fittings required for pressure joint piping systems for hydronic systems for hot water heating, glycol, condenser and chilled water systems, temperature range 5 degrees C to 120 degrees C and 860 kPa pressure, ASTM A 53 Sch. 5 pipe, sizes up to NPS2.

.2 Related Sections

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 78 10 - Closeout Submittals.

.3 Section 21 05 01 - Common Work Results - Mechanical.

.4 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

.5 Section 23 05 01 - Installation of Pipework.

.6 Section 23 05 22 - Valves - Bronze.

.7 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

1.2 REFERENCES

.1 American Society for Testing and Materials International, (ASTM).

.1 ASTM A53/A53M-02, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.

.2 ASTM A135-01, Standard Specification for Electric-Resistance-Welded Steel Pipe.

.3 ASTM A795-00, Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.

.4 ASTM B61-02, Standard Specification for Steam or Valve Bronze Castings.

.5 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.

.2 Manufacturer's Standardization of the Valve and Fittings Industry (MSS).

.1 MSS-SP-71-97, Cast Iron Swing Check Valves Flanged and Threaded Ends.

.2 MSS-SP-80-03, Bronze Gate, Globe, Angle and Check Valves.

1.3 SUBMITTALS

.1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit data for following:

.1 Valves.

.2 Couplings, Components.

.3 Closeout Submittals.

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals and include following:

Part 2 Products

2.1 PIPING

.1 Steel pipe: to ASTM A53/A53M, minimum wall thickness 1.45 mm and to supplier installation instructions, acceptable for LP hydronic systems, (complete with CRN numbers) oil applications to working pressure of fittings.

2.2 FITTINGS

.1 Cold drawn steel complete with grade "C" Butylene water and glycol or grade "T" Nitrile (oil service) O-ring.

2.3 GATE VALVES

.1 Rising stem, screwed ends:

.1 To MSS-SP-80 , Class 125, 860 kPa, bronze body, screw-in bonnet, solid wedge disc as specified Section 23 05 22 - Valves - Bronze.

2.4 GLOBE VALVES

.1 To MSS-SP-80 , Class 125, 860 kPa, lead free bronze body, screw-over bonnet, renewable composition disc suitable for service stainless steel disc as specified Section 23 05 22 - Valves - Bronze.

2.5 SWING CHECK VALVES

.1 To MSS-SP-71 80, Class 125, 860 kPa, lead free bronze body, screw-in cap, bronze swing disc, regrindable seat as specified Section 23 05 22 - Valves - Bronze.

2.6 BALL VALVES

.1 To ASTM B62, 4 MPa WOG, lead free bronze body, hard chrome solid ball, TFE seal, PTFE adjustable packing, PTFE seat, lever handle.

2.7 SILENT CHECK VALVES

.1 To ASTM B62 , Class 125, 860 kPa, cast steel, wafer style, lead free brass seat rings, lead free brass inner valve, stainless steel spring heavy duty spring when in vertical down flow applications as specified Section 23 05 22 - Valves - Bronze.

2.8 LUBRICATED PLUG COCKS

.1 To ASTM B61, Class 150, 1 MPa, lead free bronze body.

2.9 CIRCUIT BALANCING VALVES (CBV)

.1 General:

.1 Y style globe valve, designed to provide precise flow measurement and control, with valved ports for connected to differential pressure meter.

.2 Accuracy:

.1 Readout to be within plus or minus 2% of actual flow at design flow rate.

.2 Pressure die-cast dezincification resistant copper alloy Ametal stainless steel construction, 1.7MPa, 121 degrees C, screwed ends, Teflon disc, screw-in bonnet.

.1 Flow control: at least four 4 full turns of handwheel with digital handwheel and tamperproof concealed mechanical memory.

.3 Insulation: use prefabricated shipping packaging of 5.4R polyurethane as insulation see valves thermal insulation.

.4 Drain connection:

.1 NPS3/4 valved and capped, suitable for hose socket.

.2 Incorporated into valve body or provided as separate item.

Part 3 Execution

3.1 PIPING

.1 Install pipework in accordance with Section 23 05 01 - Installation of Pipework, supplemented as specified herein.

.2 Install press joint piping system in accordance with manufacturer's latest recommendations.

.3 Visibly mark both ends of pipe with proper insertion depths prior to assembly and installation.

3.2 VALVES

.1 Install valves as indicated in Section 23 05 22 - Valves - Bronze.

.2 Install calibrated balancing valves for balancing purposes as indicated.

3.3 PRESSURE TESTS

.1 Test system in accordance with Section 23 05 00 - Common Work Results - Mechanical.

.2 Test pressure: test with water to greater of 1 1/2 times maximum system operating pressure or 860 kPa.

3.4 CLEANING AND START UP

.1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

3.5 TESTING AND BALANCING

.1 Balance water systems to within plus or minus 5 % of design output.

.2 Refer to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for applicable procedures and to Section 23 05 00 - Common Work Results - Mechanical.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials, equipment selection, installation and start up for hydronic system pumps.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

1.3 REFERENCES

.1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE).

  .1 Standard 90.1-2001 Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 Electrical Equipment Manufacturers Advisory Council (EEMAC).

.3 Canadian Standards Association (CSA International).

  .1 CAN/CSA-B214-01, Installation Code for Hydronic Heating Systems.

.4 National Electrical Manufacturers Association (NEMA).

  .1 NEMA MG 1-2003, Motors and Generators.

1.4 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.

.3 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.

.4 Submit product data of pump curves for review showing point of operation.

.5 Indicate piping, valves and fittings shipped loose by packaged equipment supplier, showing their final location in field assembly.

.6 Provide maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.5 EXTRA MATERIALS

.1 Provide maintenance materials in accordance with Section 01 78 10 - Closeout Submittals.

.2 Furnish following spare parts:

.1 One set of pump seals, packing for each pump.

Part 2 Products

2.1 EQUIPMENT

.1 Do component selection and sizing to: CAN/CSA-B214.

2.2 IN-LINE CIRCULATORS

.1 Volute: cast iron radially split, with screwed or flanged design suction and discharge connections.

.2 Impeller: cast bronze.

.3 Shaft: alloy steel with bronze sleeve bearing, integral thrust collar.

.4 Seal assembly: mechanical for service to 135 degrees C.

.5 Coupling: rigid self-aligning.

.6 Motor: resilient mounted, drip proof, TEFC, sleeve bearing.

.7 Refer to schedule.

2.3 VERTICAL IN-LINE CIRCULATORS

.1 Volute: cast iron radially split, with tapped openings for venting, draining and gauge connections, with screwed or flanged suction and discharge connections.

.2 Impeller: cast iron or bronze.

.3 Shaft: alloy steel with bronze sleeve bearing, integral thrust collar.

.4 Seal assembly: mechanical for service to 135 degrees C.

.5 Coupling: rigid self-aligning.

.6 Motor: resilient mounted, drip proof, sleeve bearing, TEFL.

.7 Refer to schedule.

Part 3 Execution

3.1 INSTALLATION

.1 Do Work in accordance with CAN/CSA-B214.

.2 In line circulators: install as indicated by flow arrows. Support at inlet and outlet flanges or unions. Install with bearing lubrication points accessible.

.3 Ensure that pump body does not support piping or equipment. Provide stanchions or hangers for this purpose. Refer to manufacturer's installation instructions for details.

.4 Pipe drain tapping to floor drain.

.5 Install volute venting pet cock in accessible location.

.6 Check rotation prior to start-up.

.7 Install pressure gauge test cocks.

3.2 START-UP

.1 General

.1 In accordance with manufacturer's recommendations.

.2 Procedures:

.1 Before starting pump, check that cooling water system over-temperature and other protective devices are installed and operative.
.2 After starting pump, check for proper, safe operation.
.3 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.
.4 Check base for free-floating, no obstructions under base.
.5 Run-in pumps for 12 continuous hours.
.6 Verify operation of over-temperature and other protective devices under low- and no-flow condition.
.7 Eliminate air from scroll casing.
.8 Adjust water flow rate through water-cooled bearings.
.9 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.
.10 Adjust alignment of piping and conduit to ensure true flexibility at all times.
.11 Eliminate cavitation, flashing and air entrainment.
.12 Adjust pump shaft seals, stuffing boxes, glands.
.13 Measure pressure drop across strainer when clean and with flow rates as finally set.
.14 Replace seals if pump used to degrease system or if pump used for temporary heat.
.15 Verify lubricating oil levels.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

  .1 Materials and installation for copper tubing and fittings for refrigerant.

.2 Related Sections:

  .1 Section 01 33 00 - Submittal Procedures.
  .2 Section 01 78 00 - Closeout Submittals.
  .3 Section 23 05 01 - Installation of Pipework.

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME)

  .1 ASME B16.22-01, Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.
  .2 ASME B16.24-02, Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 400, 600, 900, 1500 and 2500.
  .3 ASME B16.26-88, Cast Copper Alloy Fittings for Flared Copper Tubes.
  .4 ASME B31.5-01, Refrigeration Piping and Heat Transfer Components.

.2 American Society for Testing and Materials International (ASTM)

  .1 ASTM A307-04, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  .2 ASTM B280-03, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

.3 Canadian Standards Association (CSA International)

  .1 CSA B52-99, Mechanical Refrigeration Code.

.4 Environment Canada (EC)

  .1 EPS 1/RA/1-96, Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

1.3 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Instructions: submit manufacturer's installation instructions.

.3 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

Part 2 Products

2.1 TUBING

.1 Processed for refrigeration installations, deoxidized, dehydrated and sealed.

- .1 Hard copper: to ASTM B280, type ACR B.
- .2 Annealed copper: to ASTM B280, with minimum wall thickness as per CSA B52 and ASME B31.5.

2.2 FITTINGS

.1 Service: design pressure 2070 kPa and temperature 121 degrees C.

.2 Brazed:

- .1 Fittings: wrought copper to ASME B16.22.
- .2 Joints: silver solder, 15% Ag-80% Cu-5%P and non-corrosive flux.

.3 Flanged:

- .1 Bronze or brass, to ASME B16.24, Class 150 and Class 300.
- .2 Gaskets: suitable for service.
- .3 Bolts, nuts and washers: to ASTM A307, heavy series.

.4 Flared:

- .1 Bronze or brass, for refrigeration, to ASME B16.26.

2.3 PIPE SLEEVES

.1 Hard copper or steel, sized to provide 6 mm clearance around between sleeve and uninsulated pipe or between sleeve and insulation.

2.4 VALVES

.1 22 mm and under: Class 500, 3.5 Mpa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moisture proof seal for below freezing applications, brazed connections.

.2 Over 22 mm: Class 375, 2.5 Mpa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and bonnet, moisture proof seal for below freezing applications, brazed connections.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 GENERAL

.1 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5 Section 23 05 01 - Installation of Pipework.

3.3 BRAZING PROCEDURES

.1 Bleed inert gas into pipe during brazing.

.2 Remove valve internal parts, solenoid valve coils, sight glass.

.3 Do not apply heat near expansion valve and bulb.

3.4 PIPING INSTALLATION

.1 General:

.1 Soft annealed copper tubing: bend without crimping or constriction Hard drawn copper tubing: do not bend. Minimize use of fittings.

3.5 PRESSURE AND LEAK TESTING

.1 Close valves on factory charged equipment and other equipment not designed for test pressures.

.2 Leak test to CSA B52 before evacuation to 2MPa and 1MPa on high and low sides respectively.

.3 Test Procedure: build pressure up to 35 kPa with refrigerant gas on high and low sides. Supplement with nitrogen to required test pressure. Test for leaks with electronic or halide detector. Repair leaks and repeat tests.

3.6 DEMONSTRATION

.1 Instructions:

.1 Post instructions in frame with glass cover in accordance with Section 01 78 10 - Closeout Submittals and CSA B52.

3.7 CLEANING

.1 Perform cleaning operations as specified in Section 01 74 00 and in accordance with manufacturer's recommendations.

.2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials, components, equipment and chemicals for installation of complete HVAC water treatment system.

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME)

1.3 SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures . Include product characteristics, performance criteria, and limitations.

.2 Shop Drawings:

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures .

.3 Closeout Submittals:

.1 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals .

.2 Include following:

.1 Log sheets as recommended by manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Product Requirements .

Part 2 Products

2.1 MANUFACTURER

.1 Equipment, chemicals, service provided by one supplier.

2.2 POT FEEDER

.1 Welded steel, pressure rating 1200 kPa. Temperature rating: 90 degrees C.

2.3 CHEMICAL FEED PIPING

.1 Resistant to chemicals employed. Pressure rating: 1200 kPa.

2.4 CHEMICAL FEED PUMPS

.1 Top-mounted electronic metering diaphragm type: flow range 0-100%, adjustable, plus or minus 1.0% accuracy (repetitive), on-off operation, with pressure relief valve, check valve, foot valve, injection fitting.

2.5 SHIPPING/FEEDING CHEMICAL CONTAINERS

.1 High density moulded polyethylene, with liquid level graduations, cover.

2.6 CONDUCTIVITY CONTROLLER

.1 Fully transistorized, suitable for wall or flush panel mounting, linear over full measuring range of 0-5000 microhms.

.2 Insensitive to phase angle shifts, capable of operating on 95-130 Volts without affecting accuracy, power, bleedoff status lights.

2.7 CONDUCTIVITY PROBES

.1 Dual carbon elements in PVC holder, quick disconnect, self-locking connection.

2.8 WATER TREATMENT FOR HYDRONIC SYSTEMS

.1 Hot water heating system: pot feeder, 25 or 19 L as required per system size x3, operating pressure 1200 kPa.

.2 Micron filter for each pot feeder:

- .1 Capacity 2% of pump recirculating rate at operating pressure.
- .2 Six (6) sets of filter cartridges for each type, size of micron filter.

2.9 CHEMICALS

.1 Provide 1-year supply.

.2 Obtain chemicals from manufacturer.

2.10 TEST EQUIPMENT

.1 Provide one set of test equipment for each system to verify performance.

.2 Complete with carrying case, reagents for chemicals, specialized or supplementary equipment.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Install HVAC water treatment systems in accordance with ASME Boiler Code Section VII, and requirements and standards of authorities having jurisdiction, except where specified otherwise.

.2 Ensure adequate clearances to permit performance of servicing and maintenance of equipment.

3.3 CHEMICAL FEED PIPING

.1 Install crosses at changes in direction. Install plugs in unused connections.

3.4 CLEANING OF MECHANICAL SYSTEM

.1 Provide copy of recommended cleaning procedures and chemicals for approval by Contract Administrator.

.2 Flush mechanical systems and equipment with approved cleaning chemicals designed to remove deposition from construction such as pipe dope, oils, loose mill scale and other extraneous materials. Use chemicals to inhibit corrosion of various system materials that are safe to handle and use.

.3 Examine and clean filters and screens, periodically during circulation of cleaning solution, and monitor changes in pressure drop across equipment.

.4 Drain and flush systems until alkalinity of rinse water is equal to make-up water. Refill with clean water treated to prevent scale and corrosion during system operation.

.5 Disposal of cleaning solutions approved by authority having jurisdiction.

3.5 WATER TREATMENT SERVICES

.1 Provide water treatment monitoring and consulting services for period of one year after system start-up. Service to include:

.1 Initial water analysis and treatment recommendations.
.2 System start-up assistance.
.3 Operating staff training.
.4 Visit plant during period of operation and as required until system stabilizes, and advise on treatment system performance.
.5 Provide necessary recording charts and log sheets for one year operation.
.6 Provide necessary laboratory and technical assistance.
.7 Provide clear, concise, written instructions and advice to operating staff.

3.6 FIELD QUALITY CONTROL

.1 Start-up:

.1 Start up water treatment systems in accordance with manufacturer's instructions.

.2 Commissioning:

.1 Commissioning Agency: to be water holder of service contract.

.2 Timing:

 .1 After start-up deficiencies rectified.

 .2 After start-up and before TAB of connected systems.

.3 Pre-commissioning Inspections: verify:

 .1 Presence of test equipment, reagents, chemicals, details of specific tests performed, and operating instructions.

 .2 Suitability of log book.

 .3 Currency and accuracy of initial water analysis.

 .4 Required quality of treated water.

.4 Commissioning procedures - applicable to Water Treatment Systems:

 .1 Establish, adjust as necessary and record automatic controls and chemical feed rates.

 .2 Monitor performance continuously during commissioning of connected systems and until acceptance of project.

 .3 Establish test intervals, regeneration intervals.

 .4 Record on approved report forms commissioning procedures, test procedures, dates, times, quantities of chemicals added, raw water analysis, treated water analysis, test results, instrument readings, adjustments made, results obtained.

 .5 Establish, monitor and adjust automatic controls and chemical feed rates as necessary.

 .6 Visit project at specified intervals after commissioning is satisfactorily completed to verify that performance remains as set during commissioning (more often as required until system stabilizes at required level of performance).

 .7 Advise Contract Administrator in writing on matters regarding installed water treatment systems.

.5 Commissioning procedures - Closed Circuit Hydronic Systems:

 .1 Analyze water in system.

 .2 Based upon an assumed rate of loss approved by Contract Administrator , establish rate of chemical feed.

 .3 Record types, quantities of chemicals applied.

.6 Training:

 .1 Commission systems, perform tests in presence of, and using assistance of, assigned O&M personnel.

.7 Certificates:

 .1 Upon completion, furnish certificates confirming satisfactory installation and performance.

.8 Commissioning Reports:

 .1 To include system schematics, test results, test certificates, raw and treated water analyses, design criteria, other data required by Contract Administrator.

.9 Commissioning activities during Warranty Period:

.1 Check out water treatment systems on regular basis and submit written report to City's Representative.

3.7 CLEANING

.1 Proceed in accordance with Section 01 74 00 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and installation of low-pressure metallic ductwork, joints and accessories.

.2 Related Sections:

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 07 84 00 - Firestopping.

.3 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

.4 Section 23 05 94 - Pressure Testing of Ducted Air Systems.

.5 Section 23 44 00 - HVAC Air Filtration.

1.2 REFERENCES

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).

.2 American Society for Testing and Materials International, (ASTM).

.1 ASTM A480/A480M-03c, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.

.2 ASTM A635/A635M-02, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.

.3 ASTM A653/A653M-03, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

.3 National Fire Protection Association (NFPA).

.1 NFPA 90A-02, Standard for the Installation of Air-Conditioning and Ventilating Systems.

.2 NFPA 96-01, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

.4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

.1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2nd Edition 1995 and Addendum No. 1, 1997.

.2 SMACNA HVAC Air Duct Leakage Test Manual, 1985, 1st Edition.

.3 IAQ Guideline for Occupied Buildings Under Construction 1995, 1st Edition.

1.3 SUBMITTALS

.1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures .

1.4 DELIVERY, STORAGE AND HANDLING

.1 Protect on site stored or installed absorptive material from moisture damage.

Part 2 Products

2.1 SEAL CLASSIFICATION

.1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	C
250	C
125	C
125	Unsealed

.2 Seal classification:

- .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
- .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant.
- .3 Class C: transverse joints and connections made air tight with gaskets sealant. Longitudinal seams unsealed.
- .4 Unsealed seams and joints.

2.2 SEALANT

.1 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

2.3 TAPE

.1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.

2.4 DUCT LEAKAGE

.1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual.

2.5 FITTINGS

.1 Fabrication: to SMACNA .

.2 Radiused elbows.

- .1 Rectangular: standard radius short radius with single thickness turning vanes Centreline radius: 1.5 times width of duct.
- .2 Round: smooth radius five piece. Centreline radius: 1.5 times diameter.

.3 Mitred elbows, rectangular:

- .1 To 400 mm: with single thickness turning vanes.
- .2 Over 400 mm: with double thickness turning vanes.

.4 Branches:

.1 Rectangular main and branch: with radius on branch 1.5 times width of duct 45 degrees entry on branch.

.2 Round main and branch: enter main duct at 45 degrees with conical connection.

.3 Provide volume control damper in branch duct near connection to main duct.

.4 Main duct branches: with splitter damper.

.5 Transitions:

.1 Diverging: 20 degrees maximum included angle.

.2 Converging: 30 degrees maximum included angle.

.6 Offsets:

.1 Full short radiused elbows as indicated.

.7 Obstruction deflectors: maintain full cross-sectional area.

.1 Maximum included angles: as for transitions.

2.6 FIRE STOPPING

.1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 - Firestopping.

.2 Fire stopping material and installation must not distort duct.

2.7 GALVANIZED STEEL

.1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.

.2 Thickness, fabrication and reinforcement: to SMACNA.

.3 Joints: to SMACNA.

2.8 STAINLESS STEEL

.1 To ASTM A480/A480M, Type 304.

.2 Finish: No. 4.

.3 Thickness, fabrication and reinforcement: to SMACNA.

.4 Joints: to SMACNA.

2.9 ALUMINUM

.1 To ASHRAE and SMACNA. Aluminum type: 3003-H-14.

.2 Thickness, fabrication and reinforcement: to ASHRAE SMACNA as indicated.

.3 Joints: to ASHRAE SMACNA be continuous weld.

2.10 BLACK STEEL

.1 To ASTM A635/A635M.

.2 Thickness: 1.2 mm or as indicated.

.3 Fabrication: ducts and fittings to ASHRAE SMACNA.

.4 Reinforcement: as indicated.

.5 Joints: continuous weld.

2.11 KITCHEN EXHAUST SYSTEMS

.1 Construct in accordance with NFPA 96.

.2 Material: Type 304 stainless steel (exposed to view),black galvanized steel 3003-H-14 aluminum sheet.

.3 Thickness: 1.58 mm.

.4 Fabrication: as indicated .

2.12 HANGERS AND SUPPORTS

.1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment .

- .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct .
  - .1 Maximum size duct supported by strap hanger: 500 .
- .2 Hanger configuration: to ASHRAE and SMACNA.
- .3 Hangers: black galvanized steel angle with black galvanized steel rods to ASHRAE and SMACNA following table :

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

- .4 Upper hanger attachments:
  - .1 For concrete: manufactured concrete inserts.
  - .2 For steel joist: manufactured joist clamp.
  - .3 For steel beams: manufactured beam clamps:

Part 3 Execution

3.1 GENERAL

.1 Do work in accordance with NFPA 90A NFPA 90B ASHRAE, SMACNA.

.2 Do not break continuity of insulation vapour barrier with hangers or rods.

 .1 Insulate strap hangers 100 mm beyond insulated duct Ensure diffuser is fully seated .

.3 Support risers in accordance with SMACNA as indicated .

.4 Install breakaway joints in ductwork on sides of fire separation.

.5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions .

.6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining .

3.2 HANGERS

.1 Strap hangers: install in accordance with SMACNA .

.2 Angle hangers: complete with locking nuts and washers.

.3 Hanger spacing: in accordance with SMACNA and as follows:

Duct Size (mm)	Spacing (mm)
to 1500	3000
1501 and over	2500

3.3 WATERTIGHT DUCT

.1 Provide watertight duct for:

 .1 Dishwasher exhaust.
 .2 Fresh air intake.
 .3 Minimum 3000 mm from duct mounted humidifier in all directions.

.2 Form bottom of horizontal duct without longitudinal seams.

 .1 Solder joints of bottom and side sheets.
 .2 Seal other joints with duct sealer.

.3 Slope horizontal branch ductwork down towards hoods served.

 .1 Slope header ducts down toward risers.

.4 Fit base of riser with 150 mm deep drain sump and 32 mm drain connected, with deep seal trap and discharging to open funnel drain or as indicated.

3.4 SEALING AND TAPING

.1 Apply sealant to outside of joint to manufacturer's recommendations.

.2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturers recommendations.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

  .1 Materials and performance criteria for sound attenuation for mechanical systems.

1.2 REFERENCES

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

.2 American Society for Testing and Materials International (ASTM)

  .1 ASTM A653/A653M-05, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

  .2 ASTM C423-02a, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.

  .3 ASTM E90-04, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

  .4 ASTM E477-99, Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.

.3 National Building Code (NBC)-2005

.4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

1.3 SUBMITTALS

.1 Product Data:

  .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures . Include product characteristics, performance criteria, and limitations.

.2 Shop Drawings:

  .1 Provide separate shop drawings for each piece of attenuation equipment system shop drawings complete with product data.

1.4 PERFORMANCE REQUIREMENTS

.1 Rating Data:

  .1 Provide performance rating data, certified by professional engineer or accredited test laboratory and supported by calculations and verified by test results in accordance with referenced standards as follows:

    .1 Silencer: insertion loss, pressure drop at design conditions, generated noise level.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00 - Product Requirements .

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

Part 2 Products

2.1 ABSORPTION AND INSULATING MEDIA

.1 Acoustic quality, glass fibre, bacteria and fungus resistant; free of corrosion causing or accelerating agents; packed to density to meet performance requirements; and meet NBC fire requirements or requirements of authority having jurisdiction for duct lining.

2.2 SILENCERS

.1 Factory manufactured of prime coated or galvanized steel, compatible with ductwork specified elsewhere and to ASHRAE and SMACNA standards.

.2 Outer casing and galvanized steel inner casing with clean cut circular perforations to enclose acoustic media. Inner casing to have half-splitters pods running full length of silencer where any cross sectional dimension exceeds 450 mm. Protect media from erosion with glass fibre cloth Tedlar Mylar between media and perforated metal.

.3 Performance: Refer to schedule.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Noise flanking: where indicated, install in wall sleeve with uniform clearance around to ensure no contact of silencer with wall sleeve. Pack with flexible, non hardening caulking on both sides of sleeves.

.2 Instrument test ports: install at inlet and outlet to permit measurement of insertion loss and pressure loss.

.3 Suspension: to manufacturer's instructions.

3.3 CLEANING

.1 Proceed in accordance with Section 01 74 00 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and installation for duct accessories including flexible connections, access doors, vanes and collars.

.2 Related Sections:

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 78 10 - Closeout Submittals.

1.2 REFERENCES

.1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

.1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 95.

1.3 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and data sheet. Indicate the following:

.1 Flexible connections.

.2 Duct access doors.

.3 Turning vanes.

.4 Instrument test ports.

.3 Instructions: submit manufacturer's installation instructions.

.4 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals .

Part 2 Products

2.1 GENERAL

.1 Manufacture in accordance with SMACNA - HVAC Duct Construction Standards.

2.2 FLEXIBLE CONNECTIONS

.1 Frame: galvanized sheet metal frame mm thick with fabric clenched by means of double locked seams.

.2 Material:

.1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of 1.3 kg/m^2.

2.3 ACCESS DOORS IN DUCTS

.1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.

.2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.

.3 Gaskets: neoprene.

.4 Hardware:

.1 Up to 300 x 300 mm: two sash locks.
.2 301 to 450 mm: four sash locks.
.3 451 to 1000 mm: piano hinge and minimum two sash locks.
.4 Doors over 1000 mm: piano hinge and two handles operable from both sides.
.5 Hold open devices.

2.4 TURNING VANES

.1 Factory or shop fabricated single thickness double thickness with trailing edge , to recommendations of SMACNA and as indicated.

2.5 INSTRUMENT TEST

.1 1.6 mm thick steel zinc plated after manufacture.

.2 Cam lock handles with neoprene expansion plug and handle chain.

.3 28 mm minimum inside diameter. Length to suit insulation thickness.

.4 Neoprene mounting gasket.

2.6 SPIN-IN COLLARS

.1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.

.2 Sheet metal thickness to co-responding round duct standards.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheet.

3.2 INSTALLATION

.1 Flexible Connections:

.1 Install in following locations:
.1 Inlets and outlets to supply air units and fans.
.2 Inlets and outlets of exhaust and return air fans.
.3 As indicated.
.2 Length of connection: 100 mm.
.3 Minimum distance between metal parts when system in operation: 75 mm.
.4 Install in accordance with recommendations of SMACNA.
.5 When fan is running:
.1 Ducting on sides of flexible connection to be in alignment.
.2 Ensure slack material in flexible connection.

.2 Access Doors and Viewing Panels:

.1 Size:
.1 600 x 600 mm for person size entry.
.2 600 x 600 mm for servicing entry.
.3 300 x 300 mm for viewing.
.4 As indicated.
.5 Keep doors out of residents rooms.
.2 Locations:
.1 Fire and smoke dampers.
.2 Control dampers.
.3 Devices requiring maintenance.
.4 Required by code.
.5 Reheat coils.
.6 Manual dampers and elsewhere as indicated.
.7 Variable air volume valves.

.3 Instrument Test Ports:

.1 General:
.1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
.2 Locate to permit easy manipulation of instruments.
.3 Install insulation port extensions as required.
.4 Locations:
.1 For traverse readings:
.1 Ducted inlets to roof and wall exhausters.
.2 Inlets and outlets of other fan systems.
.3 Main and sub-main ducts.
.4 And as indicated.
.2 For temperature readings:

.1 At outside air intakes.

.2 In mixed air applications in locations as approved by Contract Administrator .

.3 At inlet and outlet of coils.

.4 Downstream of junctions of two converging air streams of different temperatures.

.5 And as indicated.

.4 Turning vanes:

.1 Install in accordance with recommendations of SMACNA and as indicated.

3.3 CLEANING

.1 Perform cleaning operations as specified in Section 01 74 00 and in accordance with manufacturer's recommendations.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Balancing dampers for mechanical forced air ventilation and air conditioning systems.

1.2 REFERENCES

.1 Sheet Metal and Air Conditioning National Association (SMACNA)

.1 SMACNA HVAC Duct Construction Standards, Metal and Flexible-1985.

1.3 SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00 - Product Requirements.

Part 2 Products

2.1 GENERAL

.1 Manufacture to SMACNA standards.

2.2 SINGLE BLADE DAMPERS

.1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.

.2 Size and configuration to recommendations of SMACNA, except maximum height 100 mm.

.3 Locking quadrant with shaft extension to accommodate insulation thickness .

.4 Inside and outside nylon end bearings.

.5 Channel frame of same material as adjacent duct, complete with angle stop.

2.3 MULTI-BLADED DAMPERS

.1 Factory manufactured of material compatible with duct.

.2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.

.3 Maximum blade height: 100 mm.

.4 Bearings: pin in bronze bushings self-lubricating nylon.

.5 Linkage: shaft extension with locking quadrant.

.6 Channel frame of same material as adjacent duct, complete with angle stop.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Install where indicated.

.2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.

.3 Locate balancing dampers in each branch duct, for supply, return and exhaust systems. Keep dampers out of residence rooms.

.4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ductwork take offs. Keep dampers out of residence rooms.

.5 Dampers: vibration free.

.6 Ensure damper operators are observable and accessible. Keep dampers out of residence rooms.

.7 Corrections and adjustments conducted by Contract Administrator.

3.3 FIELD QUALITY CONTROL

.1 Tests:

.1 Tests to demonstrate that system is functioning as specified.

3.4 CLEANING

.1 Proceed in accordance with Section 01 74 00 - Cleaning .

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Operating dampers for mechanical forced air ventilation and air conditioning systems.

1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM)

.1 ASTM A653/A653M-04a, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.

1.3 SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures . Include product characteristics, performance criteria, and limitations.

.2 Closeout Submittals

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals .

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00 - Product Requirements .

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

Part 2 Products

2.1 MULTI-LEAF DAMPERS

.1 Opposed parallel blade type as indicated.

.2 Structurally formed steel Extruded aluminum, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, structurally formed and welded galvanized steel extruded aluminum frame.

.3 Pressure fit self-lubricated bronze bearings.

.4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.

.5 Performance:

.1 Leakage: in closed position less than 2% of rated air flow at 1000 Pa differential across damper.

.2 Pressure drop: at full open position less than Pa differential across damper at m/s.

.6 Insulated aluminum dampers:

.1 Frames: insulated with extruded polystyrene foam with RSI 0.88.

.2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, RSI 0.88.

2.2 BACK DRAFT DAMPERS

.1 Automatic gravity operated, multi single leaf, aluminum steel construction with nylon bearings, centre pivoted spring assisted or counterweighted, as indicated.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Install where indicated.

.2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.

.3 Seal multiple damper modules with silicon sealant.

.4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories .

.5 Ensure dampers are observable and accessible.

3.3 CLEANING

.1 Proceed in accordance with Section 01 74 00 - Cleaning .

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Fire and smoke dampers.

1.2 REFERENCES

.1 American National Standards Institute/National Fire Protection Association (ANSI/NFPA)

.1 ANSI/NFPA 90A-2002, Standard for the Installation of Air Conditioning and Ventilating Systems.

.2 Underwriters Laboratories of Canada (ULC)

.1 CAN4-S112-M1990, Fire Test of Fire Damper Assemblies.

.2 CAN4-S112.2-M84, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.

.3 ULC-S505-1974, Fusible Links for Fire Protection Service.

1.3 SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures . Include product characteristics, performance criteria, and limitations.

.2 Indicate the following:

.1 Fire dampers.

.2 Smoke dampers.

.3 Operators.

.4 Fusible links.

.5 Design details of break-away joints.

.2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.3 Closeout Submittals:

.1 Provide maintenance data for incorporation into manual specified in Section01 78 10 - Closeout Submittals .

1.4 MAINTENANCE

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 10 - Closeout Submittals .

.2 Provide following:

.1 6 fusible links of each type.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00 - Product Requirements .

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

Part 2 Products

2.1 FIRE DAMPERS

.1 Fire dampers: arrangement Type A B C, listed and bear label of ULC UL, meet requirements of provincial fire authority and ANSI/NFPA 90A authorities having jurisdiction. Fire damper assemblies fire tested in accordance with CAN4-S112.

.2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.

.1 Fire dampers: 1-1/2 hour fire rated unless otherwise indicated.

.2 Fire dampers: automatic operating type and have dynamic rating suitable for maximum air velocity and pressure differential to which it will be subjected.

.3 Top hinged: offset single damper , round or square; multi-blade hinged or interlocking type; roll door type; guillotine type; sized to maintain full duct cross section as indicated .

.4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.

.5 40 x 40 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.

.6 Equip fire dampers with steel sleeve or frame installed disruption ductwork or impair damper operation.

.7 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.

.8 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.

.9 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition of floor slab depth or thickness.

.10 Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Install in accordance with ANSI/NFPA 90A and in accordance with conditions of ULC listing.

.2 Maintain integrity of fire separation.

.3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.

.4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories or assure access door provided on fire/smoke damper is accessible. Review at shop drawing stage.

.5 Co-ordinate with installer of firestopping.

.6 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.

.7 Install break-away joints of approved design on each side of fire separation.

3.3 CLEANING

.1 Proceed in accordance with Section 01 74 00 - Cleaning .

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and installation of flexible ductwork, joints and accessories.

.2 Related Sections:

.1 Section 01 33 00 - Submittal Procedures.

1.2 REFERENCES

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).

.2 National Fire Protection Association (NFPA).

.1 NFPA 90A-02, Standard for the Installation of Air-Conditioning and Ventilating Systems.

.2 NFPA 90B-02, Standard for Installation of Warm Air Heating and Air-Conditioning Systems.

.3 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA).

.1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 95 (Addendum No.1, November 1997).

.2 SMACNA IAQ Guideline for Occupied Buildings under Construction, 1st Edition 1995.

.4 Underwriters' Laboratories Inc. (UL).

.1 UL 181-96, Standard for Factory-Made Air Ducts and Air Connectors.

.5 Underwriters' Laboratories of Canada (ULC).

.1 CAN/ULC-S110-1986(R2001), Fire Tests for Air Ducts.

1.3 SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures .

.2 Samples: submit samples with product data of different types of flexible duct being used in accordance with Section 01 33 00 - Submittal Procedures .

1.4 DELIVERY, STORAGE AND HANDLING

.1 Protect on site stored or installed absorptive material from moisture damage.

Part 2 Products

2.1 GENERAL

.1 Factory fabricated to CAN/ULC-S110.

.2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.

.3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

2.2 NON-METALLIC - UNINSULATED

.1 Type 3 : non-collapsible, coated mineral base fabric type, mechanically bonded to, and helically supported by, external steel wire, as indicated.

.2 Performance:

.1 Factory tested to 2.5 kPa without leakage.

.2 Maximum relative pressure drop coefficient: 3.

2.3 NON-METALLIC - INSULATED

.1 Type 4 : non-collapsible, coated mineral base fabric type mechanically bonded to, and helically supported by, external steel wire with factory applied, 37 mm thick flexible mineral fibre thermal insulation with vapour barrier and vinyl jacket, as indicated.

.2 Performance:

.1 Factory tested to 2.5 kPa without leakage.

.2 Maximum relative pressure drop coefficient: 3.

.3 Thermal loss/gain: W/m^2. degrees C mean.

Part 3 Execution

3.1 DUCT INSTALLATION

.1 Install in accordance with: CAN/ULC-S110 UL-181 NFPA 90A NFPA 90B SMACNA .

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation for acoustic duct lining.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

1.3 REFERENCES

.1 American Society for Testing and Materials International, (ASTM).

- .1 ASTM C423-02a, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
- .2 ASTM C916-85(2001)e1, Standard Specification for Adhesives for Duct Thermal Insulation.
- .3 ASTM C1071-00, Standard specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- .4 ASTM C1338-00, Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
- .5 ASTM G21-96(2002), Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

.2 National Fire Protection Association (NFPA).

- .1 NFPA 90A-02, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .2 NFPA 90B-02, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

.3 North American Insulation Manufacturers Association (NAIMA).

- .1 NAIMA AH116-5th Edition, Fibrous Glass Duct Construction Standards.

.4 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA).

- .1 SMACNA, HVAC DCS, HVAC, Duct Construction Standards, Metal and Flexible-95 (Addendum No.1, Nov. 97).
- .2 SMACNA IAQ Guideline for Occupied Buildings 95.

.5 Underwriter's Laboratories of Canada (ULC).

- .1 CAN/ULC-S102-03-EN, Methods of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.4 SUBMITTALS

.1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures .

1.5 DELIVERY, STORAGE AND HANDLING

.1 Protect on site stored or installed absorptive material from moisture damage.

Part 2 Products

2.1 DUCT LINER

.1 Mineral Fibre duct liner: air surface coated mat facing.

.2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102 and NFPA 90A NFPA 90B.

.3 Recycled Content: EcoLogo certified with minimum 35 % by weight recycled content.

.4 Fungi resistance: to ASTM C1338 ASTM G21.

.2 Rigid:

.1 Use on flat surfaces where indicated.

.2 25 mm thick, to ASTM C1071 , Type 2 , fibrous glass rigid board duct liner.

.3 Density: 48 kg/m^3minimum.

.4 Thermal resistance to be minimum 0.76 (m^2. degrees C)/W for 25 mm thickness 1.15 (m^2.degrees C)/W for 38 mm thickness 1.53 (m^2.degrees C)/W for 50 mm thickness when tested in accordance with ASTM C177, at 24 degrees C mean temperature.

.5 Maximum velocity on faced air side: 20.3 m/sec.

.6 Minimum NRC of 0.70 at 25 mm thickness based on Type A mounting to ASTM C423.

.7 Recycled Content: EcoLogo certified containing minimum 45 % by weight recycled content.

.3 Flexible:

.1 Use on round or oval surfaces surfaces indicated .

.2 25 mm thick, to ASTM C1071 Type 1 , fibrous glass blanket duct liner.

.3 Density: 24 kg/m^3 minimum.

.4 Thermal resistance to be minimum 0.37 (m^2.degrees C)/W for 12 mm thickness 0.74 (m^2.degrees C)/W for 25 mm thickness 1.11 (m^2.degrees C)/W for 38 mm thickness 1.41 (m^2.degrees C)/W to 50 mm thickness when tested in accordance with ASTM C177 , at 24 degrees C mean temperature.

.5 Maximum velocity on coated air side: 25.4 30.5 m/sec.

.6 Minimum NRC of 0.65 at 25 mm thickness based on Type A mounting to ASTM C423.

2.2 ADHESIVE

.1 Adhesive: to NFPA 90A and NFPA 90B ASTM C916.

.2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 29 degreesC to plus 93 degreesC.

.3 Water-based fire retardant type.

2.3 FASTENERS

.1 Weld pins 2.0 mm diameter, length to suit thickness of insulation. Polymer Nylon Metal retaining clips, 32 mm square.

2.4 JOINT TAPE

.1 Poly-Vinyl treated open weave fiberglass membrane 50 mm wide.

2.5 SEALER

.1 Meet requirements of NFPA 90A and NFPA 90B.

.2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 68 degrees C to plus 93 degrees C.

Part 3 Execution

3.1 GENERAL

.1 Do work in accordance with SMACNA except as specified otherwise.

.2 Line inside of ducts where indicated.

.3 Duct dimensions, as indicated, are clear inside duct lining.

3.2 DUCT LINER

.1 Install in accordance with manufacturer's recommendations, and as follows:

- .1 Fasten to interior sheet metal surface with 90-100 % coverage of adhesive to ASTM C916
  - .1 Exposed leading edges and transverse joints to be factory coated or coated with adhesive during fabrication.
- .2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425 mm on centres impact driven mechanical fasteners to compress duct liner sufficiently to hold it firmly in place.
  - .1 Spacing of mechanical fasteners in accordance with SMACNA. In systems, where air velocities exceeds 20.3 m/sec, install galvanized sheet metal noising to leading edges of duct liner.

3.3 JOINTS

.1 Seal butt joints, exposed edges, weld pin and clip penetrations and damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer's written recommendations, and as follows:

- .1 Bed tape in sealer.
- .2 Apply two coats of sealer over tape.

.2 Replace damaged areas of liner at discretion of Contract Administrator.

.3 Protect leading and trailing edges of duct sections with sheet metal nosing having 15 mm overlap and fastened to duct.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Fans, motors, accessories and hardware for commercial use.

1.2 REFERENCES

.1 Air Conditioning and Mechanical Contractors (AMCA)

.1 AMCA Publication 99-2003, Standards Handbook.

.2 AMCA 300-1996, Reverberant Room Method for Sound Testing of Fans.

.3 AMCA 301-1990, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

.2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)

.1 ANSI/AMCA 210-1999, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.

.3 Canadian General Standards Board (CGSB)

.1 CAN/CGSB 1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

1.3 SYSTEM DESCRIPTION

.1 Performance Requirements:

.1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.

.2 Capacity: flow rate, total static pressure, bhp W, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.

.3 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.

.4 Sound ratings: comply with AMCA 301, tested to AMCA 300. Supply unit with AMCA certified sound rating seal .

.5 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210. Supply unit with AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter .

1.4 SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures . Include product characteristics, performance criteria, and limitations.

.2 Shop Drawings:

.1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures .

.3 Provide :

.1 Fan performance curves showing point of operation, BHP kW and efficiency.

.2 Sound rating data at point of operation.

.4 Indicate:

.1 Motors, sheaves, bearings, shaft details .

.2 Minimum performance achievable with variable speed controllers and variable inlet vanes as appropriate.

.5 Closeout Submittals:

.1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.5 MAINTENANCE

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 10 - Closeout Submittals .

.1 Spare parts to include:

.1 Matched sets of belts.

.2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:

.1 Bearings and seals.

.2 Addresses of suppliers.

.3 List of specialized tools necessary for adjusting, repairing or replacing.

1.6 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00 - Product Requirements .

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

Part 2 Products

2.1 FANS GENERAL

.1 Motors:

.1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.

.2 For use with variable speed controllers.

.3 Sizes as indicated.

.4 Two speed with two windings and speeds of approximately as indicated.

.5 Two speed with split winding, constant horsepower constant or variable torque and speeds of r/min.

.2 Accessories and hardware: matched sets of V-belt drives, adjustable motor bases, belt guards, coupling guards fan inlet safety screens as indicated and as specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment . inlet outlet dampers and vanes and as indicated.

.3 Factory primed before assembly in colour standard to manufacturer.

.4 Scroll casing drains: as indicated.

.5 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.

.6 Vibration isolation: to Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment.

.7 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

2.2 CENTRIFUGAL FANS

.1 Fan wheels:

.1 Welded steel aluminum construction.

.2 Maximum operating speed of centrifugal fans not more than 50 % of first critical speed.

.3 Air foil forward curved backward inclined blades, as indicated.

.2 Bearings: heavy duty split pillow-block flange mounted grease lubricated ball or roller self aligning type with oil retaining, dust excluding seals and a certified minimum rated life of 100,000 hours.

.3 Shaft seals on exhaust fans:

.1 Single disc seals.

.4 Housings:

.1 Volute with inlet cones: fabricated steel for wheels 300 mm or greater, cast iron, steel, aluminum, for smaller wheels, braced, and with welded supports.

.2 For horizontally and vertically split housings provide flanges on each section for bolting together, with gaskets of non-oxidizing non-flammable material.

.3 Provide bolted latched airtight access doors with handles.

2.3 CABINET FANS - GENERAL PURPOSE

.1 Fan characteristics and construction: as centrifugal fans.

.2 Cabinet hung single or multiple wheel with DWDI centrifugal fans in factory fabricated casing complete with vibration isolators and seismic control measures, motor, V-belt drive and guard inside or outside casing.

.3 Fabricate casing of zinc coated or phosphate treated steel of reinforced and braced for rigidity. Provide removable panels for access to interior. Paint uncoated, steel parts with corrosion resistant paint to CAN/CGSB 1.181. Finish inside and out, over prime coat, with rust resistant enamel. Internally line cabinet with 50 mm thick rigid acoustic insulation, pinned and cemented, kg/m^3density, complete with perforated metal liner.

2.4 AXIAL FLOW FANS (TUBE-AXIAL OR VANE-AXIAL)

.1 Casings: welded steel with welded motor support, hinged or bolted access plates, streamlined inlet cone and discharge bell sections and integral silencer casing external.

.2 Blade material: steel aluminum. Hub material: steel aluminum.

.3 Supports:

.1 Ceiling suspended units: support brackets welded to side of casing. Extend grease lubrication facilities to outside of casing.

.4 Bearings: ball or roller with extension tubes to outside of casing.

.5 Belt drive:

.1 Drive fixed adjustable blades by externally mounted motors through V-belt drive. Provide internal belt fairing, external belt guards and adjustable motor mounts.

.2 Adjust blades for varying range of volume and pressure. Hubs to facilitate indexing of blade angle. Provide manual automatic adjustment stops to avoid overloading motor.

2.5 IN-LINE CENTRIFUGAL FANS

.1 Characteristics and construction: as for centrifugal fan wheels, with axial flow construction and belt drive .

.2 Provide AMCA arrangements 1 or 9 as indicated with stiffened flanges, smooth rounded inlets, and stationary guide vanes.

2.6 PROPELLER FANS

.1 Fabricate multi-bladed propellers of sheet steel or aluminum of airfoil shape within bell mouth entrance on integral mounts, with grease lubricated ball bearings, with extended lubrication fittings, suited for operating in any position, direct or belt driven, complete with motor as indicated.

.2 Provide blade guards, bird screen and automatic back draft dampers on discharge, with gasketted edges.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 FAN INSTALLATION

.1 Install fans as indicated, complete with resilient mountings specified in Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment , flexible electrical leads and flexible connections in accordance with Section 23 33 00 - Air Duct Accessories.

.2 Provide sheaves and belts required for final air balance.

.3 Bearings and extension tubes to be easily accessible.

.4 Access doors and access panels to be easily accessible.

3.3 ANCHOR BOLTS AND TEMPLATES

.1 Size anchor bolts to withstand acceleration and velocity forces as specified .

3.4 CLEANING

.1 Proceed in accordance with Section 01 74 00 - Cleaning .

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Fans, window ventilators, exterior, wall and ceiling mounted discharge fans for domestic use.

1.2 REFERENCES

.1 Air Conditioning and Mechanical Contractors Association (AMCA)

.1 AMCA 201-02, Fans and Systems.

.2 AMCA 300-2005, Reverberant Room Method for Sound Testing of Fans.

.3 AMCA 301-2005, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

.4 AMCA 302-73, Application of Sone Ratings for Non-Ducted Air Moving Devices.

.5 AMCA 303-79, Application of Sound Power Level Ratings for Fans.

.2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)

.1 ANSI/AMCA 210-1999, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.

1.3 SYSTEM DESCRIPTION

.1 Performance Requirements:

.1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.

1.4 SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures . Include product characteristics, performance criteria, and limitations.

.2 Shop Drawings:

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures .

.3 Closeout Submittals

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.5 MAINTENANCE

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

.2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:

.1 Bearings and seals.

.2 Addresses of suppliers.

.3 List of specialized tools necessary for adjusting, repairing or replacing.

1.6 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00 - Product Requirements.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

Part 2 Products

2.1 FANS - GENERAL

.1 Standard of rating:

.1 AMCA 201 for fan application.

.2 AMCA 302 for application of sone loudness ratings for non-ducted air moving devices.

.3 AMCA 303 for application of sound power ratings for ducted air moving devices.

.4 Performance: to ANSI/AMCA 210.

.2 Sound level ratings to comply with AMCA 301, tested to AMCA 300.

.3 Maximum loudness: 5 sones or as per schedule.

2.2 EXTERIOR MOUNTED DISCHARGE FANS

.1 Roof mounted, direct driven centrifugal fan, 93 W electric ball bearing thermally protected motor.

.2 Sizes and capacity: as per schedule.

.3 Control: switch or thermostatically operated.

.4 Rust resistant aluminum with aluminum backdraft damper, spring loaded complete with foam cushioned frame.

2.3 WALL AND CEILING DISCHARGE FANS

.1 Propeller, centrifugal direct drive, with plug-in type electric motor suitable for ceiling installation, zinc coated rectangular metal housing.

.2 Sizes and capacity: as indicated in Schedule.

.3 Operated complete with integral electrical outlet box with plug-in type receptacle.

.4 Top Side 75 mm diameter 80 mm x 250 mm rectangular duct outlet with integral backdraft damper.

.5 Roof jack Wall cap complete with spring loaded backdraft damper with neoprene gasket.

.6 White polymeric Silver anodized aluminum grille.

2.4 RANGE HOOD – DOMESTIC

.1 Complete system including:

- .1 750 mm hood.
- .2 Lifetime washable aluminum filter.
- .3 Light unit with bulb.
- .4 Centrifugal twin blower and two speed motor.
- .5 Fan and light switches.

.2 Roof outlet complete with backdraft damper.

.3 Acceptable material: Broan, Whirlpool.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Install in accordance with manufacturer's recommendations.

3.3 ANCHOR BOLTS AND TEMPLATES

.1 Supply for installation by other divisions.

3.4 CLEANING

.1 Proceed in accordance with Section 01 74 00 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

- .1 Roof exhausters.

1.2 REFERENCES

.1 Air Movement and Control Association (AAMC)

- .1 AMCA Publication 99-2003, Standards Handbook (Revised 2003).
- .2 AMCA 300-1996, Reverberant Room Method for Sound Testing of Fans.
- .3 AMCA 301-1990, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

.2 American National Standards Institute (ANSI)

- .1 ANSI/AMCA 210-99, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.

1.3 SYSTEM DESCRIPTION

.1 Performance Requirements:

- .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force. Provide confirmation of testing.
- .2 Capacity: as indicated on schedule.

.2 Statically and dynamically balanced. Constructed to AMCA 99.

.3 Sound ratings: comply with AMCA 301, tested to AMCA 300.

.4 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210.

.5 Bearings: sealed lifetime oilite ball bearings heavy duty grease lubricated ball or roller bearings of self aligning type with oil retaining, dust excluding seals and a certified minimum rated life of 80,000 100,000 hours.

1.4 SUBMITTALS

.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.2 Closeout Submittals

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00 - Product Requirements.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.6 MAINTENANCE

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 10 - Closeout Submittals.

.2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:

.1 Bearings and seals.

.2 Addresses of suppliers.

.3 List of specialized tools necessary for adjusting, repairing or replacing.

Part 2 Products

2.1 ROOF EXHAUSTERS

.1 Centrifugal or Axial V belt direct driven.

.1 Housings: spun aluminum galvanized black steel prefinished in enamel FRP PVC stainless steel complete with resilient mounted motor and fan.

.2 Impeller: aluminum non-overloading.

.3 Adjustable motor sheave.

.4 12 mm mesh 2.0 mm diameter aluminum birdscreen.

.5 Automatic Motorized gasketted aluminum backdraft dampers.

.6 Disconnect switch within fan housing.

.7 Continuous curb gaskets, cadmium plated stainless steel securing bolts and screws, and special mated sound insulating 300 mm high curbs where indicated. Hinge curb plate for access to internals for maintenance.

.2 Sound curbs: where indicated of same manufacturer as fan and built to suit model specified.

.1 Double baffle and self-flashing type. Required decibel sound attenuation spectrum:

Frequency Octave Band	1	2	3	4	5	6	7	8
dB Attenuation	3	5	11	16	22	20	17	13

.2 Pressure loss through curbs: 37 Pa max at rated L/s.

.3 Two speed fan motors: two windings or split windings with speeds of approximately RPM high and r/s low as indicated.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Install in accordance with manufacturer's instructions.

3.3 CLEANING

.1 Proceed in accordance with Section 01 74 00 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Electronic variable air volume boxes.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)

.1 ANSI/AMCA 210-1999, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.

.2 ANSI/NFPA 90A-2002, Standard for the Installation of Air Conditioning and Ventilating Systems.

.2 International Organization of Standardization (ISO)

.1 ISO 3741-2001, Acoustics-Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Methods for Reverberation Rooms.

.3 Underwriter's Laboratories (UL)

.1 UL 181-2003, Factory-Made Air Ducts and Air Connectors.

1.3 SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.2 Test data: to ANSI/AMCA 210.

.1 Submit published test data on DIN (Direct Internal Noise), in accordance with ISO 3741 made by independent testing agency for 0, 2.5 and 6 m/s branch velocity or inlet velocity.

.2 Sound power level with minimum inlet pressure of 0.25 0.5 1 1.5 kPa in accordance with ISO 3741 for 2nd through 7th octave band, also made by independent testing agency.

.3 Pressure loss through silencer shall not exceed 60% of inlet velocity pressure maximum.

.2 Shop Drawings:

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Indicate the following:

.1 Capacity.

.2 Pressure drop.

.3 Noise rating.

.4 Leakage.

.3 Closeout Submittals:

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00 - Product Requirements.

1.5 MAINTENANCE

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 10 - Closeout Submittals.

Part 2 Products

2.1 MANUFACTURED UNITS

.1 Terminal units of the same type to be product of one manufacturer.

2.2 DIGITAL VARIABLE AIR VOLUME BOXES

.1 Pressure independent, reset to air flow between zero and maximum air volume.

.2 At inlet velocity of 10 m/s, differential static pressure for unit with attenuator section not to exceed 25 Pa.

.3 Sound ratings of assembly not to exceed NC 40.

.4 Air velocity sensor resistance wire or pitot rack as standard to manufacturer.

.5 Signals between temperature sensing device, velocity controller, velocity sensor and damper actuator analogue and or digital as indicated. Shielded or twisted wire requirements is not acceptable.

.6 Digital thermostat furnished by terminal unit manufacturer and have set points and velocity adjustments located in thermostat. Heating and cooling set point range 13 to 30 degrees C. Set points not overlapping. Thermostat to have C proportional band at velocity settings.

.7 Electronic control package factory calibrated and set at factory. Features to accommodate field calibration and readjustment of air volume settings to include:

.1 Metre taps for balancing with digital DC voltmeter.

.2 Adjustable flow settings at thermostat.

.8 Factory installed 20 VA transformer, 115 V to 24 V. Power consumption of terminal not to exceed 15 VA.

.9 Terminal unit to be CSA certified.

.10 Casing: mm thick galvanized steel, internally lined with 25 mm. 0.7 kg density fibrous glass, to UL 181 and ANSI/NFPA 90A. Mount control components inside protective metal shroud.

.11 Damper: mm thick steel with peripheral gasket and self lubricating bearings. Air leakage past closed damper not to exceed 2% of nominal rating at 750 Pa inlet static pressure, in accordance with Air Diffusion Council test procedure.

.12 Sizes and capacity: as indicated.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Install in accordance with manufacturers recommendations.

.2 Support independently of ductwork.

.3 Install with at least 1000 mm of flexible inlet ducting and minimum of four duct diameters of straight inlet duct, same size as inlet.

.4 Locate controls, dampers and access panels for easy access.

3.3 CLEANING

.1 Proceed in accordance with Section 01 74 00 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Supply, return and exhaust grilles and registers, diffusers and linear grilles, for commercial and residential use.

1.2 SYSTEM DESCRIPTION

.1 Performance Requirements:

.1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

1.3 SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures . Include product characteristics, performance criteria, and limitations.

.2 Samples:

.1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.

.2 Samples are required for following:

.1 Exhaust, return air and supply diffuser for residence room.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00 - Product Requirements.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.5 MAINTENANCE

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 10 - Closeout Submittals.

.2 Include:

.1 Keys for volume control adjustment.

.2 Keys for air flow pattern adjustment.

Part 2 Products

2.1 GENERAL

.1 To meet capacity acceptable noise levels.

.2 Frames:

- .1 Full perimeter gaskets.
- .2 Plaster frames where set into plaster or gypsum board and as specified.
- .3 Concealed fasteners or vandal proof screws.
- .4 Counter sunk screw holes.

.3 Concealed manual volume control damper operators.

.4 Colour: Final approval by Architect at Shop Drawing time.

.5 Refer to Schedules and Drawings.

2.2 MANUFACTURED UNITS

.1 Grilles, registers and diffusers of same generic type, products of one manufacturer.

2.3 SUPPLY GRILLES AND REGISTERS

.1 Refer to schedule.

2.4 RETURN AND EXHAUST GRILLES AND REGISTERS

.1 Refer to schedule.

2.5 DIFFUSERS

.1 Refer to schedule.

2.6 LINEAR GRILLES

.1 Refer to schedule.

2.7 SECURITY GRILLES

.1 Refer to schedule.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Install in accordance with manufacturers instructions.

.2 Install with flat head oval head vandal proof screws in countersunk holes where fastenings are visible.

.3 Grilles and diffusers to be installed as security type installation where noted in schedule.

3.3 CLEANING

.1 Proceed in accordance with Section 01 74 00 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Mechanical louvers; intakes; vents; and reinforcement and bracing for air vents, intakes and gooseneck hoods.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)/ National Fire Protection Association (NFPA)

.2 American Society for Testing and Materials International (ASTM)

.1 ASTM E90-04, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

1.3 SYSTEM DESCRIPTION

.1 Performance Requirements:

.1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

1.4 SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.2 Indicate following:

.1 Pressure drop.

.2 Face area.

.3 Free area.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00 - Product Requirements.

Part 2 Products

2.1 GRAVITY ROOF OUTSIDE AIR INTAKES AND RELIEF VENTS

.1 Factory manufactured galvanized steel.

- .1 Complete with integral birdscreen of 2.7 mm diameter aluminum wire.
- .2 Horizontal backdraft dampers on faces.
- .3 Maximum throat velocity: 3.3 m/s intake.
- .4 Maximum loss through unit: 15 Pa exhaust static pressure.
- .5 Maximum velocity through damper area: 1.5 m/s.
- .6 Shape: as indicated.

.2 Birdscreens:

- .1 Complete with integral birdscreen of 2.7 mm diameter aluminum wire. Use 12 mm mesh on exhaust 19 mm mesh on intake.

2.2 GOOSENECK HOODS

.1 Thickness: to SMACNA.

.2 Fabrication: to SMACNA.

.3 Joints: to SMACNA

.4 Supports: as indicated.

.5 Complete with integral birdscreen of 2.7 mm diameter aluminum wire. Use 12 mm mesh on exhaust 19 mm mesh on intake.

.6 Horizontal backdraft dampers on face.

2.3 FIXED LOUVRES - ALUMINUM

.1 Construction: welded with exposed joints ground flush and smooth.

.2 Material: extruded aluminum alloy 6063-T5.

.3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm.

.4 Frame, head, sill and jamb: 100 150 mm deep one piece extruded aluminum, minimum 3 mm thick with approved caulking slot, integral to unit.

.5 Mullions: at 1500 mm maximum centres.

.6 Fastenings: stainless steel SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.

.7 Screen: 12 mm exhaust 19 mm intake mesh, 2 mm diameter wire aluminum birdscreen on inside face of louvres in formed U-frame.

.8 Finish: factory applied enamel. Colour: to Contract Administrator's approval.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 In accordance with manufacturer's and SMACNA recommendations.

.2 Reinforce and brace as indicated.

3.3 CLEANING

.1 Proceed in accordance with Section 01 74 00 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Filters and filter gauges for various types of mechanical air handling equipment.

1.2 REFERENCES

.1 American National Standards Institute/National Fire Prevention Association (ANSI/NFPA) ANSI/NFPA 96-04, Ventilation Control and Fire Protection of Commercial Cooking Operations.

.2 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)

.1 ASHRAE 52.1-1992, Gravimetric And Dust Spot for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter (ANSI Approved).

.3 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-115.10-M90, Disposable Air Filters for the Removal of Particulate Matter from Ventilating Systems.

.2 CAN/CGSB-115.18-M85, Filter, Air, Extended Area Panel Type, Medium Efficiency.

.4 Underwriters' Laboratories of CanadaULC -S111-95, Standard Method of Fire Tests for Air Filter Units.

.1 ULC-S649-1993, Exhaust Hoods and Related Controls for Commercial and Institutional Kitchens.

1.3 SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures . Include product characteristics, performance criteria, and limitations.

.2 Shop Drawings:

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.3 Closeout Submittals

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00 - Product Requirements .

1.5 MAINTENANCE

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 10 - Closeout Submittals .

.2 Furnish list of individual manufacturer's recommended spare parts for equipment such as frames and filters, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing for inclusion in operating manual.

.3 Spare filters: in addition to filters installed immediately prior to acceptance by Contract Administrator , supply 1 complete set of filters for each filter unit or filter bank in accordance with section 01 78 10 - Closeout Submittals .

Part 2 Products

2.1 GENERAL

.1 Media: suitable for air at 100% RH and air temperatures between minus 40 and 50 degrees C.

.2 Number of units, size and thickness of panels, overall dimensions of filter bank, configuration and capacities: as indicated .

.3 Pressure drop when clean and dirty, sizes and thickness: as indicated on schedule.

2.2 ACCESSORIES

.1 Holding frames: permanent "T" section or channel section construction of galvanized steel or extruded aluminum same material as casing/hood, 1.6 mm thick, except where specified.

.2 Seals: to ensure leakproof operation.

.3 Blank-off plates: as required, to fit all openings and of same material as holding frames.

.4 Access and servicing: through doors/panels on each side and/or from upstream downstream face of filter bank.

2.3 FIBROUS GLASS PANEL FILTERS

.1 Disposable fibrous glass media: to CAN/CGSB-115.10 with adhesive.

.2 Holding frame: 1.2 mm minimum thick galvanized steel with 3 mm diameter hinged wire mesh screen.

.3 Performance: minimum average synthetic dust weight arrestance 70 % to ASHRAE 52.1.

.4 Fire rated: to ULC -S111.

.5 Nominal thickness: 50 mm.

2.4 FILTER GAUGES - DIAL TYPE

.1 Diaphragm actuated, direct reading.

.2 Range: 0 to 2 times initial pressure 0 to 250 Pa.

2.5 FILTER GAUGES - MANOMETER TYPE

.1 Inclined acrylic tube.

.2 Complete with levelling screws.

.3 Range: 0 to 2 times initial pressure 0 to 250 Pa.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION GENERAL

.1 Install in accordance with manufacturer's recommendations and with adequate space for access, maintenance and replacement.

3.3 REPLACEMENT MEDIA

.1 Replace media with new upon acceptance.

.2 Filter media new and clean, as indicated by pressure gauge, at time of acceptance.

3.4 FILTER GAUGES

.1 Install type as indicated across each filter bank (pre-filter and final filter) in approved and easy readable location.

.2 Mark each filter gauge with value of pressure drop for clean condition and manufacturer's recommended replacement (dirty) value.

3.5 CLEANING

.1 Proceed in accordance with Section 01 74 00 - Cleaning .

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Specialty filtration for mechanical air handling equipment.

1.2 REFERENCES

.1 American National Standards Institute/National Fire Prevention Association (ANSI/NFPA)ANSI/NFPA 96-04, Ventilation Control and Fire Protection of Commercial Cooking Operations.

.2 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)

.1 ASHRAE 52.1-1992, Gravimetric And Dust Spot for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter (ANSI Approved).

.3 Canadian General Standards Board (CGSB)

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.2 CAN/CGSB-115.18-M85, Filter, Air, Extended Area Panel Type, Medium Efficiency.

.4 Underwriters' Laboratories of CanadaULC -S111-95, Standard Method of Fire Tests for Air Filter Units.

.1 ULC-S649-1993, Exhaust Hoods and Related Controls for Commercial and Institutional Kitchens.

1.3 SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures . Include product characteristics, performance criteria, and limitations.

.2 Shop Drawings:

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.3 Closeout Submittals

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 61 00 - Product Requirements.

1.5 MAINTENANCE

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 10 - Closeout Submittals.

.2 Furnish list of individual manufacturer's recommended spare parts for equipment such as frames and filters, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing for inclusion in operating manual.

.3 Spare filters: in addition to filters installed immediately prior to acceptance by Contract Administrator, supply 1 complete set of filters for each filter unit or filter bank in accordance with section 01 78 10 - Closeout Submittals .

1.6 PERFORMANCE

.1 Efficiency: The StrionAir System shall have a minimum efficiency reporting value (MERV) of 16.

.1 Size Range (microns) Initial Fractional Efficiency (%)

.1	0.3 - 0.4	91.2
.2	0.4 - 0.55	93.5
.3	.55 - 0.7	95.6
.4	00.7 - 1.0	97.5

.2 Resistance: The System has shall have a nominal initial resistance of 0.4” wg at a face velocity of 500 feet per minute (FPM).

.3 Germicidal Effectiveness: The System shall achieve >95% effectiveness at killing both gram positive and gram negative bacteria, bacterial spores and mold spores in independent testing under controlled laboratory conditions.

Part 2 Products

2.1 GENERAL

2.2 STRIONAIR SYSTEM SECURESEAL FILTER RACK (S-RACK)

.1 The S-Rack is composed of heavy-gauge extruded-aluminum, horizontally-oriented top, center and bottom beams mounted to vertical side supports. All beams contain: a downstream 2” channel to accommodate the 2” DFE and an upstream channel to capture the FEM mounting brackets. Included in the 2” channel is an upstream fin-seal gasket to help eliminate air bypass.

2.3 SYSTEM COMMAND AND COMMUNICATIONS MODULE (SCCM)

.1 The SCCM provides three functions: conversion of line voltage to 24 VDC, control of line voltage depending upon various inputs, and routing of communication signals from the individual high voltage power modules (PM). Each SCCM is composed of a 18-gauge metal enclosure containing one or two converters, depending upon installation size. A SCCM-8 contains one 24 VDC converter and will provide 24 VDC power for up to 8 FEMs.

.2 Power Conversion: The SCCM converts 120 VAC or 240 VAC line voltage to 24 VDC and supplies this power to the individual power modules mounted directly to each FEM. Line current ratings for the individual converters at maximum load are 6A and 3.5A, respectively.

.3 Line Voltage Control: The SCCM provides a 24 VDC output to the door safety switches as well as the AHU fan relay. If the switches and relay are closed, the output will return to the SCCM and will close relays, allowing the flow of line voltage to the 24 VDC converters. In this way, an open AHU door will interrupt voltage as will a shutdown of the AHU fan.

.4 Communication Signals. The SCCM combines the signals from individual PMs into a single interface with the building automation system (BAS). Voltage provided by the BAS is routed through a loop controlled by independent relays. Each relay is controlled by any one of eight PMs attached in series to a single 24 VDC converter in the SCCM. Failure of any individual PM in the series causes the relay to open and the BAS signal to be interrupted. Failure is indicated by a voltage of 0 (zero) VDC while normal operation is indicated by a voltage greater than 0 (zero), as determined by the BAS. Multiple SCCMs can be connected in series to provide a single communication signal back to the BAS.

.5 Integrated LED display lights provide visual indication that electronics are properly functioning.

2.4 DOOR SAFETY SWITCHES

.1 24 VDC magnetic contact door safety switches shall be mounted to any door accessing the filter section. These switches shall serve as a fail-safe device and will interrupt the 24VDC supply upon opening the access door.

2.5 2.4 BLOWER RELAY

.1 The SCCM will send a 24 VDC signal of less than 100 mA to the AHU blower auxillary relay. This relay will interrupt power to the individual PMs when the blower is not running.

2.6 FILTER ENHANCEMENT MODULE (FEM)

.1 Components: Each FEM is composed of the following factory assembled component pieces

.1 a precision-stainless-steel ionization array.

.2 high-voltage-insulated upstream field electrode.

.3 power module,

.1 each PM provides electrical power, circuit control and monitoring for one FEM, and includes LED diagnostic array

.4 a safety screen contained within a UL94 5V rated polymer housing.

.5 a 2” pre filter track.

.2 Filter Enhancement Module (FEM) Dimensions

.1 See AHU Schedule

2.7 SECURESEAL DISPOSABLE FILTER ELEMENT (DFE)

.1 Fiberglass mini-pleat construction with extruded rigid PVC, UL94 rated, low-bypass frame.

.2 Integrated uninsulated downstream field electrode.

.3 Closed-cell foam gaskets and knife-edge seals on either vertical side to limit side-to-side bypass between filters.

.4 Fin-seal gasket on either horizontal upstream edge to limit bypass between filter and S-Rack.

.5 SecureSeal Dimensions:

.1 See AHU Schedule

Part 3 Execution

3.1 INSTALLATION SIZE

.1 The structural element of the System is the SecureSeal filter rack. As a result, the number of individual FEMs that may compose a System is limited only by the size of the SecureSeal rack to which they will be mounted.

.2 A single SecureSeal rack may be constructed up to 10’ high and 10’ wide.

.3 Multiple racks can be joined together with stiffeners to create larger assemblies.

.4 While the use of proper filter rack construction techniques will allow a rack of any practical size to be constructed filter racks should not exceed structural limits as determined by a design engineer.

3.2 FILTER ENHANCEMENT MODULE (FEM) ACCESS

.1 To ensure adequate access for installation and service, access space upstream of the StrionAir. System FEM shall be no less than 20”.

3.3 SECURESEAL DISPOSABLE FILTER ELEMENT ACCESS

.1 Side change of the DFE or optional pre-filters require the filters to be accessible via a side access door or readily removable panel.

3.4 S-RACK CONSTRUCTION

.1 The S-Rack is assembled by attaching a set of horizontal beams spaced apart at regular intervals (24”, 20” or 12”) to two vertical side supports (one on each side) using the hardware provided.

.2 The rack is subsequently fitted into place and fastened, via the side supports, to the air handler unit (AHU) housing.

.3 While a single rack is limited to 10’ high by 10’ wide, multiple racks can be joined together to form a larger rack.

.4 Filter racks will be flat panel in configuration and shall not be configured as V-Banks.

.5 Rack Size: the required rack size can be calculated from system CFM requirements. StrionAir performance is rated at a nominal 500 FPM per the latest ASHRAE standard, 52.2. StrionAir

.6 recommends the rack be sized so that air flow does not exceed 500 FPM. StrionAir System performance at higher air flows cannot be validated.

3.5 SCCM MOUNTING

.1 Each SCCM shall be mounted on the AHU housing or a component rack such as Unistrut.

.2 Since a single SCCM (SCCM-16) can handle up to 16 FEMs, installations with more than 16 FEMs will require additional SCCMs.

.3 The mounting area for each SCCM can be calculated by adding a two-inch perimeter to the base dimensions from the table in section 2.2 D (e.g., 11.5”x17.5”+ 2” perimeter =15.5”x21.5”).

.4 A SCCM may be located up to 35' from the FEM series that it powers. However, location and proximity to the air handler shall be such that the SCCM power on-off switch is readily accessible and promotes compliance with StrionAir System safety procedures, common industry practices and local codes: specifically, the System power shall be interrupted via the SCCM switch before entering the air handler or servicing the StrionAir System.

.5 Weather-resistant protective enclosures should be used to guard the system command and communications module (SCCM) if they are mounted directly on a rooftop and exposed to weather.

3.6 DOOR SAFETY SWITCH MOUNTING

.1 A 24-VDC magnetic contact door safety switch shall be mounted to any door accessing the . lter section. These switches shall serve as a fail-safe device and will shut down the high voltage upon opening the access door.

3.7 FEM MOUNTING

.1 Each FEM mounts to its position in the provided channel on the upstream side of the S-Rack.

.2 Optional pre-filters must be side or upstream loading.

3.8 POWER MODULE CONNECTIONS

.1 24 VDC wire harness provided with the System. Connections are made to factory installed molex plugs. PMs are factory-attached on the upstream edge of the FEMs.

3.9 DFE MOUNTING

.1 Each DFE mounts to its position in the provided 2" channel on the down steam side of the S-Rack.

.2 DFEs must be side or downstream loading.

3.10 ELECTRICAL REQUIREMENTS

.1 Power Consumption: Each FEM's power module uses a maximum of 45 watts.

.2 Current Draw: Each FEM's power module draws no more than 1.5A at 24 VDC, depending upon operating conditions. SCCMs are internally fused with 4A replaceable fuses.

.3 Power Supply: For each SCCM - 8, voltage input of 120 VAC or 240 VAC @ 6A and 3.5A respectively, shall be provided. For each SCCM - 16, voltage input of 120 VAC or 240 VAC @ 12A and 7A respectively, shall be provided.

.4 Communications: The SCCM combines the signals from individual PMs into a single interface with the BAS. Voltage provided by the BAS is routed through a loop controlled by independent relays. Failure is indicated by a voltage of 0 (zero) VDC while normal operation is indicated by a voltage greater than 0 (zero), as determined by the BAS.

.5 Door Safety Switches: Magnetic contact door safety switches shall be mounted to any door accessing the filter section. These switches shall serve as a fail-safe device and will shut down the high voltage upon opening the AHU access door. The voltage sent to the door safety switches will be 24 VDC @ less than 100 mA.

.6 Blower Relay: The SCCM will send a 24 VDC signal of less than 100 mA to the AHU blower auxillary relay. This relay will interrupt power to the individual PMs when the blower is not running.

3.11 SAFETY

.1 SCCM location and mounting: location and proximity to the air handler shall be such that the SCCM power on-off switch is readily accessible and promotes compliance with StrionAir System safety procedures, common industry practices and local codes: specifically, the System power shall be interrupted via the SCCM switch before entering the air handler or servicing the StrionAir System.

.2 Safety Switches: 24 VDC magnetic contact door safety switch shall be mounted to any door accessing the filter section. These switches shall serve as a fail-safe device and will shut down the high voltage upon opening the access door.

.3 FEM safety rating: UL94 5V.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

- .1 Materials, accessories and installation for breechings, chimneys and stacks.

1.2 REFERENCES

.1 Sheet Metal and Air Conditioning Contractors National Association (SMACNA)

.2 Underwriters' Laboratories of Canada (ULC)

1.3 SUBMITTALS

.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.2 Shop Drawings:

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Manitoba, Canada.
- .2 Indicate following:
  - .1 Methods of sealing sections.
  - .2 Methods of expansion.
  - .3 Details of thimbles.
  - .4 Bases/Foundations.
  - .5 Supports.
  - .6 Guy details.
  - .7 Rain caps.

.3 Closeout Submittals

- .1 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Product Requirements.

Part 2 Products

2.1 BREECHINGS - DOMESTIC HOT WATER

.1 Shop fabricated 3.5 mm thick galvanized steel with sweep bends from outlet to chimney.

2.2 FUELS: PRESSURE CHIMNEY AND BREECHING (GENERATOR EXHAUST)

.1 ULC labelled, 760 degrees C rated.

.2 Sectional, prefabricated, double wall with 100mm mineral wool insulation with mated fittings and couplings.

- .1 Liner: .088 mm thick, type 304 stainless steel.
- .2 Shell: .0064 mm thick, type 304 stainless steel.
- .3 Outer seals between sections: to suit application Low temp P-600 sealant.
- .4 Inner seals between sections: to suit application or P2000E high temp.

2.3 CONDENSING BOILER BREECHINGS AND STACKS

.1 Boiler breeching and stack components, supports and terminations shall be factory prefabricated, tested and listed by ULC, S636 for use with condensing boilers. The breeching and stack system, shall comply with all safety and building codes where applicable.

.2 Breeching assemblies and stack/s shall be a double wall air-insulated system, having inner walls AL 29-4C stainless steel and the outer casing of 430 stainless steel.

.3 Breeching and stack system section joints shall be sealed with a tapered end closure system with tabs, sealant and locking containment bands each band locked from a single point for a pressure tight assembly. Assemblies using metal screws through inner and/or outer walls will not be accepted.

.4 The breeching and stack system shall maintain air tight integrity at pressures up to 381mm w.c. Breeching and stack systems shall be designed to adjust to thermal expansion caused by the heating and cooling of normal equipment operation.

.5 The manufacturer of the system must furnish complete CAD system drawings of the assembly to be furnished.

.6 Material required for breeching and stacks is Cleaver-Brooks SaF-T Vent CI Plus having double wall construction with 25mm air insulation, suitable for use with ANSI Category I, II, III and IV, gas burning appliances.

2.4 ACCESSORIES

.1 Cleanouts: bolted, gasketted type, full size of breeching, as indicated.

.2 Hangers and supports: in accordance with recommendations of Sheet Metal and Air Conditioning Contractors National Association Inc. SMACNA as per manufacturers instructions.

.3 Rain cap.

.4 Expansion sleeves with heat resistant caulking, held in place as indicated.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION - GENERAL

.1 Follow manufacturer's and SMACNA installation recommendations for shop fabricated components.

.2 Suspend breeching at centres and at each joint.

.3 Support chimneys at bottom, roof and intermediate levels as indicated.

.4 Install thimbles where penetrating roof, floor, ceiling and where breeching enters masonry chimney. Pack annular space with heat resistant caulking.

.5 Install flashings on chimneys penetrating roofs, as indicated.

.6 Install rain caps and cleanouts, as indicated.

3.3 CLEANING

.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Heating boiler units:

.1 Forced draft condensing type hot water.

.2 Installation.

.3 Commissioning.

1.2 REFERENCES

.1 American Boiler Manufacturer's Association (ABMA)

.2 American National Standards Institute (ANSI)

.1 ANSI Z21.13-2004/CSA 4.9-2004, Gas-Fired Low-Pressure Steam and Hot Water Boilers.

.3 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME)

.1 ANSI/ASME Boiler and Pressure Vessel Code, Section IV, 2004.

.4 Canadian Gas Association (CGA)

.1 CAN1-3.1-77(R2001), Industrial and Commercial Gas-Fired Package Boilers.

.2 CAN/CSA-B149.1-05, Natural Gas and Propane Installation Code.

.5 Canadian Standards Association (CSA International)

.1 CSA B51-03, Boiler, Pressure Vessel, and Pressure Piping Code.

.2 CSA B139-04, Installation Code for Oil Burning Equipment.

.3 CSA B140.7-05, Oil Burning Equipment: Steam and Hot-Water Boilers.

.6 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)

1.3 SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.2 Shop Drawings:

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Indicate the following:

.1 General arrangement showing terminal points, instrumentation test connections.

.2 Clearances for operation, maintenance, servicing, tube cleaning, tube replacement.
.3 Foundations with loadings, anchor bolt arrangements.
.4 Piping hook-ups.
.5 Equipment electrical drawings.
.6 Burners and controls.
.7 All miscellaneous equipment.
.8 Flame safety control system.
.9 Breeching and stack configuration.

.3 Engineering data to include:
.1 Boiler efficiency at 25%, 50%, 75%, 100%, of design capacity.
.2 Radiant heat loss at 100% design capacity.

.3 Closeout Submittals:

.1 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Product Requirements.

1.5 MAINTENANCE

.1 Extra materials:

.1 Special tools for burners, manholes, handholes and Operation and Maintenance.
.2 Spare parts for 1 year of operation.
.3 Spare gaskets.
.4 Spare gauge glass inserts.
.5 Probes and sealants for electronic indication.
.6 Spare burner tips.
.7 Spare burner gun.
.8 Safety valve test gauge.

Part 2 Products

2.1 GENERAL

.1 Packaged boiler:

.1 Complete with burner and necessary accessories and controls.
.2 Factory tested at rated capacity to, and bearing seal or nameplate certifying compliance with, CSA B140.7 CAN1-3.1.
.3 Ready for attachment to piping, electrical power, controls, flue gases exhaust.
.4 Designed and constructed to ANSI/ASME Boiler and Pressure vessel Code.

.5 CRN (Canadian Registration Number), to CSA B51.

.6 Boiler/burner package to bear CGA label.

.2 Controls: factory wired. Enclosed in Electrical and Electronic Manufacturers' Association of Canada steel cabinet.

.3 Temporary use by contractor:

.1 Contractor may use boilers only after written approval from Contract Administrator.

.2 Monitor and record performance continuously. Keep log of maintenance activities carried out.

.3 Refurbish to as-new condition before final inspection and acceptance.

2.2 MODULAR HOT WATER BOILER, FORCED DRAFT, CONDENSING TYPE

.1 Heating boilers, AERCO KC-1000 boiler plant consisting of two (2) hydronic boiler modules, condensing firetube, thermal shock proof design, with a forced draft, modulating burner, equipped for firing natural gas, and positive pressure vent discharge.

.2 Each boiler module input, firing natural gas or propane, to be 1,000 mbh with a gross output of 860 to 915 mbh, dependent upon return water temperature.

.3 Individual boiler module, known part load efficiencies, over the specified burner turndown range, to be published by the boiler manufacturer. Thermal efficiencies, to increase, as firing rate is decreased.

.4 Each boiler module to be cUL Listed, CSD-1 approved. The heat exchangers to be constructed of 316L stainless steel fire tubes and tube sheets. The pressure vessel/heat exchangers to be ASME and Province of Manitoba CRN, coded and stamped and incorporate gas trains designed in accordance with FM and CGA requirements.

.5 Burner turndown capability for each boiler, to be 20 to 1, without loss of combustion efficiency or staging of gas valves, for a total boiler plant turndown of 40 to 1.

.6 Boiler plant efficiency to increase upon a decrease in boiler firing rate. Three boiler modules to be controlled for firing in unison to provide maximum plant, seasonal efficiency.

.7 Burners to be nozzle mix design having spark ignition and flame rectification. Burner heads to be cast stainless steel and all burner material exposed to the combustion zone to be of stainless steel construction.

.8 Natural gas input, to be metered with a modulating air/fuel ratio control valve. The modulating fuel input control motor to be connected to the gas control valve and air valve with a single shaft linkage. Field adjustment of this linkage, will not be required.

.9 The boiler module combustion systems to be equipped for dual fuel capacity capable of operating with both natural gas or propane and incorporate a single, manual, easily accessible, mechanism to switch from one fuel to the other.

.10 Natural gas to be the primary fuel. The efficiency and turn down capability, of the boiler modules, will not deviate from that of the boiler modules, when operating with natural gas.

.11 Boiler plant control system to be segregated into four components: "C-More" Control Panels, Power Boxes and Input/Output Connection Boxes, mounted and wired on each boiler and one BMS, Boiler Management System Panel, shipped separately, for interconnecting control wiring by Control Section.

.12 Boiler plant outlet water temperature to be controlled to +/- 2° F.

.13 The boiler modules to be capable of operation in the following control modes:

- .1 Internal set point
- .2 Indoor/outdoor reset
- .3 4 to 20 mA Temperature set point
- .4 4 to 20 mA Direct Drive
- .5 Boiler Management System BMS

.14 Each boiler module, AERCO C-More, control system to include:

- .1 Six (6) surface mounted circuit boards:
  - .1 LED temperature display
  - .2 VFD module for all message annunciation
  - .3 CPU, housing all control functions
  - .4 Low water cut off with test and manual reset functions
  - .5 Power supply board
  - .6 Ignition, stepper and flame safeguard control
- .2 Combination safeguard/flame monitoring system with spark ignition and rectification type flame sensor.
- .3 Annunciation for boiler and sensor status to include eight separate status and 34 separate fault, self diagnostic messages.
- .4 PID set pint, high limit
- .5 Set point low limit
- .6 Fail safe change over to internal signal, on loss of external signal.

.15 The AERCO Model 168 microprocessor based control, Boiler management System programmed to control all operation and energy input of the boiler plant utilizing a pulse width modulated (PWM) signal, or MODBUS protocol with RS-458 port, to communicate with the boiler plant modules.

- .1 The controller to vary the input of the three boiler modules throughout the full burner turndown range of each, to maximize the condensing capability of the boiler plant.
- .2 The controller to be PID type for accurate temperature control and frequency response , with contact closure for automatic heat start up and auxiliary equipment operation.
- .3 BMS 168 panel to control boiler plant system outlet water temperature to +/- 2° F, utilizing:

.1 Internal set point mode

.2 Outdoor reset, field adjustable from 0.3 to 3.0, in operation

.3 4 to 20 mA mode, to vary header temperature set point linearly as the external signal is applied.

.4 BMS 168 panel to control firing of the boiler plant modules in unison, for a 40 to 1 turndown. Maximum plant efficiency to be achieved at minimum firing input. BMS 168 control to automatically balance the operating time on each module through a first on - first off mode. Set back to be provided for remote alarms.

.5 BMS 168 controller to be shipped loose for wall mounting and field connection to the system and boiler modules, by the installer. Connection to each boiler module to be twisted pair, low voltage wiring, to internal terminal strips.

.16 Each boiler module to be furnished with:

.1 Integral electric probe type low water cut off.

.2 McD-M #750 auxiliary low water cut off wit manual reset and 3-way test valve, shipped loose.

.3 Integral dual over temperature protection, with manual reset

.4 Auxiliary high limit aquastat with manual reset, shipped loose.

.5 ASME relief valve, set at 40 psig.

.17 Boiler module gas trains to be furnished in accordance with CGA and cUL requirements for gas supplied at a regulated pressure of 5 psig. Gas train controls shall include manual main lubricated gas shut of valve, gas control pressure regulators, air/fuel control valve, high and low gas pressure switches and electro-hydraulic safety shut off valve.

.18 Main gas regulators to accept a 5 psig supply pressure, to be furnished, shipped loose.

.19 Boilers to operate on a 208-230/3/60, 15 amp service, CSA approved components.

.20 Upon notification of completion of the installation, the boiler manufacturer to provide the services of a field technician to:

.1 Provide a "dry run" of the boiler plant control sequences

.2 Fire the boiler and adjust control and fuel/air ratio settings to optimum operating conditions.

.3 Record combustion performance and efficiencies over the operating range.

.4 Provide combustion analysis and commissioning reports to the purchaser and Contract Administrator.

.5 Furnish instruction and training to the City's operating personnel.

.6 Furnish inspection and combustion setting check, six months after date of start up.

.7 Provide warranty service at no charge for labour, for one year after the completion of the initial start up.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Install in accordance with ANSI/ASME Boiler and Pressure Vessels Code Section IV, regulations of Provinces having jurisdiction, except where specified otherwise, and manufacturers recommendations.

.2 Make required piping connections to inlets and outlets recommended by boiler manufacturer.

.3 Maintain clearances as indicated or if not indicated, as recommended by manufacturer for operation, servicing and maintenance without disruption of operation of any other equipment/system.

.4 Mount unit level using specified vibration isolation in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.

.5 Pipe hot water relief valves full size to nearest drain.

.6 Natural gas fired installations - in accordance with CAN/CSA-B149.1.

3.3 MOUNTINGS AND ACCESSORIES

.1 Safety valves and relief valves:

- .1 Run separate discharge from each valve.
- .2 Terminate discharge pipe as indicated.
- .3 Run drain pipe from each valve outlet and drip pan elbow to above nearest drain.

.2 Blowdown valves:

- .1 Run discharge to terminate as indicated.

3.4 FIELD QUALITY CONTROL

.1 Commissioning:

- .1 Manufacturer to:
  - .1 Certify installation.
  - .2 Start up and commission installation.
  - .3 Carry out on-site performance verification tests.
  - .4 Demonstrate operation and maintenance.
- .2 Provide Contract Administrator at least 24 hours notice prior to inspections, tests, and demonstrations. Submit written report of inspections and test results.

3.5 CLEANING

.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 78 10 - Closeout Submittals.

.3 Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment.

.4 Section 23 84 13 - Humidifiers.

.5 Section 23 33 00 - Air Duct Accessories.

.6 Section 23 33 15 - Dampers - Operating.

.7 Section 23 44 00 - HVAC Air Filtration.

.8 Section 23 44 01 – Strion Air Filtration

1.2 REFERENCES

.1 American National Standards Institute/Air-Conditioning and Refrigeration Institute (ANSI/ARI)

  .1 ANSI/ARI 430-99, Central Station Air Handling Units.

.2 Canadian General Standards Board (CGSB)

  .1 CAN/CGSB 1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.

.2 Indicate following: fan curves showing point of operation motor drive bearings filters mixing box dampers coil; include performance data.

1.4 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

.2 Include following: fan bearings motor damper heat recovery control air volume total cooling sensible cooling EDB EWB OAT.

1.5 EXTRA MATERIALS

.1 Provide maintenance materials in accordance with Section 01 78 10 - Closeout Submittals.

.2 Provide one spare sets of filters.

.3 Provide list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

.4 Spare filters: in addition to filters installed immediately prior to acceptance by Contract Administrator, supply 1 complete set of filters for each filter unit or filter bank.

Part 2 Products

2.1 GENERAL

.1 Factory assembled components to form units supplying air at designed conditions, as indicated.

.2 Certify ratings: to ARI 430 with ARI seal.

.3 As indicated, having air tight modular components, consisting of casing, fan section with motor and drive, filter section, heating coil, cooling coil, humidifier, section mixing, box.

.4 Acceptable material: Refer to Schedule.

2.2 CASINGS

.1 General

.1 Air Handling Units shall be built to the level of quality as herein specified and to the description of the Air Handling Unit Schedule.

.2 Substitution of any product other than that specified, must ensure no deviation below the stated capacities, air flow rate, heat transfer rate, filtration efficiency and air mixing quality. Power requirements must not be exceeded, and where specifically defined, sound power levels must not be exceeded.

.3 Unless stated otherwise, air-handling units are to be shipped to the job in one piece, factory assembled. Modular units assembled to achieve a close proximation to the intent of this specification will not be considered equal. All equipment shall where specified and applicable, be pre-wired, and factory certified by an approved testing agency such as ETL, UL, CSA prior to shipment.

.4 Pre-wired air handling units shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the Canadian Electrical Code.

.5 All electrical circuits shall undergo a dielectric strength test, and shall be factory tested and checked as to proper function.

.6 The air handling units and major components shall be products of manufacturers regularly engaged in the production of such equipment and with a minimum of fifteen continuous years of proven production experience.

.2 Unit Construction

.1 Unit casing shall be of minimum 18 gauge (1.3mm) satin coat galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two-part acid based etching primer. Finish coat shall be an electrostatically applied enamel, to all exposed surfaces. All unprotected metal and welds shall be factory coated. Final color to be approved by Architect/Contract Administrator.

.2 All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and on all outdoor units roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.

.3 Units shall be provided with access doors to the following components: fans and motors, filters, dampers and operators, access plenums and humidifiers/wet cells, electrical control panels, compartments. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.

.4 Units shall be provided with hinged access doors, with extruded neoprene gasket, fully lined, and a minimum of two Leverlok handles, operable from both sides for all units. Whenever possible, hinged access doors to areas of negative pressure shall open out, and to areas of positive pressure shall open in. Where space constrictions require the use of outward opening doors to an area of positive pressure, a clear warning label and safety chain must be affixed.

.5 Provide marine lights with Lexan bulb covers in each section provided with an access door. Lights shall be wired in EMT conduit to a switch with pilot light, from single source manufacturer’s power supply.

.6 All units shall be internally insulated with 50mm thick nominal 3 lb./cu.ft. (48 kg./cu.m.) density acoustic insulation.

.7 3 lb./cu.ft. (48 kg/cu.m.) insulation is secured with steel angles. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges. Drain pans and all floor areas shall be insulated on the underside.

.8 Cooling coil drain pans shall be fabricated of stainless steel and are an integral part of the floor paneling, a minimum of 50mm deep, with welded corners. Drain pans shall extend a minimum of 150mm downstream of coil face and be provided with a 38mm S.S. M.P.T. drain connection. Drain pans must have a fast pan and be sloped and pitched such that there is no standing water. Intermediate fast pans shall be provided between cooling coils where required for effective moisture removal.

.9 Provide stainless steel (extended) drain under complete section downstream of humidifier.

.10 Service corridor (integral) shall be insulated with 50mm thick nominal 3 lb./cu. ft.(48 kg/cu. m) density acoustic insulation. Corridor shall also be fully lined with 22 gauge (0.85mm) solid liner. Floor to be 14 ga.(2.0mm) black iron floor with rust resistant and non-skid coating.

.11 Access doors to service corridor shall be complete with zinc plated piano hinges and brass pins in welded steel frames. Provide with Leverlok handles. Access doors from service corridor to internal unit components shall be as specified elsewhere.

.12 Corridor to be provided with marine lights with Lexan globes, wired in EMT to a switch with pilot light. Corridor shall also be provided with a 1 kW electric baseboard heater with integral thermostat and duplex service receptacle. 120v/1/60/Hz power supply.

.13 Lights, heater and service receptacle shall be fed from manufacturer's panel, for single point power supply, unit splitters to be provided.

.14 In air-to-air heat reclaim units, the exhaust section drain pans shall be an integral part of the floor paneling, a minimum of 50 mm deep, with welded corners. Drain pans shall extend over the full exhaust fan plenum and be connected with a 38 mm M.P.T. drain connection.

.15 The drain pan in the humidifier wand section shall be 18 ga (1.3mm) 304 stainless steel. Provide solid liner in the humidifier wand section.

.16 Air handling units shall be weatherproofed and equipped for installation outdoors. This shall include generally for the prevention of infiltration of rain and snow into the unit, louvers or hoods on air intakes and exhaust openings with 25mm galvanized inlet screens; rain gutters or diverters over all access doors; all joints caulked with a water resistant sealant; roof joints turned up 50mm with three break interlocking design; outer wall panels extend a minimum of 6mm below the floor panel; drain trap(s) connections for field supply and installation of drain traps. Units mounted on roof curbs incorporate welded floor to base construction. Floors are of three break upstanding design with welded corners and free of penetrations. Unit underside joints are caulked.

.17 Outdoor units over 4.9 m in width or over 3 m in height with unit split(s) shall be provided with a membrane roof to ensure prevention of infiltration of rain and snow through the top of the unit.

.18 Provide full perimeter roof mounting curb of heavy gauge sheet metal, minimum of 300mm high, and complete with wood nailer, neoprene sealing strip, and fully welded "Z" bar with 25mm upturn on inner perimeter, to provide a complete seal against the elements. External insulation of the roof-mounting curb shall be provided by the Roofing Subcontractor.

.3 Fans

.1 Centrifugal fans shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be selected for stable operation at least 20% below the first critical RPM. Fan shafts shall be provided with a rust inhibiting coating.

.2 Single low pressure forward curved fans shall be equipped with greaseable pillow block bearings, supported on a rigid structural steel frame.

.3 Airfoil and/or BI fans shall be equipped with greaseable, self-aligning ball or roller type pillow block bearings.

.4 Drives shall be adjustable on fans with motors 5.6 kW or smaller. On fans with larger motors, fixed drives shall be provided. All drives shall be provided with a rust inhibiting coating. The air balancer shall provide for drive changes during the air balance procedure.

.5 Provide full section return air fans as scheduled. The use of power exhaust propeller or centrifugal fan arrangements will not be considered.

.6 Motor, fan bearings and drive assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly, where required. Motor mounting shall be adjustable to allow for variations in belt tension.

.7 Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor, which is welded to the structural frame of the unit. The isolators shall be neoprene-in-shear type for single 230mm to 380mm diameters forward curve fans. All other fans shall incorporate vertical spring type isolators with leveling bolts, bridge bearing waffled pads with minimum 25mm static deflection designed to achieve high isolation efficiency. Fans shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric, with a sealed double locking fabric to metal connection.

.8 Provide single extended grease line from far side to access side bearing.

.9 Fan motors shall be ODP super high efficiency type.

.4 Coils

.1 Coils shall be 5/8" O.D., constructed of copper tube, aluminum fin, and copper headers with schedule 40 steel pipe connectors.

.2 Fins constructed of aluminum or copper shall be rippled for maximum heat transfer and shall be mechanically bonded to the tubes by mechanical expansion of the tubes. The coils shall have a galvanized steel casing. All coils shall be factory tested with air at 300 psig (2070 kPa) while immersed in an illuminated water tank.

.3 Headers with schedule 40 steel pipe connections utilize male N.P.T. up to 100mm connections.

.4 Headers shall be outside the air-handling unit for maximum serviceability except for blow through applications where headers are internal. The non-headered end of the coil shall be fully concealed. Provide auxiliary drain pan complete with 13mm MPT drain connection at headered end of cooling coils.

.5 Coils shall be removable from the unit at the header end, unless shown otherwise on the drawings. All water coils shall be equipped with a capped vent tapping at the top of the return header or connection, and a capped drain tapping at the bottom of the supply header or connection.

.6 Water and glycol coils shall be circuited to provide adequate tube velocities to meet design requirements. Internal turbulators are not acceptable.

.7 5/8” O.D. tube diameter water coils shall be ARI Certified.

.5 Filters

.1 Refer to air handling unit schedule

.6 Dampers

.1 Damper frames shall be U-shaped galvanized metal sections securely screwed or welded to the air handling unit chassis. Pivot rods of 1/2" (13mm) aluminum shall turn in nylon or bronze bushings. Rods shall be secured to the blade by means of straps and set screws.

.2 Dampers shall be extruded aluminum low leak airfoil Tamco Series 1000 with extruded aluminum, low leak, thermally broken, insulated blade Tamco Series 9000 for all outside air dampers. DDC controls by Control Trade.

.3 Mixing dampers shall be parallel blade type. Return and outside air mixing dampers blades will be directed into each other.

.4 Two position inlet dampers shall be parallel blade type.

.5 Gravity relief dampers shall be single blade gasketted design.

.7 Factory Supplied Controls/Wiring

.1 Provide a system of motor control, including all necessary terminal blocks, motor contactors, motor overload protection, grounding lugs, control transformers, auxiliary contactors and terminals for the connection of external control devices or relays. Variable frequency drives provided by Controls Section.

.2 Fire alarm circuits (where required) shall be powered from a relay in unit circuitry.

.3 Automatic controls shall be provided by Controls Trade.

Part 3 Execution

3.1 INSTALLATION

.1 Provide appropriate protection apparatus.

.2 Install units in accordance with manufacturer's instructions and as indicated.

.3 Ensure adequate clearance for servicing and maintenance.

3.2 FANS

.1 Install fan sheaves required for final air balance.

.2 Install flexible connections at fan inlet and fan outlets.

.3 Install vibration isolators.

3.3 DRIP PANS

.1 Install deep seal P-traps and trap seal primer on drip lines.

.1 Depth of water seal to be 1.5 times static pressure at this point.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and installation for fan coil units.

1.2 SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.1 Product data to include:

.1 Filters, fan accessibility.

.2 Suspension of cabinet.

.3 Physical size.

.4 Thermostat, transformer, controls where integral.

.5 Finish.

.6 kW rating, voltage, phase.

.7 Cabinet material thicknesses.

.2 Shop Drawings:

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Product Requirements.

Part 2 Products

2.1 FAN COIL UNITS (DIRECT DRIVE)

.1 General - Slimline hideaway type, direct drive fan-coil units. Types, sizes and performance shall be as tabulated in the unit schedule.

.2 Horizontal hideaway (TSH) - Basic unit shall consist of base casing and optional return air plenum fabricated of heavy-gauge galvanized steel with four-sided 20mm duct collar for ease of connecting discharge ductwork. Return air plenum shall have a filter frame with one-inch return air duct collar that can be interchanged for back or bottom return air. Provide TSC with enclosed cabinet as per Schedule. Plenum shall be fully insulated with 12mm multi-density glass fiber to prevent unit sweating and attenuate fan noise.

.1 Electrical Raceway - Unit shall have an electrical raceway providing a single location for all field wiring connections. All factory mounted electrical components shall have wire leads terminating in the unit raceway.

.2 Coils - Coils shall have aluminum fins with copper tubes mechanically expanded for a permanent bond. Water coils shall have a manual air vent. Unit performance shall be as tabulated in the schedule.

.3 Fan Assembly - Fans shall be DWDI forwardly curved, centrifugal type. Fan housing shall be fabricated of heavy-gauge galvanized steel and of two-piece construction with a split fan housing that is easily removed, thus allowing complete service access to the fans and motors.

.4 Motors - Units shall have 115/60/1 three-speed, sleeve bearing, permanent split capacitor motors with oilers, inherent thermal overload protection with automatic reset and resilient mounts.

.5 Speed Control - Units shall have a three-speed switch with integral on/off switch suitable for wall mounting or unit mounting which shall provide high/medium/low fan speed control.

.6 Drain Pan - Drain pan shall be constructed of 20-gauge galvanized steel, insulated with 1/2" multi-density fiberglass insulation.

.7 Filters - Filters shall be throwaway type.

.8 Valve Packages - Valve packages shall consist of 2-way motorized valve with gate hand valve on supply and ball hand valve on return piping. Two-way motorized valve packages shall have bypass capillary tubes to provide minimal flow to enable automatic changeover aquastats, where required, to sense system water temperature.

.9 Refer to Schedule.

2.2 FAN COIL UNITS - BELT DRIVE TYPE

.1 General - large capacity hideaway type, belt drive cabinet type, belt drive fan-coil units. Types, sizes and performance shall be as tabulated in the unit schedule.

.2 Cabinet shall be a horizontal console type fabricated of continuous galvanized steel and finished with an electrostatically applied, baked-on enamel paint. All panels shall be insulated with 25mm neoprene coated glass fiber. Discharge panel shall be equipped with stamped grille. Back panel shall have a 50mm filter frame with bottom filter access and be complete with duct collar. Filter shall be 50mm throwaway type. Bottom and side panels shall be removable for inspection and maintenance.

.3 Cabinet (Hideaway Type) - Cabinet shall consist of a base casing with return air plenum fabricated of continuous galvanized steel. Return air plenum shall be insulated with 25mm neoprene coated glass fiber, and have a filter frame for back or bottom return air. Filter shall be 50mm throwaway type.

.4 Fans shall be double width, double inlet, forward curved centrifugal type, dynamically balanced and mounted on solid-steel shaft. Fan bearings shall be permanently lubricated, resiliently mounted, self-aligning ball bearings.

.5 Coil shall be of the extended surface fin and staggered tube type constructed at 12mm O.D. seamless copper tubing and aluminum fins. All coils shall have manual vents. Coil capacity shall be as tabulated in the unit schedule.

.6 Drain pan shall be fabricated of continuous galvanized steel, insulated with closed cell insulation and sealed with mastic.

.7 Motor mount shall be a hinged type for simple belt tension adjustment and be securely fastened to unit. Drive shall be V-belt with a variable pitch motor sheave. Motor shall be drip-proof type with a minimum horsepower and electrical service as tabulated in the unit schedule.

.8 Provide secondary drain pan and vibration isolators.

.9 Refer to Schedule.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Hang units, c/w spring isolators.

.2 Make power and control connections.

3.3 CLEANING

.1 Proceed in accordance with Section 01 74 00 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and installation for electric ductless split cooling units, and accessories.

.2 Related Sections:

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 78 10 - Closeout Submittals.

.3 Section 26 05 01 - Common Work Results - Electrical.

1.2 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet for electric cooling units, and accessories. Include information as follows:

.1 Replacement data for motor element, thermostat and switch.

.2 Mounting methods.

.3 kW rating.

.4 Cabinet material thicknesses.

.5 Physical size.

.6 Finish.

.7 Cabinet surface temperature.

.8 Thermostat, transformer, controls where integral.

.3 Instructions: submit manufacturer's installation instructions.

.1 Closeout Submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.3 QUALITY ASSURANCE

.1 The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.

.2 All wiring shall be in accordance with the National Electrical Code (N.E.C.).

.3 The units shall be rated in accordance with ARI Standard 210 and bear the ARI label.

.4 The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which are a set of standards applying to environmental protection set by the International Standard Organization (ISO).

.5 The outdoor unit shall be pre-charged for 70 feet of refrigerant tubing.

.6 Helium holding charge shall be provided in the evaporator.

.7 System efficiency shall meet or exceed 13.0 SEER.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Delivery, Storage and Handling:

.1 Unit shall be stored and handled according to the manufacturer's recommendation.

.2 The wired controller shall be shipped inside the carton with the indoor unit and able to withstand 105° F storage temperatures and 95% relative humidity.

Part 2 Products

2.1 COOLING UNITS

.1 System Description:

.1 The air conditioning system shall be a Mitsubishi Electric split system with Variable Compressor Speed Inverter Technology (VCSI). The outdoor unit shall be pre-charge with R410A refrigerant. The system shall consist of a wall mounted suspended evaporator section with wired control and a horizontal discharge, single phase outdoor unit. Indoor unit model numbers are

System Model Numbers	
Indoor Units	**Outdoor Units**
PKA-A12GA	PUY-A12NHA
PKA-A18GA	PUY-18NHA
PKA-A24FA	PUY-A24NHA
PKA-A30FA	PUY-A30NHA
PKA-A36FA	PUY-36NHA

.2 Warranty:

.1 The units shall have a manufacturer's warranty for a period of one (1) year from date of installation. The compressor shall have a warranty of six (6) years from date of installation. If during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. This warranty does not include labour. Manufacturer shall have twenty years experience in the Canadian market.

.3 Performance:

.1 Each system shall perform in accordance to the ratings shown in the table below. Performance shall be based on 19.4°C WB, 26.6°C DB for the indoor unit and 23.8°C WB, 35°C DB, for the outdoor unit.

System Model Number	Capacity kW	TPW	SEER	Indoor l/s (Hi)
PKA-A12GA	1.75 - 3.5	1210	13.8	200
PKA-A18FA	2.34 - 5.2	2240	14.1	200
PKA-A24FA	3.5 - 7.03	2650	13.5	332
PKA-A30FA	3.5 - 8.79	4400	13.0	332
PKA-A36FA	3.5 - 10.2	5030	13.1	467

TPW = Total Power Watts

.4 Indoor Unit:

.1 The indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board and fan motor. The unit in conjunction with the remote controller shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit refrigerant pipes will be charged with helium air before shipment from the factory.

.5 Unit Cabinet:

.1 The casing shall be ABS plastic and have a munsell 3.4Y 7.7/0.8 finish. Multi-directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining shall be standard. There shall be a separate back plate which secures the unit firmly to the wall.

.6 Fan:

.1 The evaporator fan shall have a line flow fan driven by a single motor. The fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. Manual adjustable louvers shall be provided to laterally change the direction of airflow. A motorized vane shall close the outlet port when operation is stopped. It shall also automatically direct air flow in a vertical direction for uniform air distribution.

.2 The indoor fan shall consist of 2 speeds, Low and Hi.

.7 Filter:

.1 Return air shall be filtered by means of an easily removed washable filter.

.8 Coil:

.1 The evaporator coil shall be of nonferrous construction with aluminum strake pre-coated fins on copper tubing. All tube joints shall be brazed with phoscopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil.

.9 Electrical:

.1 The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz. The system shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts. The unit shall have an optional, shared power supply between indoor and outdoor units or individual power supply.

.10 Control:

.1 This unit shall have a wired controller to perform input functions necessary to operate the system. The wire controller shall have multi-language, a large DOT liquid crystal display and a weekly timer with eight pattern settings per day. The controller shall consist of an On-Off switch, Cool/Dry-Fan selector, Thermostat setting, Timer Mode, High-Low fan speed, Auto Vane selector, Test Run switching and Check Mode switching. The controller shall have a built in temperature sensor. Temperature changes shall be by 1°F increments with a range of 19-30°C. Temperature displayed in both °F and °C. The control system shall consist of two (2) microprocessors interconnected by a single non-polar two wire cable.

.2 Normal operation of the remote controller provides individual system control in which one remote controller and one indoor unit are installed in the same room.

.3 The controller shall have the capability of controlling up to a maximum of sixteen systems at a maximum developed control cable distance of 1,500 feet.

.4 Field wiring shall run direct from the indoor unit to the controller with no splices.

.5 Manufacturer shall provide 2 conductor non-polar 22 AWG. stranded wire for connection to remote controller.

.6 The system shall include self-diagnostics including total hours of compressor run time. Diagnostics codes for indoor and outdoor unit shall be displayed on wired remote panel.

.7 Controller shall display operating conditions such as pipe temperatures (i.e. liquid, discharge, indoor and outdoor), compressor operating conditions, including (running current, frequency, input voltage, on/off status and operating time), LEV opening pulses, sub cooling and discharge super heat.

.8 The microprocessor within the wall mounted remote controller shall provide automatic cooling, display set point and room temperature. Control system shall control the continued operation of the air sweep louvers, as well as provide on/off and system/mode function switching. The controller shall have the capability to provide sequential starting with up to fifty seconds delay. Two remote controllers can be used to control one unit.

.9 The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from the wired controller, providing emergency operation and controlling the outdoor unit. The control voltage from the controller to the indoor unit shall be 12 volts, DC. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. The system shall be capable of automatic restart when power is restored after power interruption.

.11 Outdoor Unit:

.1 The outdoor unit shall be compatible with PKA-wall mount indoor units. The indoor units must be of the same capacites as the outdoor unit. Models PUY-A24NHA and PUY-A36NHA shall have the option to connect two indoor units (total capacity to be equivalent to outdoor unit) to improve air distribution. The outdoor unit shall be equipped with a control board that interfaces with the indoor unit to perform all functions necessary for operation. The outdoor unit shall contain Variable Compressor Speed inverter Technology. The outdoor unit shall be completely factory assembled. The outdoor unit shall be capable of operating at -40°C ambient temperature. The outdoor unit must have the ability to operate with a maximum height difference of 100 feet and have a max. refrigerant tubing length of 165 feet (PUY-A12/A18NHA shall have max. pipe length of 100 feet) between indoor and outdoor units without the need for line size changes, traps or additional oil. Each unit must be test run at the factory.

.12 Cabinet:

.1 The casing shall be constructed from galvanized steel plate and finished with acrylic paint munsell 3Y 7.8/1.1 The fan grille shall be of ABS plastic

.13 Fan:

.1 The unit shall be furnished with one AC fan for models PUY-A24, 30 & 36, PUY-A12 & 18 shall have one DC fan and PUY-A42 shall have two DC fans. The motor bearings shall be permanently lubricated. The fan blade shall be of aerodynamic design for quiet operation. The fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front.

.14 Coil:

.1 The L shaped condenser coil shall be of copper tubing with flat aluminum fins to reduce debris build up. The coil shall be protected with an integral metal guard.

.2 Refrigerant flow from the condenser shall be controlled by means of linear expansion valve (LEV) metering orifice. The LEV shall be control by a microprocessor controlled step motor.

.15 Compressor (VCSI):

.1 The compressor shall be a Rotary (PUY-A42NHA, shall be scroll type) Compressor with Mitsubishi’s Variable Compressor Speed Inverter Technology (VSCI). The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall match the room load to significantly increase the efficiency of the system which results in vast energy savings. During the off cycle, a minimal amount of current shall be intermittently applied to the compressor motor, to maintain enough heat to prevent liquid from accumulating in the compressor. The outdoor unit shall have an accumulator and high pressure safety switch.

.16 Electrical:

.1 The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz. The unit shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts. The outdoor unit shall be controlled by the microprocessor located in the indoor unit. The control signal between the indoor unit and the outdoor unit shall be pulse signal 24 volts DC. The unit shall have pulse amplitude modulation circuit, this shall enable the unit to use 98% of input power supply.

.17 Refer to Schedule.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Install in accordance with manufacturer's written instructions.

.2 Make power and control connections.

3.3 CLEANING

.1 Perform cleaning operations as specified in Section and in accordance with manufacturer's recommendations.

.2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

1.2 PRODUCT DATA

.1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit product data sheets for unit heaters. Include:

- .1 Product characteristics.
- .2 Performance criteria.
- .3 Mounting methods.
- .4 Physical size.
- .5 kW rating, voltage, phase.
- .6 Cabinet material thicknesses.
- .7 Limitations.
- .8 Colour and finish.

.3 Manufacturer's Instructions: Provide to indicate special handling criteria, installation sequence, cleaning procedures.

1.3 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Indicate:

- .1 Equipment, capacity and piping connections.
- .2 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, sizes and location of mounting bolt holes.

1.4 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for unit heaters for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

Part 2 Products

2.1 CABINET UNIT HEATERS

.1 Refer to Force Flow Schedule.

.2 Cabinet: type surface, semi-recessed, recessed, or ducted as indicated, 1.6 mm thick steel with rounded exposed corners and edges, removable panels, glass fibre insulation and integral air outlet and inlet.

.3 Finish with factory applied primer coat.

.4 Coils: aluminum fins mechanically bonded to copper tubes. Hydrostatically tested to 1 MPa.

.5 Fans: centrifugal double width wheels, statically and dynamically balanced, direct driven, sleeve bearings, resilient mounted.

.6 Motor: multi-speed, tapped wound permanent split capacitor type with sleeve bearings, built-in thermal overload protection and resilient rubber isolation mounting.

.7 Filters: permanent washable type.

.8 Capacity: as indicated.

.9 Control:

.1 2 speed switch with integral overloads in cabinet.
.2 Low limit aquastat strapped on to hot water heating supply set to prevent fan operating below 27 ^{o}C.
.3 Control thermostat: by EMCS Section.

2.2 HORIZONTAL UNIT HEATERS

.1 Refer to Schedule.

.2 Casing: 1.6 mm thick cold rolled steel, gloss enamel finish, with threaded connections for hanger rods.

.3 Coils: seamless copper tubing, silver brazed to steel headers with evenly spaced aluminum fins mechanically bonded to tubing. Hydrostatically test to 1 MPa.

.4 Fan: direct drive propeller type, factory balanced, with anti-corrosive finish and fan guard.

.5 Motor: speed as indicated continuous duty, built-in overload protection, and resilient motor supports.

.6 Air outlet: two-way adjustable louvres.

.7 Capacity: Glycol or hot water heating capacity as per schedule.

.8 Control and room thermostat: by EMCS.

Part 3 Execution

3.1 INSTALLATION

.1 Install in accordance with manufacturer's instructions.

.2 Provide double swing pipe joints as indicated.

.3 Check final location with Contract Administrator if different from that indicated prior to installation.

.1 Should deviations beyond allowable clearances arise, request and follow Contract Administrator's directive.

.4 Water units: for each unit, install gate valve on inlet and lockshield globe balancing valve on outlet of each unit. Install drain valve at low point.

.1 Install manual air vent at high point.

.5 Clean finned tubes and comb straight.

.6 Provide supplementary suspension steel as required.

.7 Install thermostats in locations indicated.

.8 Before acceptance, set discharge patterns and fan speeds to suit requirements.

□ END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Provide complete extruded linear panel system.

1.2 SUBMITTALS

.1 Product Data:

  .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.2 Shop Drawings:

  .1 Submit shop drawings and floor plan layout in accordance with Section 01 33 00 - Submittal Procedures.

  .2 Pay costs for autocad drawings provided by Contract Administrator.

.3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

  .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

  .2 The mechanical contractor shall furnish all labour, materials, tools, equipment, appliances and services necessary to deliver and install all radiant panels as defined.

  .3 Supplier shall submit complete shop drawings showing lay outs, fixing details and piping details of all areas where radiant panels are indicated. These drawings shall be coordinated with, and interference cleared with other trades.

.4 Closeout Submittals

  .1 Submit maintenance data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

  .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Product Requirements.

Part 2 Products

2.1 GENERAL

.1 Product - Linear Radiant Panels Type ‘A’

  .1 Constructed of extruded aluminum planks.

  .2 Width and number of tubes as per design specifications.

.3 Tube saddle shall be an integral part of the aluminum plank.

.4 Circulation tubing shall be 16 mm (5/8") O.D. round tubing mechanically fastened the plank. A non hardening heat transfer paste is required between the tubing and the aluminum saddle.

.5 Planks shall interlock using tongue and groove connection and be held together using aluminum cross channels with spring clips. Panels must be factory assembled. Panels requiring site assembly are not acceptable.

.6 The length of the panels shall be based on lengths supplied by the Mechanical Contractor. The factory to allow for expansion before the final cut. No site cutting allowed.

.7 Panel performance shall be that of Frenger linear extruded ceiling panel manufactured by Twa Panel Systems Inc. of Edmonton, Alberta. Capacities of installed panels shall be as called in the specifications and shown on the drawing.

.8 Panel shall consist of (4)- 150mm sub panels fully assembled at the factory with continuous serpentine copper tubing for all panels up to 4M long. Manufactures not capable of providing continuous copper tubing for the entire width (600mm) of the panel shall factory solder "U" bends, pressure test each panel and submit pressure report test to Contract Administrator.

.9 Provide flanges around panel for drywall installation type.

.10 Refer to Specification Details. Provide final installation details at shop drawing submittal stage.

.11 Provide 300 x 600 sample at shop drawing time for City's approval.

.12 Provide recessed drapery track as per Schedule.

.13 Provide integral access panels in drywall ceiling applications.

.14 Alternate manufacturers will not differ from Twa Panel Systems with regard to number of tube rows, water pressure drops, piping connections and such features as surface finish and cleanability.

.15 Submit sample for Contract Administrator's approval before bid opportunity for approval.

.16 Refer to Schedule for capacities.

  .1 Width: 600mm.

  .2 Length: Wall to wall.

  .3 Output based on Mean Water Temperature of 82.2°C and Room Temperature of 22°C.

  .4 The maximum water pressure drops shall be in accordance with the following: Flow of:

    .1 0.1 gpm - pressure drop over 100 feet of tube = ½ ft

    .2 1.0 gpm - pressure drop over 100 feet of tube = 2 ft

    .3 2.0 gpm - pressure drop over 100 feet of tube = 7 ft

    .4 2.5 gpm - pressure drop over 100 feet of tube = 10 ft

    .5 3.0 gpm - pressure drop over 100 feet of tube = 14 ft

.2 Product Security Radiant Panels - Type ‘AS’ or ‘BS’

.1 Each panel shall consist of one piece flat face plate manufactured from sheets of 3.5mm cold reduced rigid steel with no welded seams or joints.

.2 Each panel shall be factory primed and pained with an acrylic baked enamel finish.

.3 The pipe coil shall be 16mm O.D. tubing formed into a sinuous coil at 150mm centres.

.4 The piping shall sit firmly on to an extruded aluminum heat transfer saddle which shall be uniform and one piece through the longitudinal lengths of piping. A non-hardening heat transfer paste is required between the aluminum saddle and both the face of the panel and the tubing.

.5 The tubing shall be firmly retained to the aluminum saddle with pre-sprung metal clips at 300mm spacing.

.6 The aluminum saddle shall be in turn bolted to the back of the radiant panel by means of steel studs which are to be welded to the back of the face plate.

.7 The length of the panels shall be based on lengths supplied by the Mechanical Contractor. The factory to allow for expansion before the final cut. No site cutting allowed.

.8 Panel performance shall be that of Frenger security ceiling panel manufactured by Twa Panel Systems Inc. of Edmonton, Alberta. Capacities of installed panels shall be as called in the specifications and shown on the drawing.

.9 Refer to schedule.

  .1 Width: 600mm.

  .2 Length: Wall to wall.

  .3 Output based on Mean Water Temperature of 87.2°C and Room Temperature of 21°C.

  .4 The maximum water pressure drops shall be in accordance with the following:

  Flow of: .5 gpm - pressure drop over 100 feet of tube - 1/2ft.
  1 gpm - pressure drop over 100 feet of tube - 2ft.
  2 gpm - pressure drop over 100 feet of tube - 7 ft.
  2.5 gpm - pressure drop over 100 feet of tube - 10 ft.
  3 gpm - pressure drop over 100 feet of tube - 14 ft.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 The mechanical contractor shall cooperate with other trades working in the ceiling area to achieve a neat and well coordinated installation.

.2 All support moulding shall be the responsibility of Division 9 unless specialized application is required. All wall mouldings shall be mitred with cross tees installed flush.

Perimeter moulding to be extruded aluminum - minimum 25 gauge. Ensure ceiling openings and wall mouldings are installed as per radiant panel shop drawings.

.3 All interconnecting of radiant panels by contractor shall consist of interconnecting loops and return bends supplied by panel manufacturer.

.4 Connection to supply, return piping with 16mm (5/8”) O.D. soft copper.

.5 All panels to be covered by min 25mm (1”) foil backed insulation after connection and testing of panels is complete. Insulation by Section 15180.

.6 All system piping shall be thoroughly cleaned and flushed before connecting to radiant panels. City to be present during cleaning.

.7 All radiant panels to be pressure tested as per specifications.

.8 Minimum of one hanger wire for safety and seismic restraint per crossbrace. Minimum of 2 panel.

.9 All radiant panels shall be installed by personnel wearing clean white gloves.

.10 Site measure for exact lengths and co-ordinate with reflected ceiling layout. Provide shop drawing indicating layout for each floor.

3.3 INSTALLATION SECURITY TAPE

.1 Angle iron, size detailed on drawings, shall be installed around the perimeter of the concrete slab and recessed such to support and secure radiant panels in place. Install angle iron such that final radiant panel position is flush with room ceiling.

.2 Angle iron shall be secured to structure by concrete anchor bolts. Anchor bolt size and spacing to be detailed on drawings.

.3 Angle iron, once installed and prior to radiant panel installation, shall be painted with acrylic primer.

.4 Along the perimeter of the radiant panel, holes shall be factory drilled at predetermined intervals to accommodate slotless fasteners and bushings.

.5 Expansion gap between panel and walls shall be packed with heat resistant, flexible silicone compound (GE 1200) to allow for expansion and contraction of radiant panels.

.6 Threaded tappings shall be field drilled by the contractor in support angle iron to suit spacing and size on radiant panel for slotless fasteners.

3.4 CLEANING

.1 Proceed in accordance with Section 01 74 00 - Cleaning.

3.5 EQUIPMENT

.1 Refer to Schedule.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

- .1 Materials and installation for packaged gas-fired steam generating type humidifiers and accessories.
- .2 Complete and operable humidification system which meets applicable building codes.
- .3 Equipment start-up and project inspection by qualified factory trained representative.

.2 Quality Assurance

- .1 Manufacturer: For each product specified, provide components by same manufacturer throughout.
- .2 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authority having jurisdiction, and marked for intended use.
- .3 Comply with ARI 640, "Standard for Commercial and Industrial Humidifiers."
- .4 Products shall be supported with a warranty that ensures the product will be free from defects in materials and workmanship for a period of two years after shipment.
- .5 Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the City's operation and maintenance personnel, is required in cooperation with the Commissioning Authority. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Project Closeout, Section 01700, for substantial completion details.
- .6 Products specified below are to be manufactured is an ISO 9001-2000 certified facility.

.3 Related Sections:

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 78 10 - Closeout Submittals.
- .3 Section 23 31 14 - Metal Ducts - Low Pressure to 500 Pa.
- .4 ARI 640, Standard for Commercial and Industrial Humidification.

1.2 REFERENCES

.1 References

- .1 ANSI/NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet for heating, ventilation and air conditioning distribution piping and ductwork.

.3 Shop Drawings:

.1 Submit shop drawings to indicate project layout, dimensions and extent of humidification system.

.4 Instructions: submit manufacturer's installation instructions.

.5 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 10 - Closeout Submittals.

.6 Submit coordination drawings. Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, and dispersion tubes. Detail humidifiers and adjacent equipment. Show support locations, type of support, weight on each support, and required clearances.

.7 Submit wiring diagrams including power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

.8 Submit minimum water quality requirements and water pressure requirements.

1.4 MAINTENANCE

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 10 - Closeout Submittals.

Part 2 Products

2.1 GAS FIRED STEAM HUMIDIFIER -GSTC

.1 Packaged unit, floor mounted, gas-fired, steam generating system available at 105 lbs/hr (48 kg/hr) suitable for immediate, or future, use of all water types including, De-Ionized (DI), Reverse Osmosis (RO), potable and softened water, without modification required, CSA certified.

.2 Packaged unit, wall mounted, methods of distribution require a Short Absorption Manifold [SAM-e] for mounting into AHU.

.3 Enclosed cabinet, powder painted steel construction and air gap between cabinet and insulated humidifier tank ensures safe surface temperature.

.1 Evaporation tank and all internal tank components to be constructed of 304 stainless steel.

.2 Humidifier requires zero clearance to combustibles and shall be installed against a partition to minimize floor space required. All tank surfaces shall be insulated with minimum 1" (25 mm) thick insulation and enclosed within unit cabinetry to ensure safe surface temperature, high overall efficiency, and fast unit response time. Units with exposed insulation shall not be acceptable.

.3 Humidifier shall be supplied with integrated, adjustable, telescopic stand with cross bracing.

.4 Maintenance shall not require the removal of the steam lines.

.5 Standard internal drain water cooler to ensure drain water tempering to 140º F (60 ºC). If external drain water cooler required, provide factory cross-braced unit stand and factory supplied stainless steel p-trap.

.6 Blow-down p-trap, factory installed, enclosed in cabinet, prevents steam leakage to drain. Field installation not acceptable.

.7 Provide easily accessible, primary voltage terminal block, internal to cabinetry, for single point field connection of electrical supply.

.8 Single point connection for gas inlet must be provided. Internal piping from gas inlet to burners must be factory installed and tested. Field piping from the gas inlet to the burners is not allowed.

.9 Humidifier to prevent "back-siphoning" using an internal air gap for supply water, to meet local plumbing codes.

.10 Drain line to include a vacuum breaker to prevent siphon drainage of the tank.

.11 Allowance for combustion air shall be provided in cabinet ventilation design. Option for direct vent of combustion must be available for use with BH exhaust vent.

.4 Gas appliance shall be low emission. Units with Carbon Monoxide (CO) levels higher than 10 ppm and Nitrous Oxide (NOx) levels above 40 ppm are not acceptable.

.1 System shall be rated as a class III appliance certified for use with exhaust vent type BH and use with direct vent of combustion air. <Must be specified for factory configuration>

.5 Stainless Steel combustion chamber(s)/heat exchanger(s) shall have flat surfaces to retard scale build-up. Tubular heat exchangers are not acceptable.

.1 Each burner, capable of true modulation will provide steam production of 25 to 105 lbs/hr (11 to 48 kg/hr). Time proportioning modulation is not acceptable.

.2 Gas system with gas valve(s), explosion proof, premix combustion air blower(s), microprocessor controlled ignition, flame sensing and fault indicator light(s), 100% premix infrared burner(s), hot surface igniters(s) and heat transfer efficiency maintained over all operating ranges.

.3 Blower speed rotation must to be monitored to ensure proper control of input modulation. System will lock out gas valve operation if proper blower speed is not detected.

.4 A secondary combustion air safety, in addition to blower speed monitoring, utilizing a mechanical pressure differential switch, must be used with each blower to ensure combustion air is entering the pre-mix blower properly.

.5 Modular heat exchanger shall be easily removable through unit sidewall.

.6 Removable cover at front of unit facilitates easy cleaning (when applicable) with complete access to tank and heat exchanger surfaces.

.6 Automatic water level control within a separate float chamber, isolated from the boiling action, to prevent false water level indication.

- .1 Fill rate must modulate to match capacity demand to ensure consistent output. Fill cycles based on low water only is not acceptable.
- .2 System shall fill through the bottom of the tank to reduce steam-quenching effect and noise level. Filling at top of the tank is not acceptable.
- .3 Unit water level is to be continuously monitored with a dual magnetic electronic float system, located outside of the boiling water to ensure accurate water level control and reduced maintenance. Cool fill water is to be supplied into the sensing chamber to keep the device cool. Systems using conductivity probes or floats located within hot reservoir water are not acceptable.
- .4 Tank and float chamber to be separated with a minimum of 1" (25 mm) rigid insulation, minimizing potential scale build up on float mechanisms, due to heating of the contained water.
- .5 Humidifier shall have a dual fill valve to feed water to the tank and float chamber, to reduce scaling and mineral build up on the magnetic floats.
- .6 Float chamber to include LED indication of five possible water level indications.
- .7 Ongoing self-diagnostics including periodic float operation and fill/drain rate verification.
- .8 Positive drainage/blow-down using a drain pump, drawing water from the bottom of the tank, maximizing mineral evacuation (when applicable). Skimmer not acceptable.
- .9 Blow down interval shall be based on actual steam production, and must be adjustable to compensate for all water conditions, to ensure maximum energy and maintenance efficiency.
- .10 Pre-cleaning flushing feature shall be provided to reduce maintenance time.
- .11 Must include end of season blow-down feature to evacuate contained water and minerals after 72 hours with no demand for humidification.

.7 Factory mounted, full size, backlit, Liquid Crystal Display provides full operational status. Display to include a keypad for user interface and adjustment of operational parameters including:

- .1 Unit output (lbs/hr or kg/hr) 25 lbs/hr to full output.
- .2 Water level in the tank.
- .3 Modulating control demand status.
- .4 On/off control and safety (High limit, air proving) circuit status.
- .5 Actual room and/or duct RH, and humidity set point, when using transducer input(s).
- .6 Controller configuration (Proportional band and integral) when using transducer input(s).
- .7 Troubleshooting guide with scroll down menu.
- .8 Fault indication including date and time history.
- .9 Maintenance intervals.
- .10 Fill and drain status.
- .11 Drain/flush intervals and duration.

.12 Date and time.

.13 Capacity limitation.

.14 72 hours drain enable/disable.

.15 Control type configuration on/off or full modulation when demand signal(s), or transducer input(s) are provided.

.16 Up to 10 humidifiers, supplying one AHU or area, can be controlled in series from one modulating humidity control system.

.17 Option for Johnson N2 or Modbus interface for monitoring and control from a Building Management System (BMS).

Note: All operational parameters factory set to reduce field set-up time.

.8 Standard of acceptance: NORTEC GSTC.

.9 Optional accessories:

.1 Refer to schedule.

.10 Short Absorption Manifold (Humidifier Steam Dispersion Panel) - SAM-e

.1 Short Absorption Manifold designed for atmospheric steam humidifiers to directly inject the steam into ducted air for humidification.

.2 Absorption distance characteristic shall prevent water accumulation on any in-duct surfaces beyond specified distance downstream of the steam dispersion panel.

.3 Steam dispersion panel consisting of horizontal stainless steel header supplying steam to a bank of closely spaced 75mm vertical tubes, as necessary to meet absorption distance requirements, and to reduce condensation losses.

.4 Single horizontal stainless steel header to provide steam to vertical distributor tubes and to reduce condensation losses. Dual header systems creating unnecessary condensation, or systems needing to be installed on a partition or requiring blank off plates are not acceptable.

.5 Header design is primarily round tube to minimize pressure drop. Square headers are not acceptable.

.6 Steam inlet and condensate return located on the same side and at the bottom of the header to allow single point entry and floor mounting.

.7 Headers are 304 stainless steel construction.

.8 Vertical stainless steel distribution tubes to promote condensate evacuation. Horizontal distributor tubes are not accepted.

.9 Distribution tubes shall include threaded standoffs for trouble free attachment to factory supplied support bracket.

.10 All tubes are 304 stainless steel construction.

.11 Stainless steel nozzle inserts ensure condensate free steam is discharged from the center of the distribution tubes. Systems without nozzle inserts, or other than stainless steel, are not acceptable.

.12 Stainless steel nozzle inserts shall have metered orifices, sized to provide even distribution of the discharged steam, spaced for optimum steam absorption.

.13 Standard of acceptance: Nortec SAM-e Short Absorption Manifold.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Install in accordance with manufacturers instructions.

.2 Humidifier and evaporator media to be new and clean when project is accepted.

.3 Co-ordinate control wiring requirements with EMCS Trade.

.4 Water service overflow drain: to manufacturers' recommendation.

.5 Install access doors or panels in adjacent ducting.

.6 Install capped drain connection at low point in duct.

.7 Coordination

- .1 Coordinate location and installation of humidifiers in air-handling units.
- .2 Coordinate location and installation of humidifier in the space it serves with the electrical, mechanical, and plumbing contractors.

.8 Execution

- .1 Examination
  - .1 Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
  - .2 Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.\Proceed with installation only after unsatisfactory conditions have been corrected.
- .2 Installation
  - .1 Install humidifiers and steam dispersion panels per manufacturers' instructions.
  - .2 Seal humidifier dispersion-tube duct penetrations with flange.
  - .3 Install with required clearance for service and maintenance.
- .3 Testing
  - .1 Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
    - .1 Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
    - .2 Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove

malfunctioning units, replace with new units, and retest. . 5 Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.3 DEMONSTRATION

.1 Training: in accordance with Section 01 79 00 – Demonstration & Training.

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

.1 Train City's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.

.2 Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."

.3 Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."

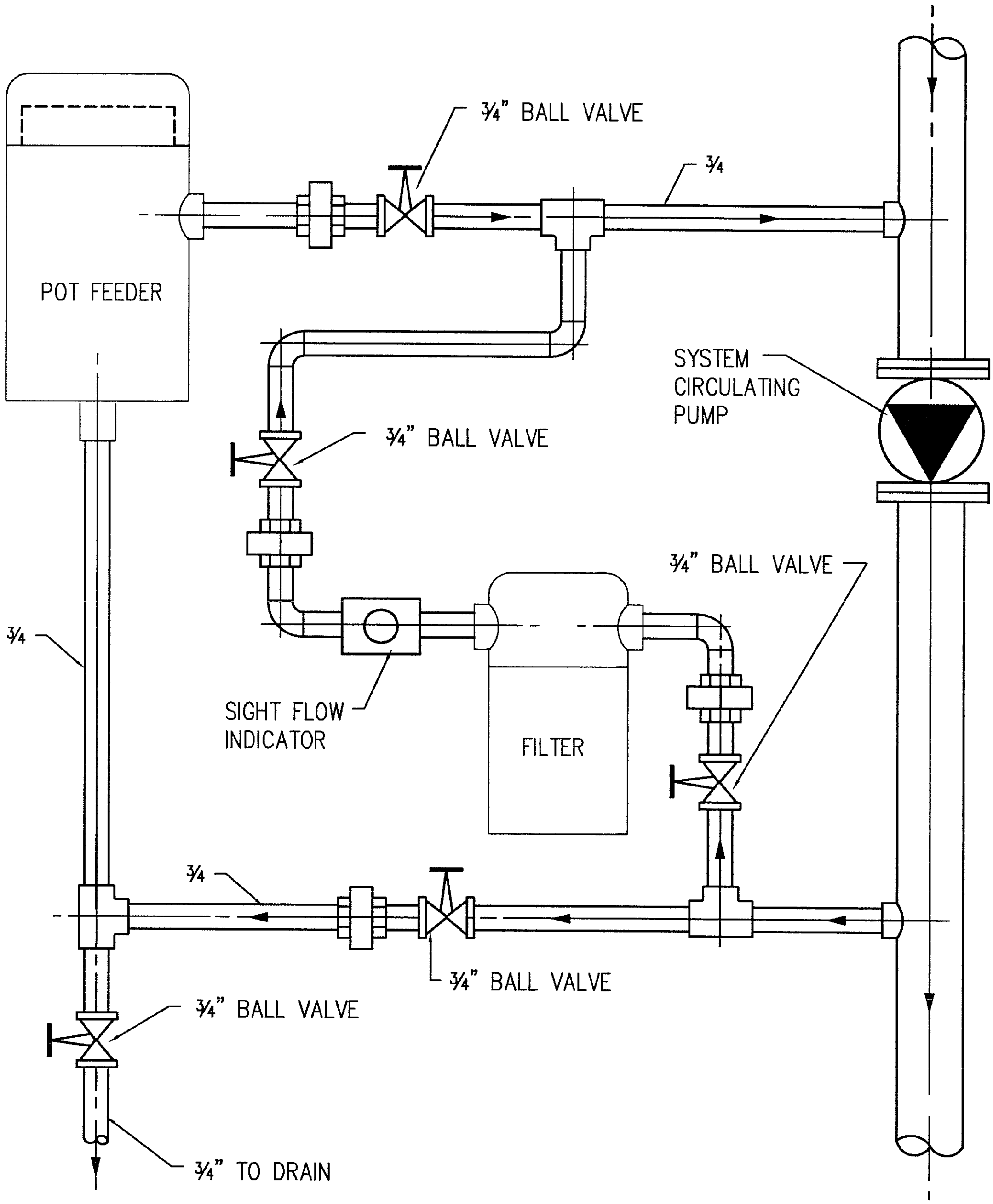
.4 Schedule training with City, through Contract Administrator, with at least seven days advance notice.

3.4 CLEANING

.1 Perform cleaning operations as specified and in accordance with manufacturer's recommendations.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION



NOTE:
INSTALL ON HOT WATER HEATING, GLYCOL HEATING, GLYCOL HEAT RECOVERY AND CHILLED WATER SYSTEMS.

CHEMICAL POT FEEDER AND FILTER

N.T.S.

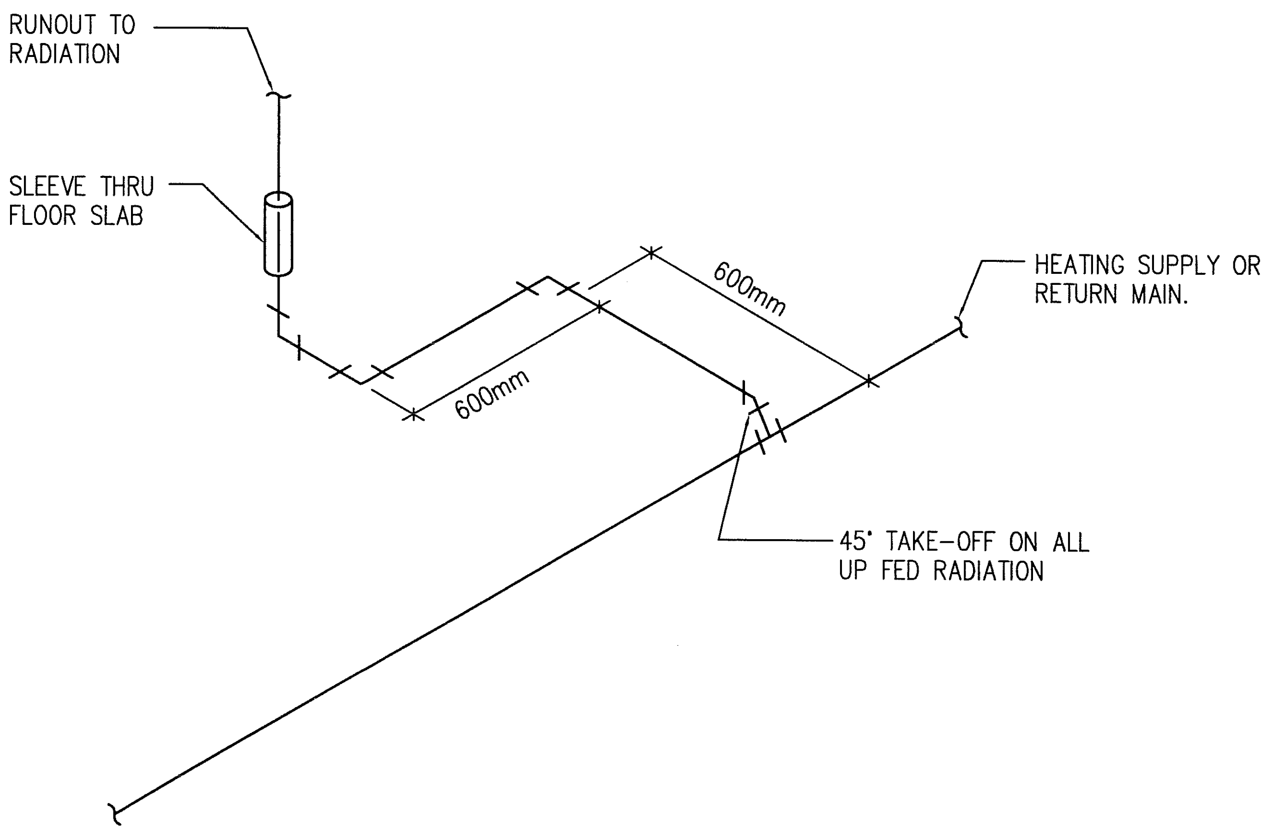
SMS ENGINEERING

SMS Engineering Ltd. Consulting Engineers
770 Bradford Street Winnipeg MB Canada R3H 0N3
Telephone 204.775.0291 Fax 204.772.2153
sms@smseng.com

SPECIFICATION DETAIL

CHEMICAL POT FEEDER AND FILTER

Drawn By	Approved By	Reference
SMS	SMS	6020
File No.	Date	Detail Sheet
04-214-01	MARCH 2007	MD-1



TYPICAL TAKE-OFF TO HOT WATER RADIATION

N.T.S.

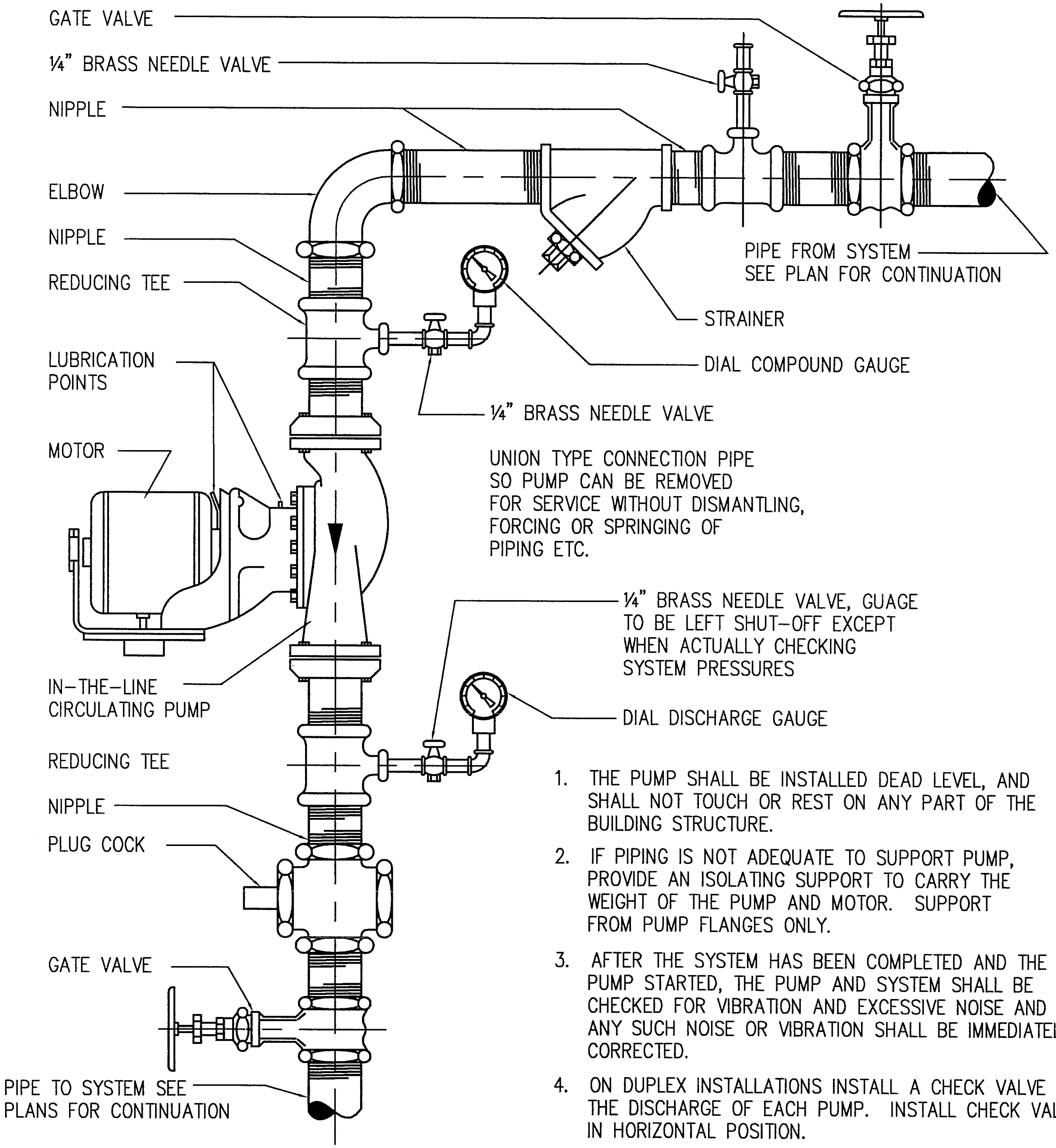
SMS ENGINEERING

SMS Engineering Ltd. Consulting Engineers
770 Bradford Street Winnipeg MB Canada R3H 0N3
Telephone 204.775.0291 Fax 204.772.2153
sms@smseng.com

SPECIFICATION DETAIL

RADIATION TAKE-OFF

Drawn By	Approved By	Reference
SMS	SMS	6050
File No.	Date	Detail Sheet
04-214-01	MARCH 2007	MD-2



1. THE PUMP SHALL BE INSTALLED DEAD LEVEL, AND SHALL NOT TOUCH OR REST ON ANY PART OF THE BUILDING STRUCTURE.
2. IF PIPING IS NOT ADEQUATE TO SUPPORT PUMP, PROVIDE AN ISOLATING SUPPORT TO CARRY THE WEIGHT OF THE PUMP AND MOTOR. SUPPORT FROM PUMP FLANGES ONLY.
3. AFTER THE SYSTEM HAS BEEN COMPLETED AND THE PUMP STARTED, THE PUMP AND SYSTEM SHALL BE CHECKED FOR VIBRATION AND EXCESSIVE NOISE AND ANY SUCH NOISE OR VIBRATION SHALL BE IMMEDIATELY CORRECTED.
4. ON DUPLEX INSTALLATIONS INSTALL A CHECK VALVE ON THE DISCHARGE OF EACH PUMP. INSTALL CHECK VALVE IN HORIZONTAL POSITION.

INSTALLATION DETAILS OF IN-LINE CIRCULATING PUMP (HEATING ONLY)

N.T.S.

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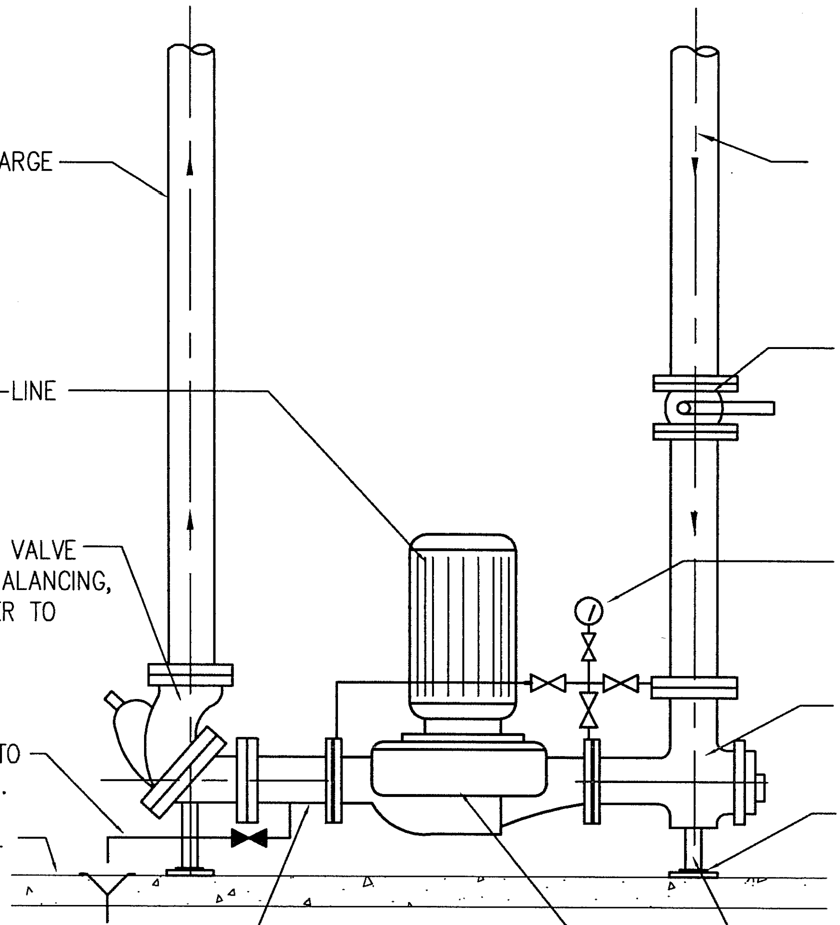
SMS Engineering Ltd. Consulting Engineers
770 Bradford Street Winnipeg MB Canada R3H 0N3
Telephone 204.775.0291 Fax 204.772.2153
sms@smseng.com

SPECIFICATION DETAIL

IN-LINE CIRCULATION PUMP (HEATING ONLY)

Drawn By	Approved By	Reference
SMS	SMS	6070
File No.	Date	Detail Sheet
04-214-01	MARCH 2007	MD-3



VERTICAL IN-LINE PUMP INSTALLATION

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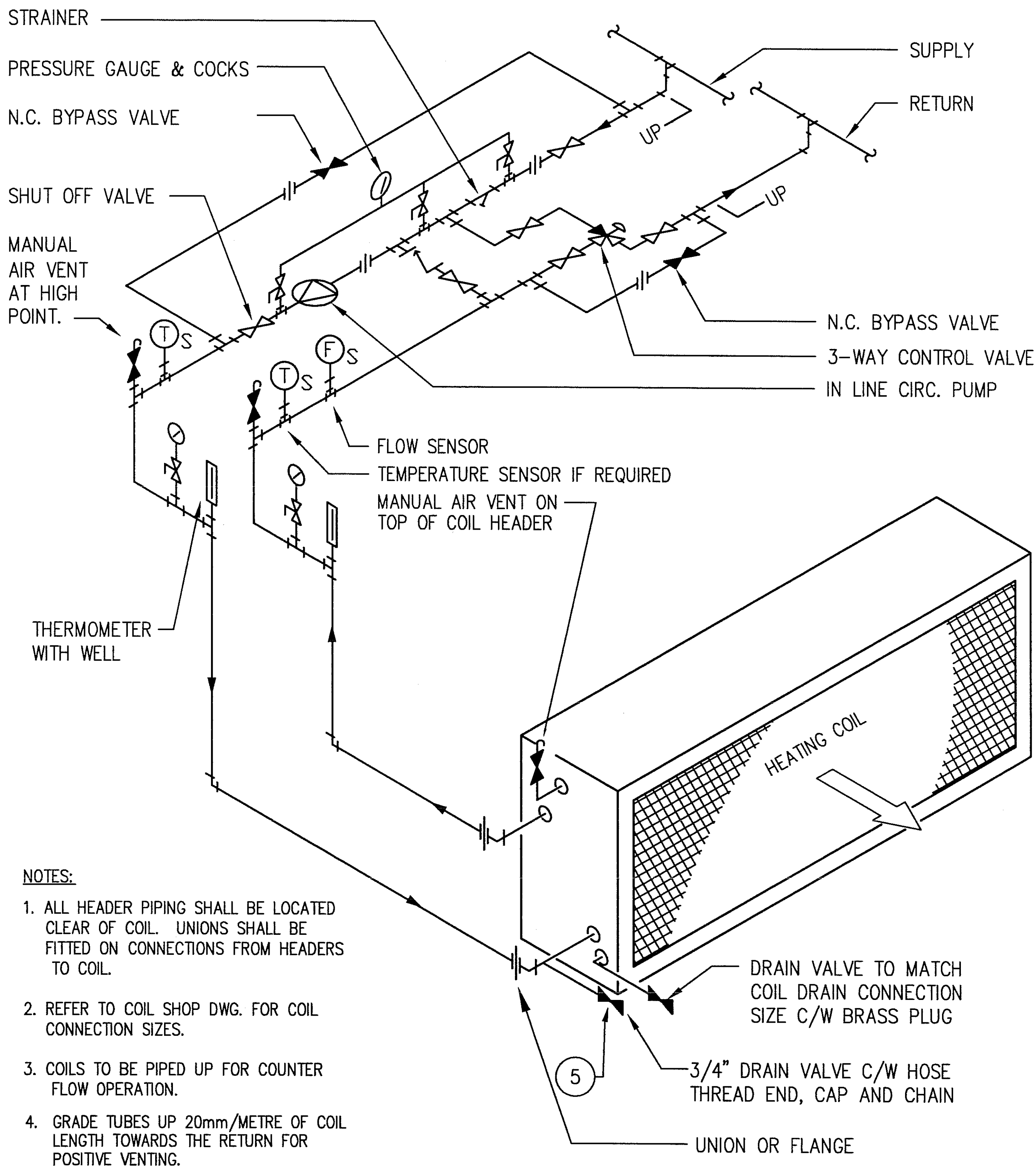
SPECIFICATION DETAIL

VERTICAL IN-LINE PUMP DETAIL FLOOR SUPPORT

Drawn By	Approved By	Reference
SMS	SMS	6072
File No.	Date	Detail Sheet
04-214-01	MARCH 2007	MD-4



NOTES:

1. ALL HEADER PIPING SHALL BE LOCATED CLEAR OF COIL. UNIONS SHALL BE FITTED ON CONNECTIONS FROM HEADERS TO COIL.
2. REFER TO COIL SHOP DWG. FOR COIL CONNECTION SIZES.
3. COILS TO BE PIPED UP FOR COUNTER FLOW OPERATION.
4. GRADE TUBES UP 20mm/METRE OF COIL LENGTH TOWARDS THE RETURN FOR POSITIVE VENTING.
5. NOT REQUIRED IF COIL DRAIN CONNECTION IS ¾" OR LARGER. IN THIS CASE COIL DRAIN VALVE SHALL BE C/W HOSE THREAD END, CAP AND CHAIN

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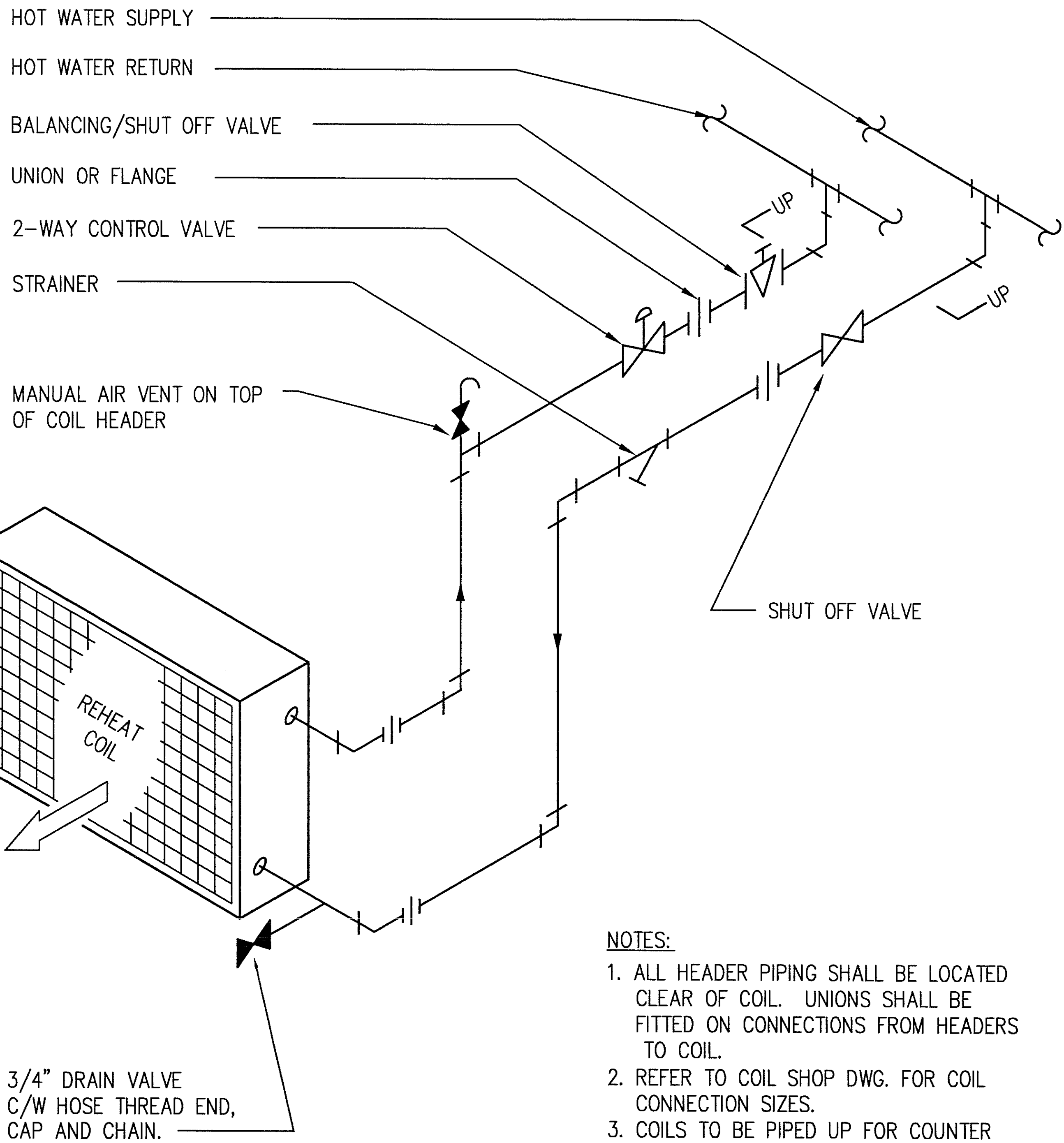
SPECIFICATION DETAIL

Revised	JUNE 2002

GLYCOL OR HOT WATER HTG. COIL SINGLE BANK, 3-WAY CONTROL, PUMP

Drawn By	Approved By	Reference
SMS	SMS	6077
File No.	Date	Detail Sheet
04-214-01	MARCH 2007	MD-5



NOTES:

1. ALL HEADER PIPING SHALL BE LOCATED CLEAR OF COIL. UNIONS SHALL BE FITTED ON CONNECTIONS FROM HEADERS TO COIL.
2. REFER TO COIL SHOP DWG. FOR COIL CONNECTION SIZES.
3. COILS TO BE PIPED UP FOR COUNTER FLOW OPERATION.
4. GRADE TUBES UP 20mm/METRE OF COIL LENGTH TOWARDS THE RETURN FOR POSITIVE VENTING.

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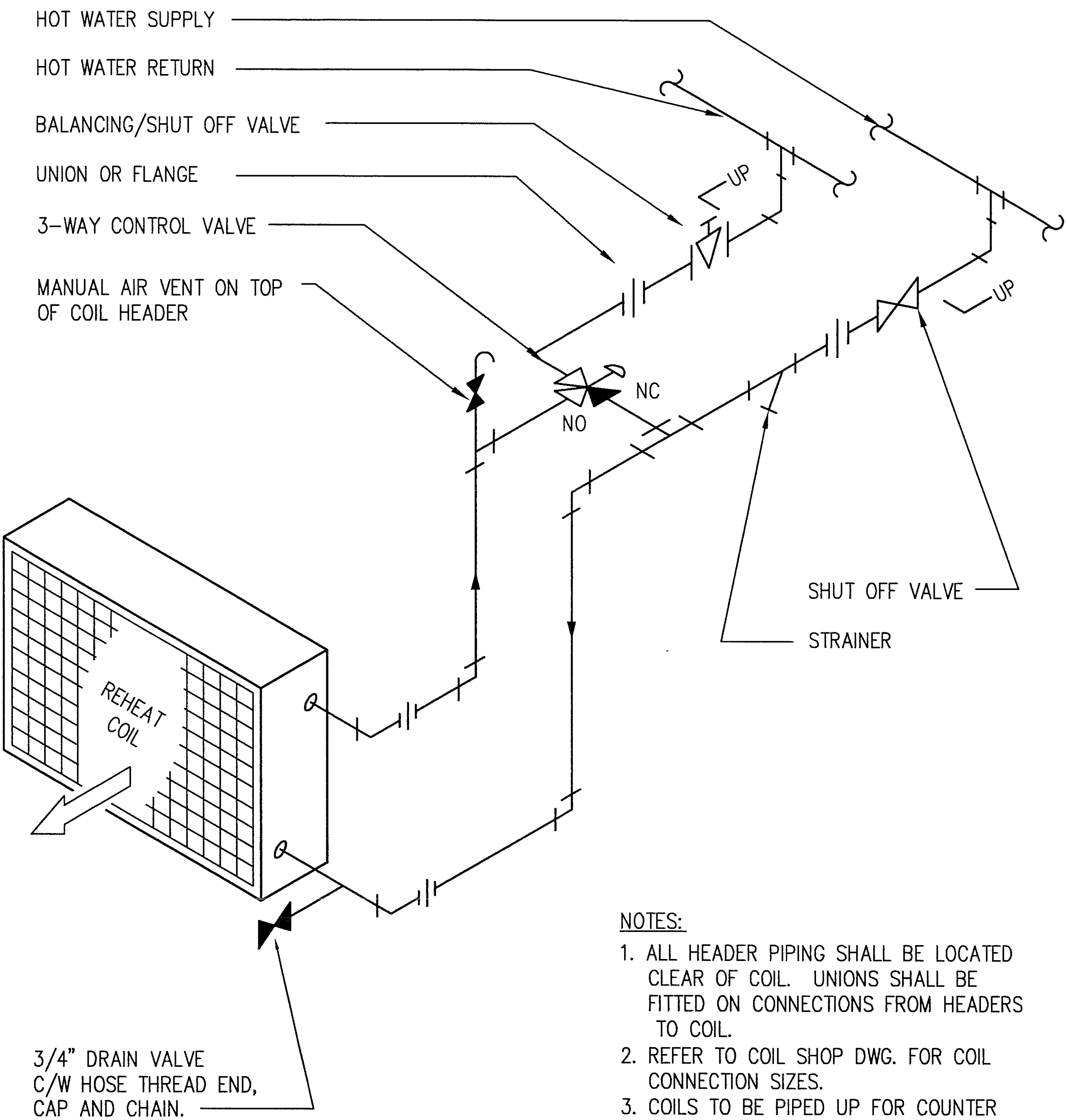
SPECIFICATION DETAIL

HOT WATER REHEAT COIL
2 -WAY CONTROL

Drawn By	Approved By	Reference
SMS	SMS	6091
File No.	**Date**	**Detail Sheet**
04-214-01	MARCH 2007	MD-6



NOTES:

1. ALL HEADER PIPING SHALL BE LOCATED CLEAR OF COIL. UNIONS SHALL BE FITTED ON CONNECTIONS FROM HEADERS TO COIL.
2. REFER TO COIL SHOP DWG. FOR COIL CONNECTION SIZES.
3. COILS TO BE PIPED UP FOR COUNTER FLOW OPERATION.
4. GRADE TUBES UP 20mm/METRE OF COIL LENGTH TOWARDS THE RETURN FOR POSITIVE VENTING.

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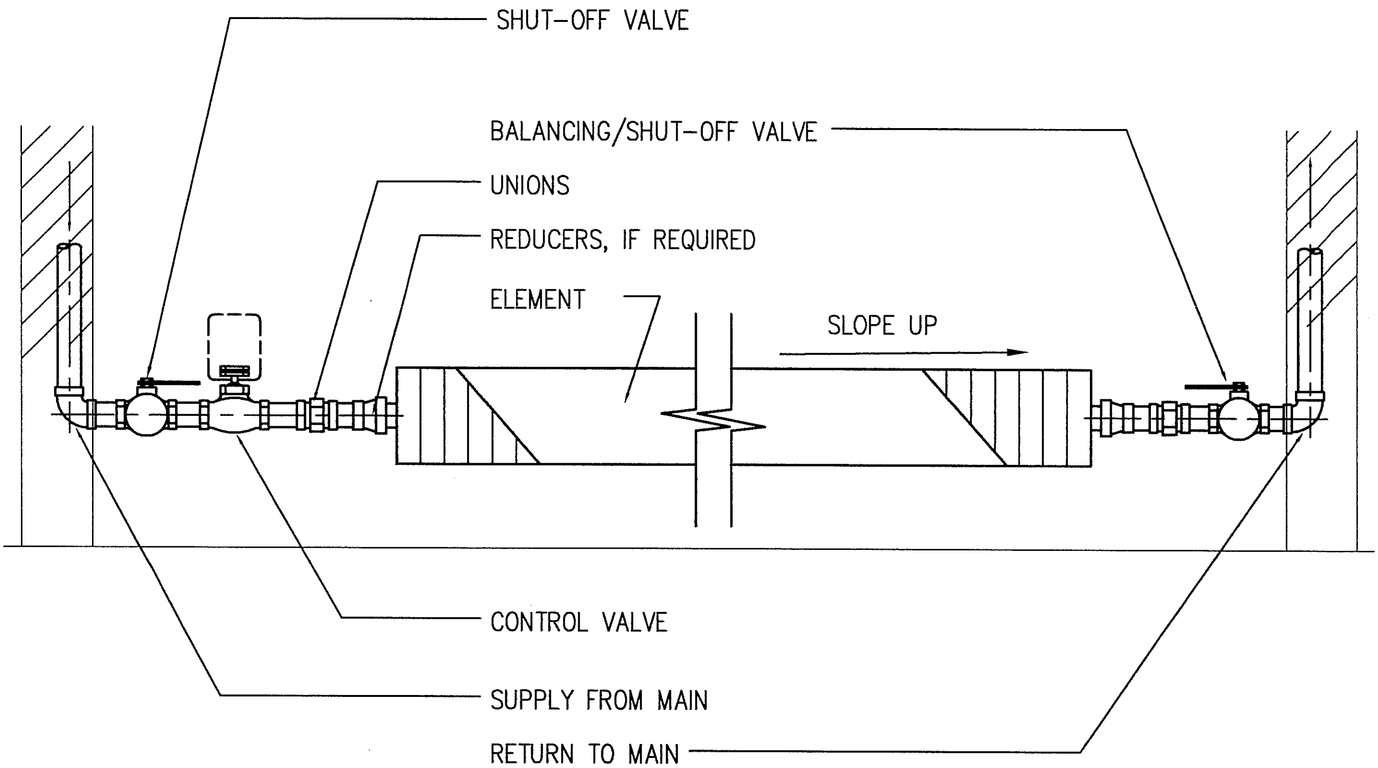
SPECIFICATION DETAIL

HOT WATER REHEAT COIL 3- WAY CONTROL

Drawn By	Approved By	Reference
SMS	SMS	6096
File No.	**Date**	**Detail Sheet**
04-214-01	MARCH 2007	MD-7



HOT WATER PIPING FOR WALL FIN

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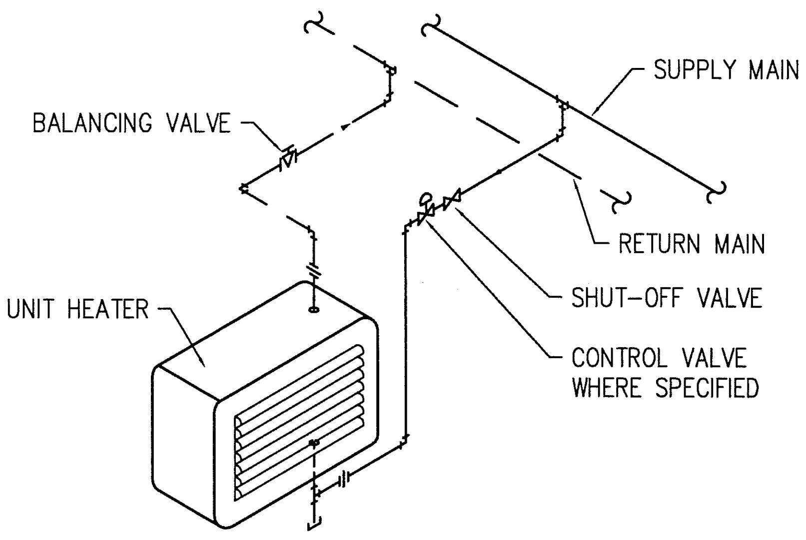
sms@smseng.com

SPECIFICATION DETAIL

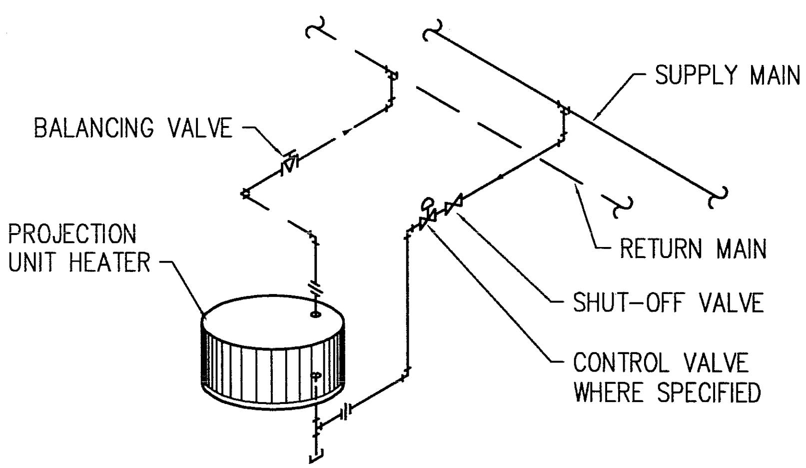
HOT WATER PIPING - WALLFIN

Drawn By	Approved By	Reference
SMS	SMS	6121
File No.	Date	Detail Sheet
04-214-01	MARCH 2007	MD-8



HORIZONTAL UNIT HEATER (HOT WATER OR GLYCOL)

N.T.S.



PROJECTION UNIT HEATER (HOT WATER OR GLYCOL)

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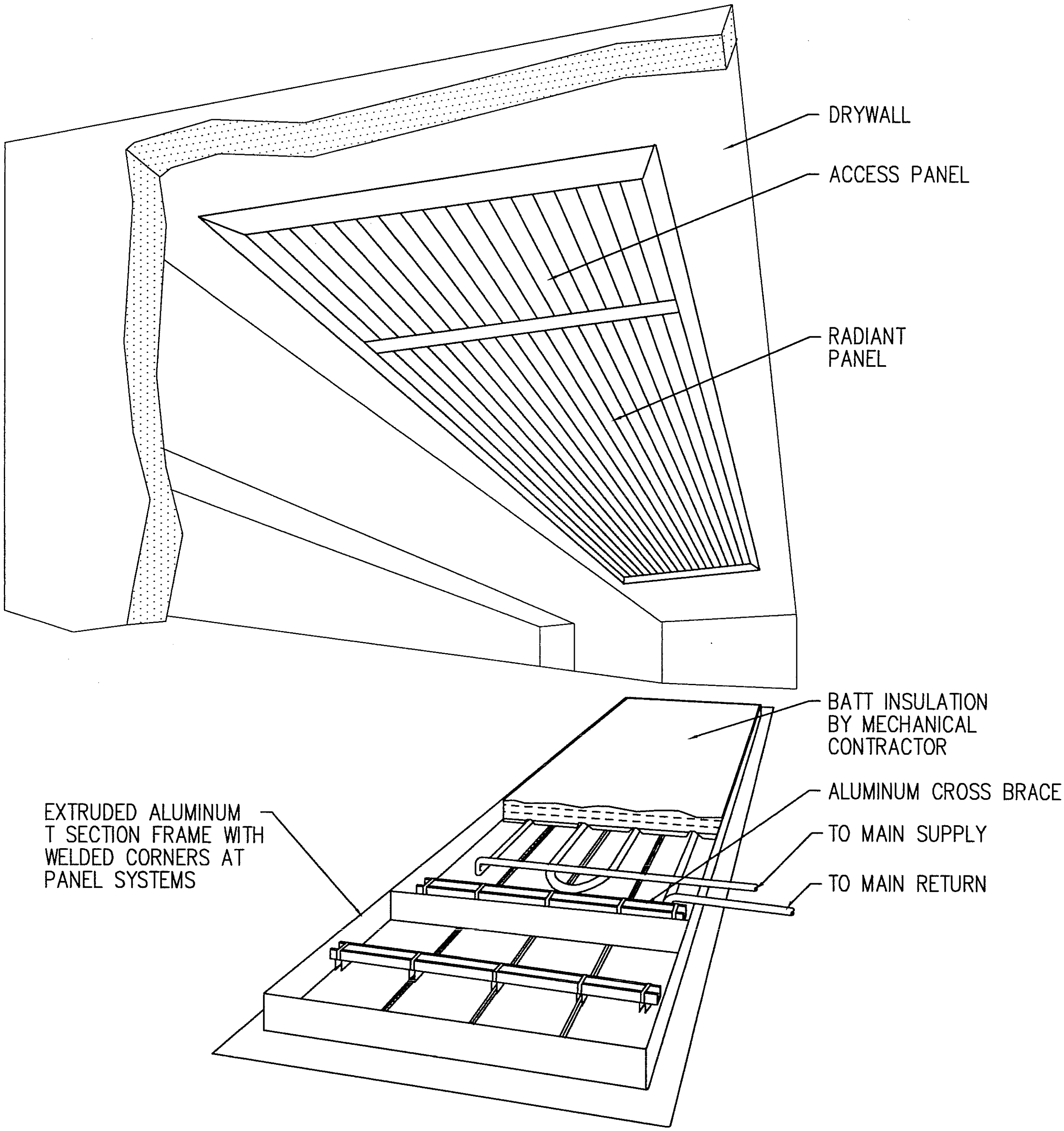
SPECIFICATION DETAIL

UNIT HEATERS - GLYCOL OR HOT WATER PIPING

Drawn By	Approved By	Reference
SMS	JTW	6170
File No.	Date	Detail Sheet
04-214-01	MARCH 2007	MD-9



NOTE: CONNECTIONS TO VALVES DONE ABOVE ACTIVE PANEL TO ALLOW FOR ACCESS PANEL PLACEMENT.

FRAMED LINEAR PANEL WITH ACCESS PANEL IN DRYWALL CEILING

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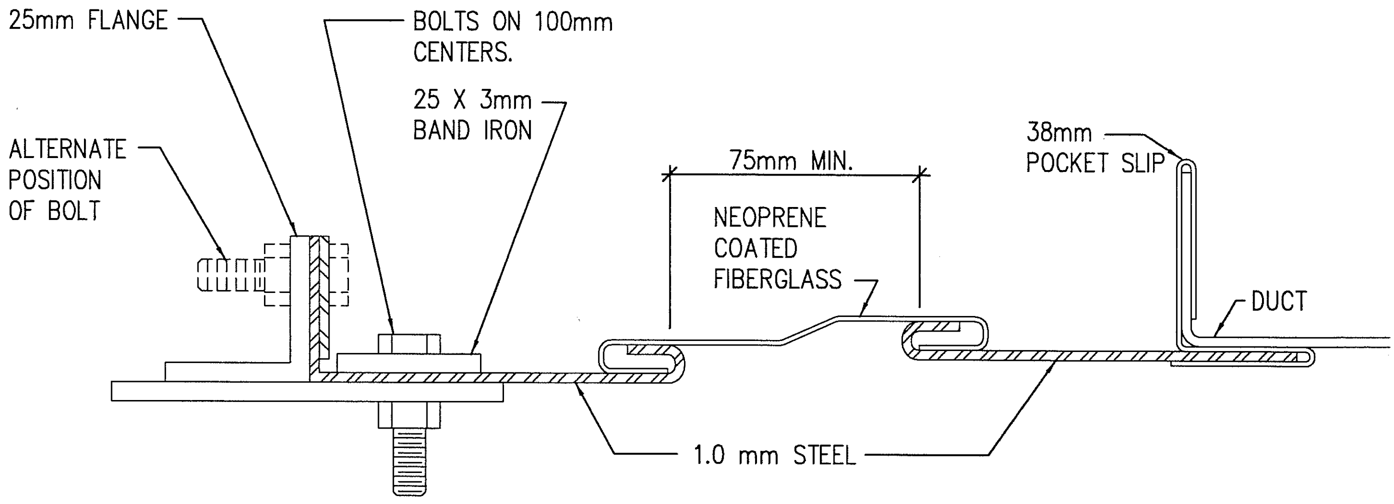
SPECIFICATION DETAIL

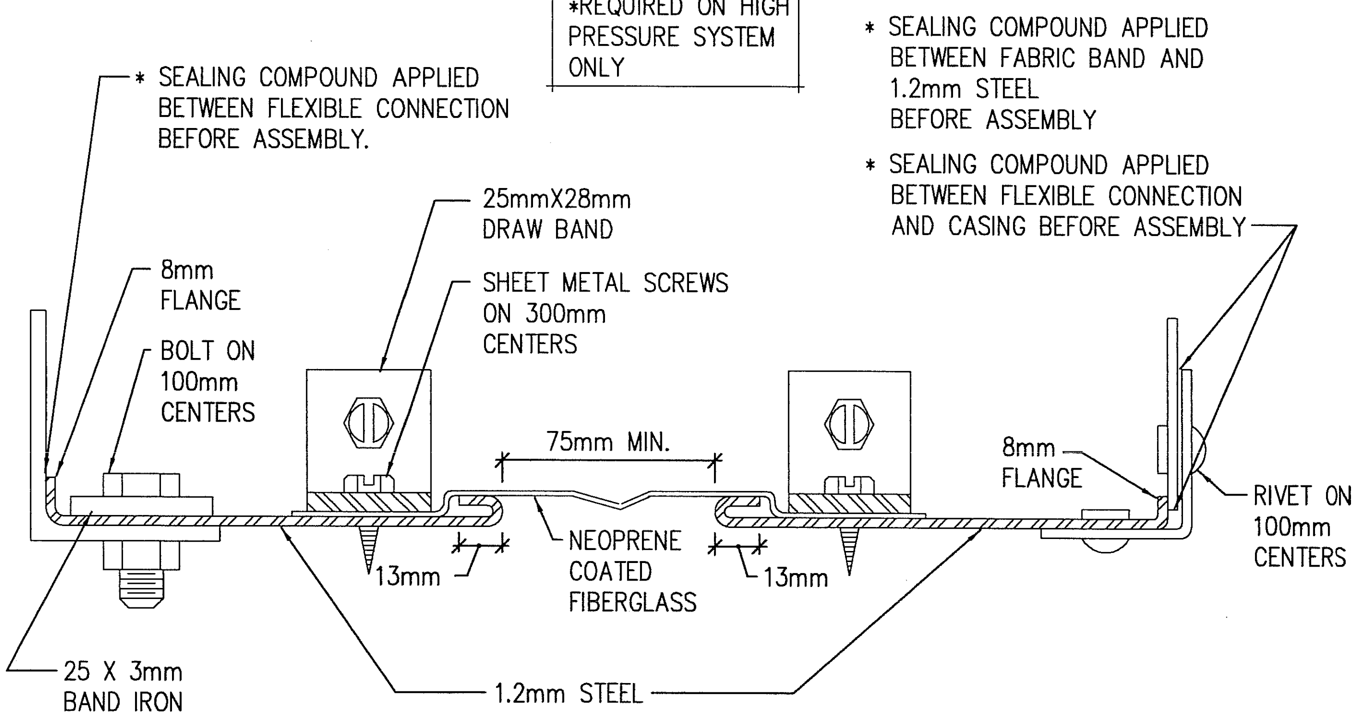
FRAMED LINEAR PANEL

Drawn By	Approved By	Reference
SMS	SMS	6294
File No.	Date	Detail Sheet
04-214-01	MARCH 2007	MD-10



RECTANGULAR CONNECTION
N.T.S.

*REQUIRED ON HIGH PRESSURE SYSTEM ONLY



ROUND CONNECTION
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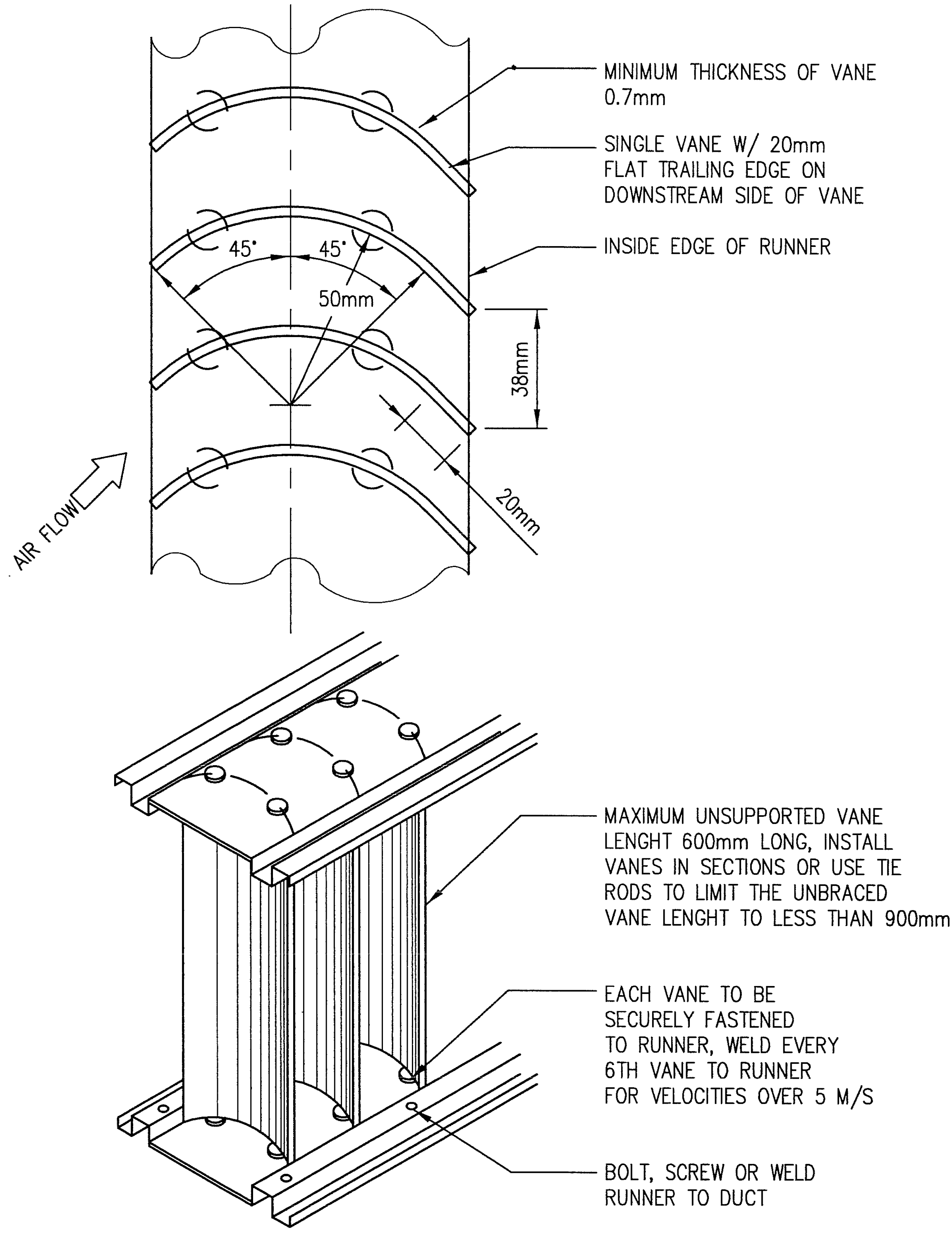
SPECIFICATION DETAIL

FLEX CONNECTION

Drawn By	Approved By	Reference
SMS	SMS	8000
File No.	Date	Detail Sheet
04-214-01	MARCH 2007	MD-11



TURNING VANE CONSTRUCTION

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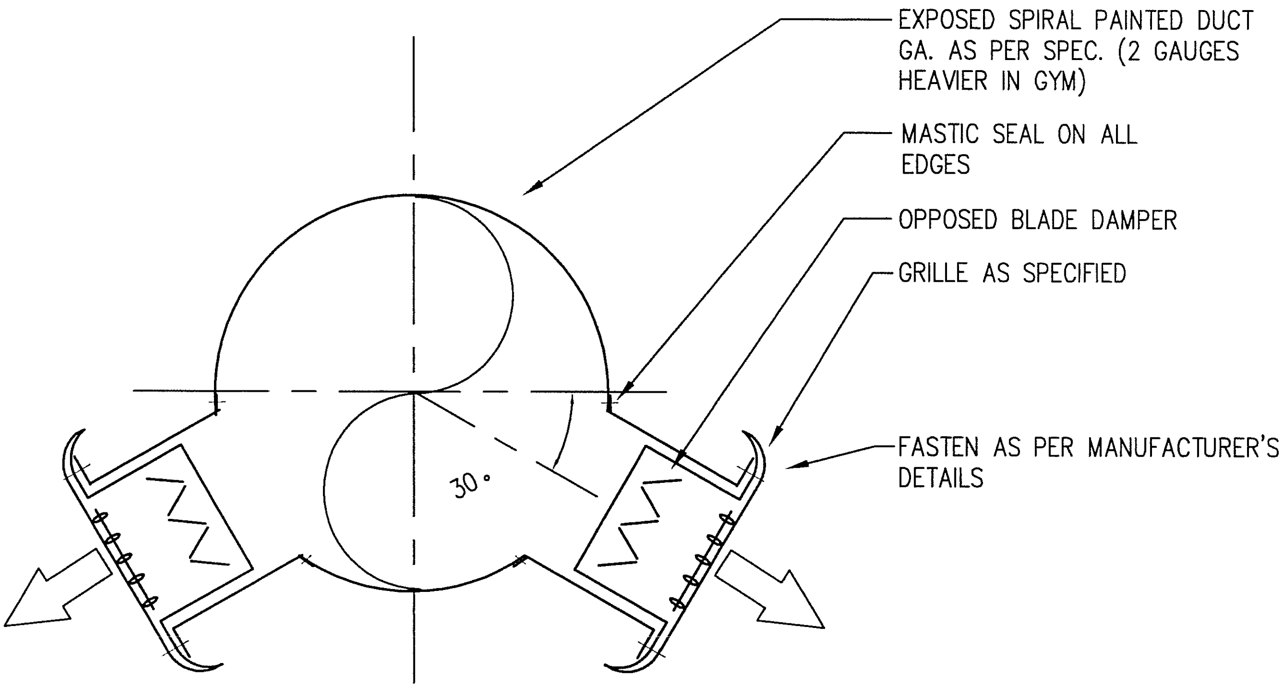
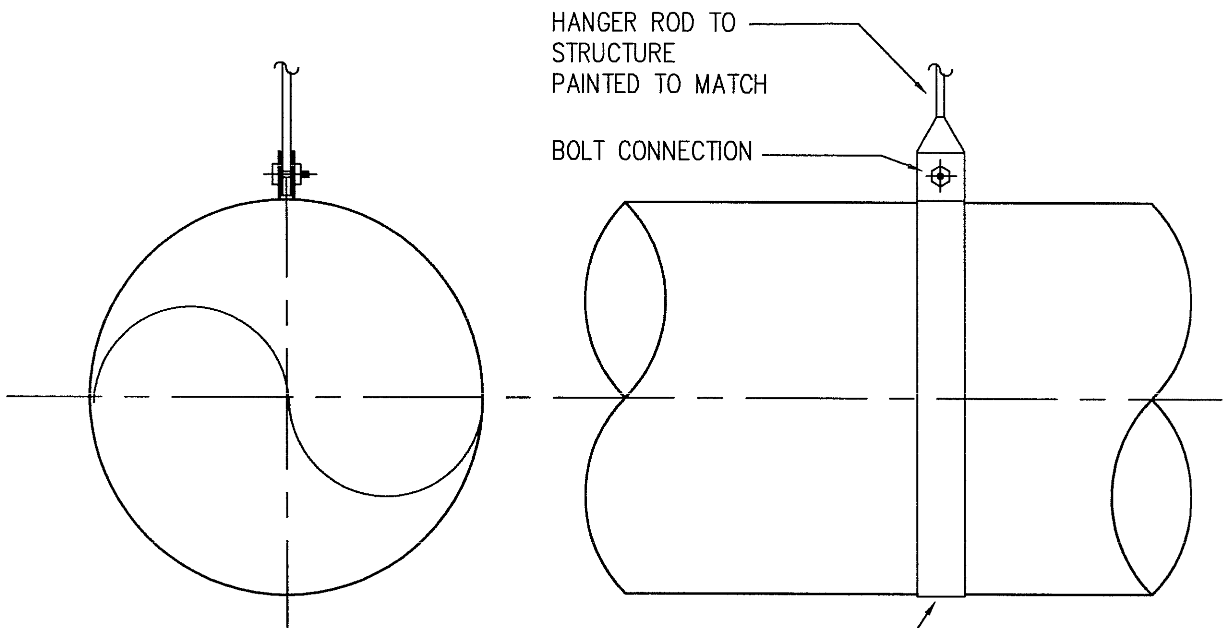
SPECIFICATION DETAIL

TURNING VANE CONSTRUCTION

Drawn By	Approved By	Reference
SMS	SMS	8006
File No.	**Date**	**Detail Sheet**
04-214-01	MARCH 2007	MD-12



DIFFUSER INSTALLATION



HANGER INSTALLATION

EXPOSED ROUND DUCT INSTALLATION

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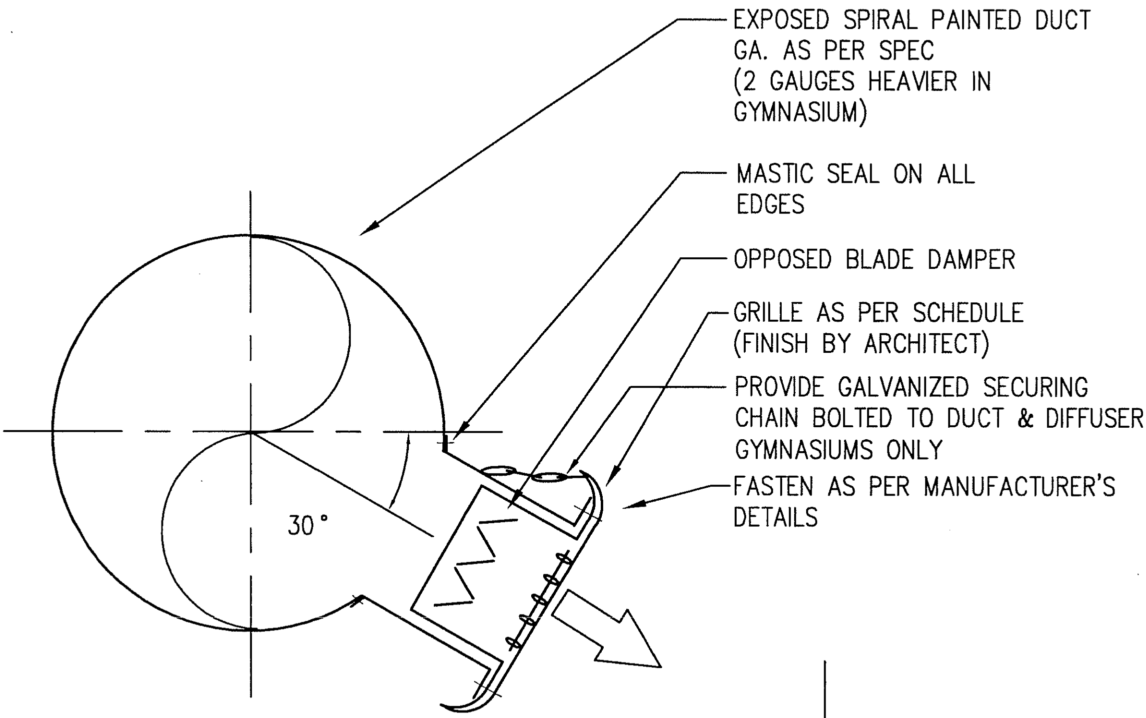
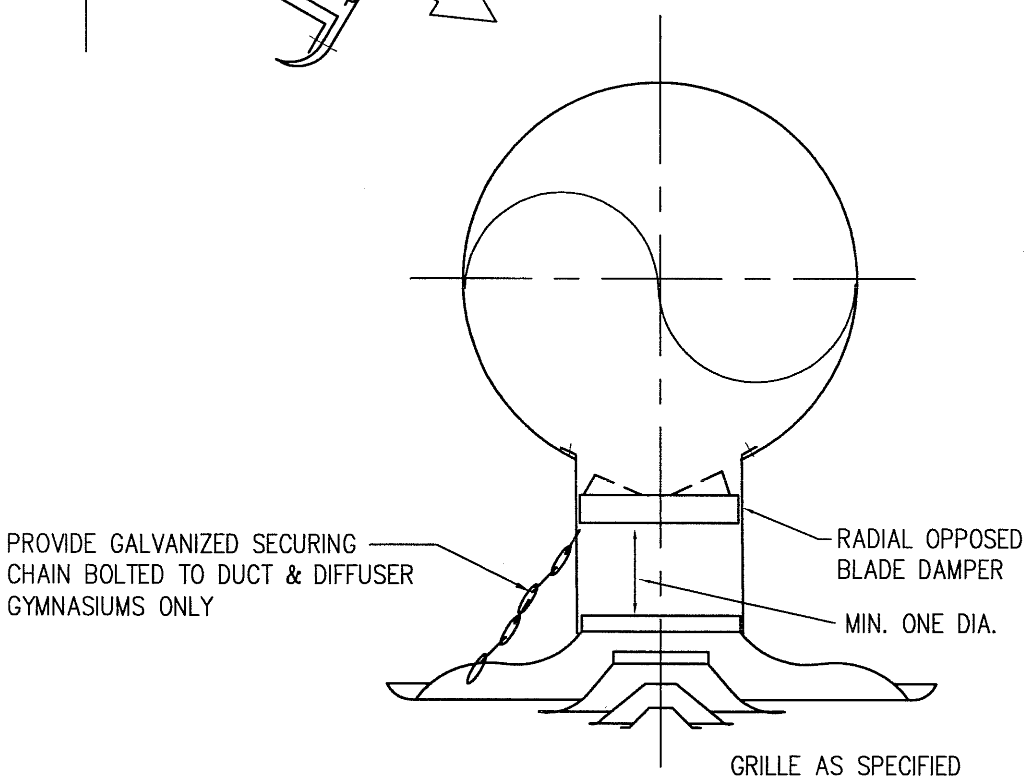
SPECIFICATION DETAIL

EXPOSED ROUND DUCT INSTALLATION

Drawn By	Approved By	Reference
SMS	SMS	8020
File No.	Date	Detail Sheet
04-214-01	MARCH 2007	MD-13





EXPOSED DUCT DIFFUSER INSTALLATION

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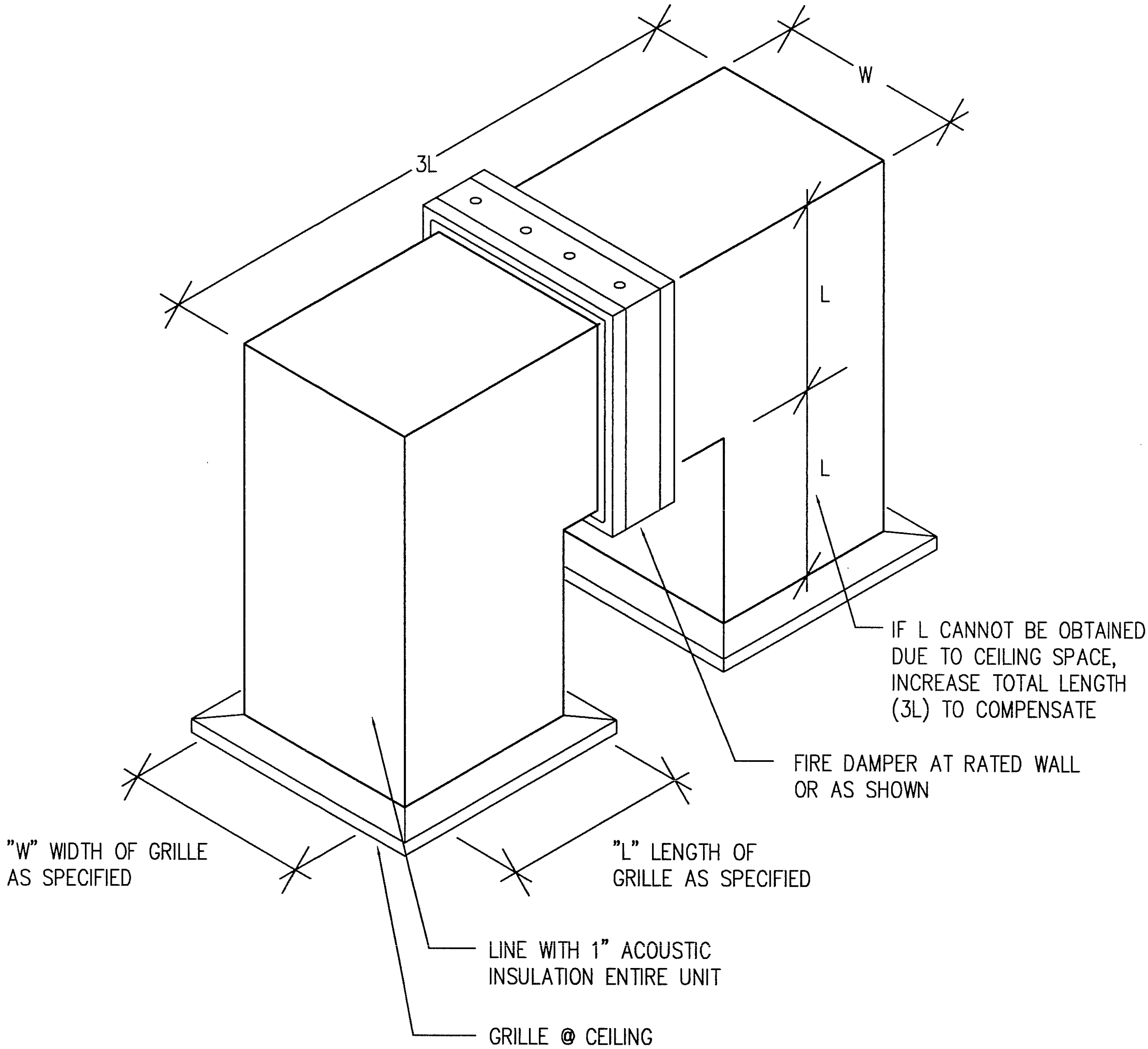
SPECIFICATION DETAIL

EXPOSED ROUND DIFFUSER INSTALLATION

Drawn By	Approved By	Reference
SMS	SMS	8021
File No.	**Date**	**Detail Sheet**
04–214–01	MARCH 2007	MD–14



TRANSFER AIR ELBOW WITH GRILLES

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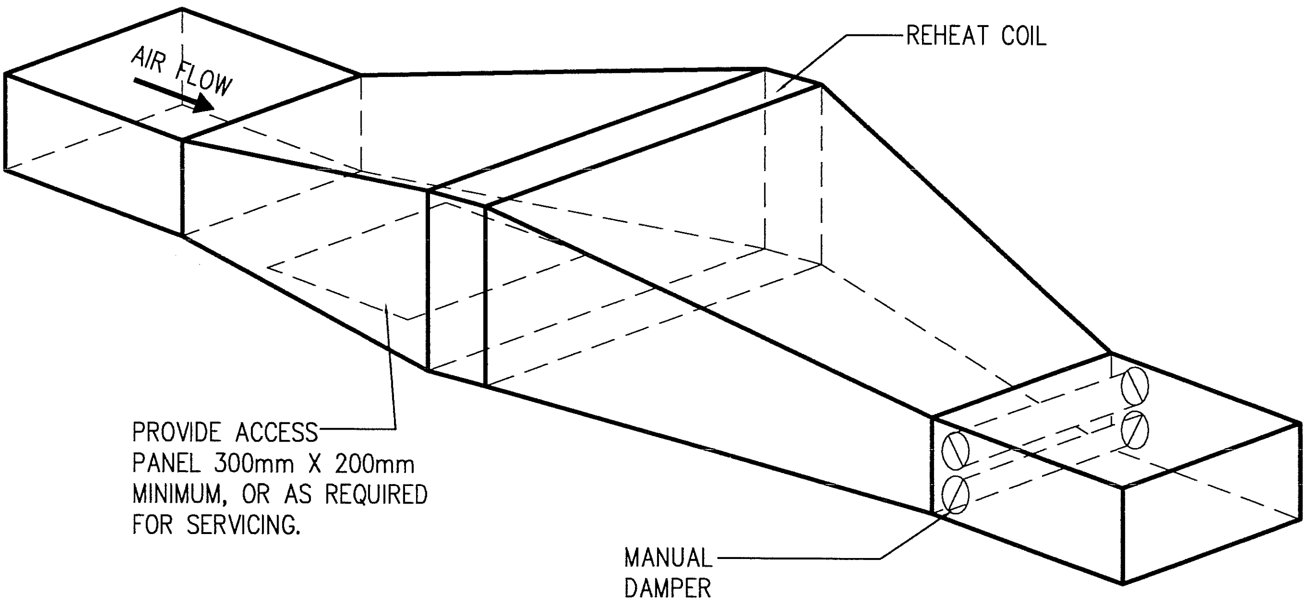
SPECIFICATION DETAIL

TRANSFER AIR ELBOW WITH GRILLES

Drawn By	Approved By	Reference
SMS	SMS	8050
File No.	Date	Detail Sheet
04-214-01	MARCH 2007	MD-15



REHEAT COIL ACCESS DOOR

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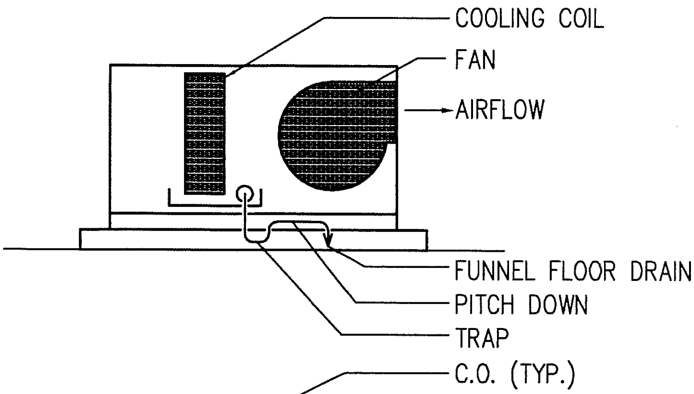
SPECIFICATION DETAIL

ACCESS DOOR DETAIL

Drawn By	Approved By	Reference
SMS	SMS	8070
File No.	Date	Detail Sheet
04-214-01	MARCH 2007	MD-16



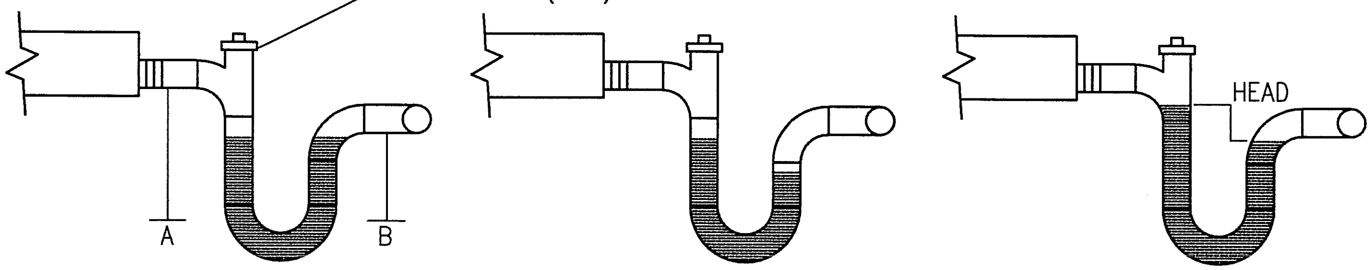
DRAW THRU UNIT

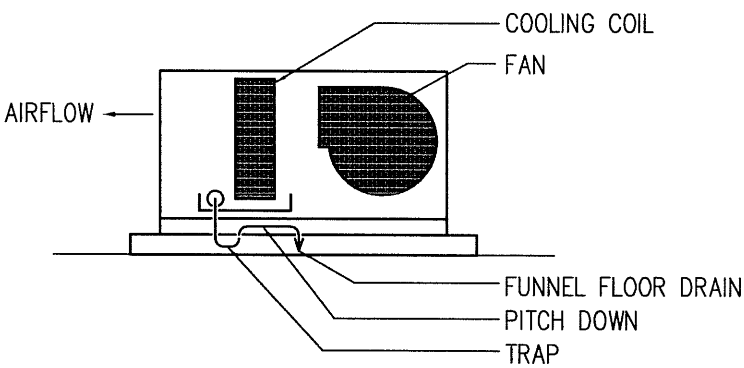
MINIMUM DIMENSIONS

(A) EQUAL TO 1½ TIMES OPERATING SUCTION PLUS 2.0"

(B) EQUAL TO ½ OF OPERATING SUCTION PLUS 1.0"

USE 1½" DWV PIPE & FITTINGS





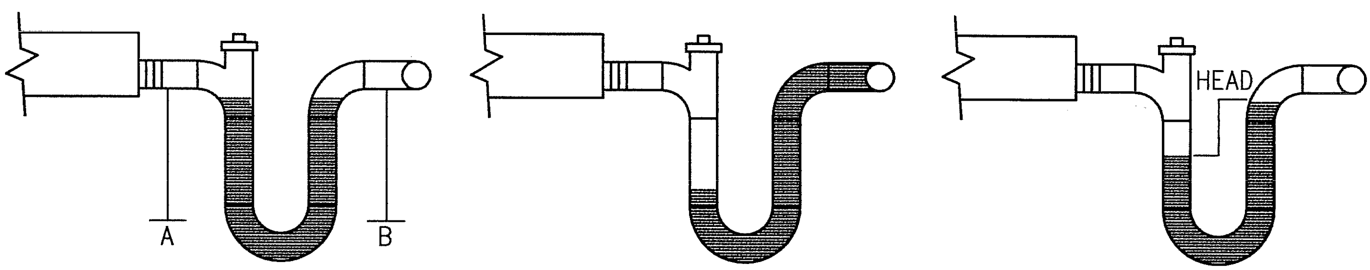
BLOW THRU UNIT

MINIMUM DIMENSIONS

(A) EQUAL TO 1½ TIMES OPERATING PRESSURE PLUS 1.0"

(B) EQUAL TO ½ OF OPERATING PRESSURE PLUS 2.0"

USE 1½" DWV PIPE & FITTINGS



NOTE:

THE TRAP IS CONSTRUCTED TO HOLD A HEAD OF WATER, THE WEIGHT OF WHICH EQUALS THE PRESSURE DIFFERENCE THAT EXISTS BETWEEN THE COIL ON ONE SIDE AND THE ATMOSPHERE ON THE OTHER. WHEN THE FAN IS STARTED, THE PRESSURE WITHIN THE UNIT IS DRAWN DOWN, CAUSING THE WATER WITHIN THE TRAP TO RISE IN THE VERTICAL PIPING. THIS PRODUCES A WATER COLUMN OF SUFFICIENT HEIGHT TO BALANCE THE PRESSURE DIFFERENCE. ONCE THE WATER COLUMN IS ESTABLISHED, ADDITIONAL CONDENSATE SIMPLY FILLS AND OVERFLOWS THE TRAP ON ITS WAY TO THE DRAIN.

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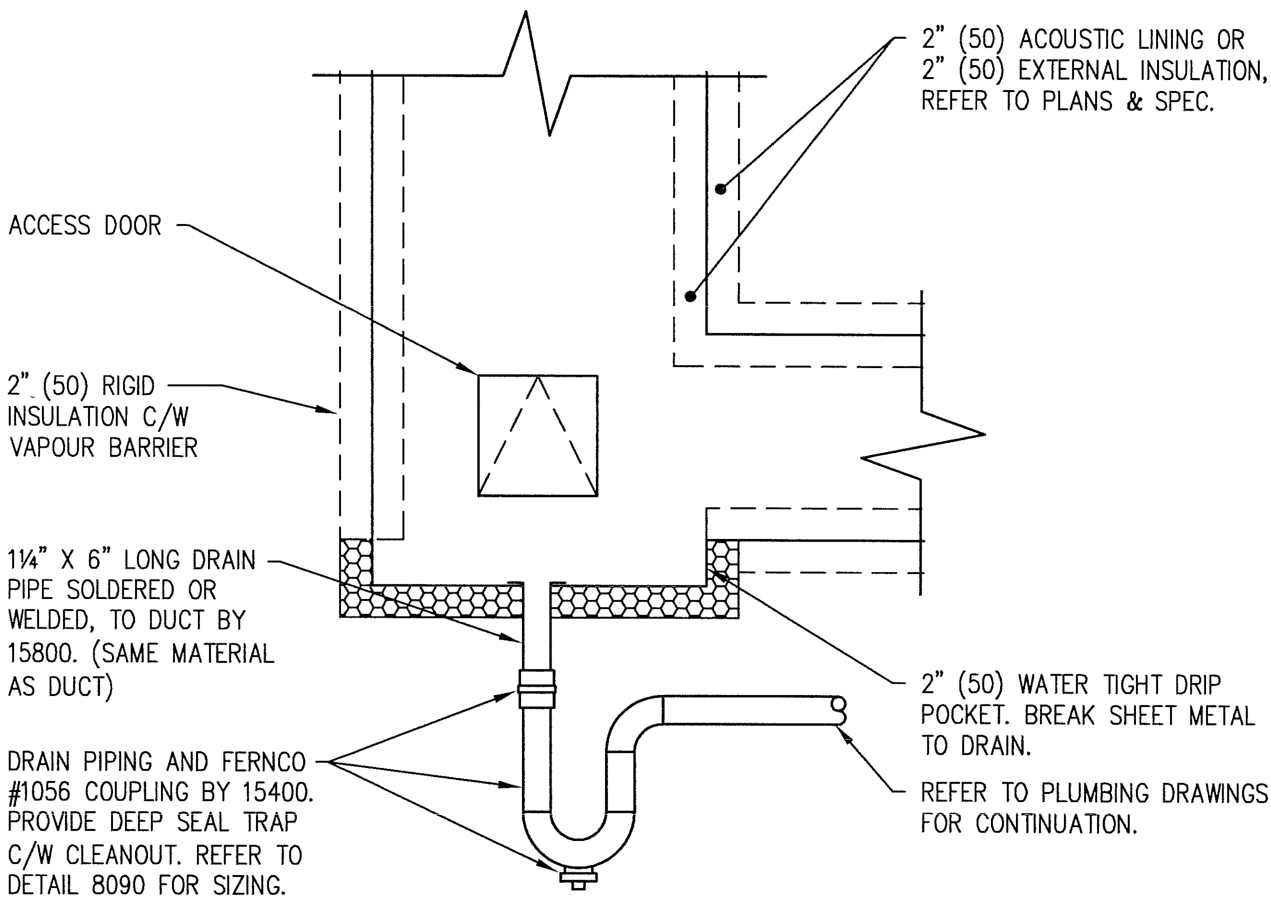
SPECIFICATION DETAIL

DEEP SEAL TRAP SCHEDULE

Drawn By	Approved By	Reference
SMS	SMS	8090
File No.	**Date**	**Detail Sheet**
04-214-01	MARCH 2007	MD-17



DUCT DRAIN DETAIL

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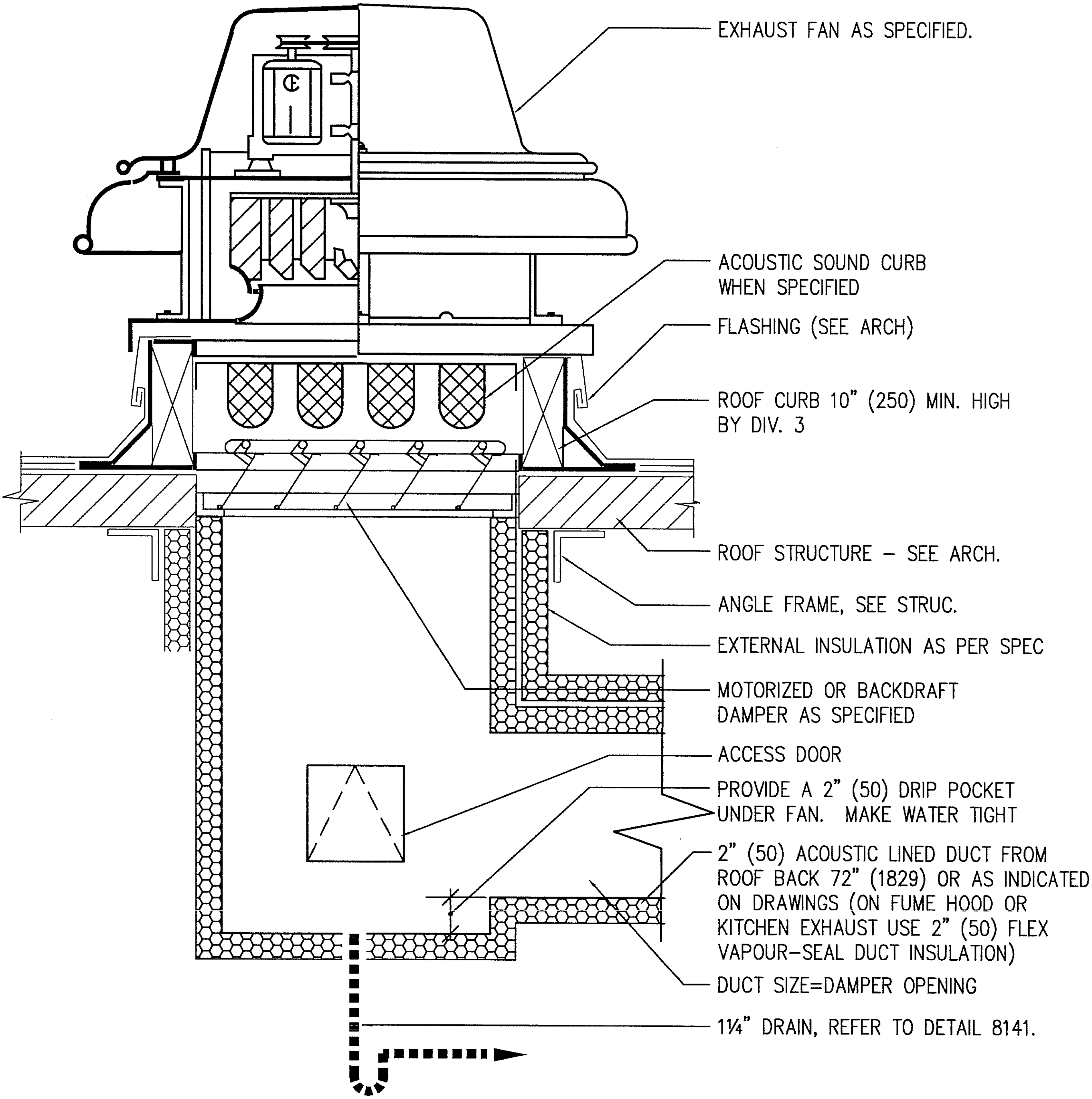
SPECIFICATION DETAIL

DUCT DRAIN DETAIL

Drawn By	Approved By	Reference
SMS	SMS	8141
File No.	Date	Detail Sheet
04–214–01	MARCH 2007	MD–18



NOTE:
ON FAN UNITS NOT DUCTED, PROVIDE A 2" (50) DEEP WATER TIGHT DRIP PAN UNDER ROOF OPENING. THE PAN SHALL BE 4" (100) LARGER THAN ROOF OPENING AND SHALL BE SUSPENDED A MIN. OF 12" (300) BELOW OPENING. SEAMS AND JOINTS SEALED WITH DURO-DYNE S-2

ROOF EXHAUST FAN

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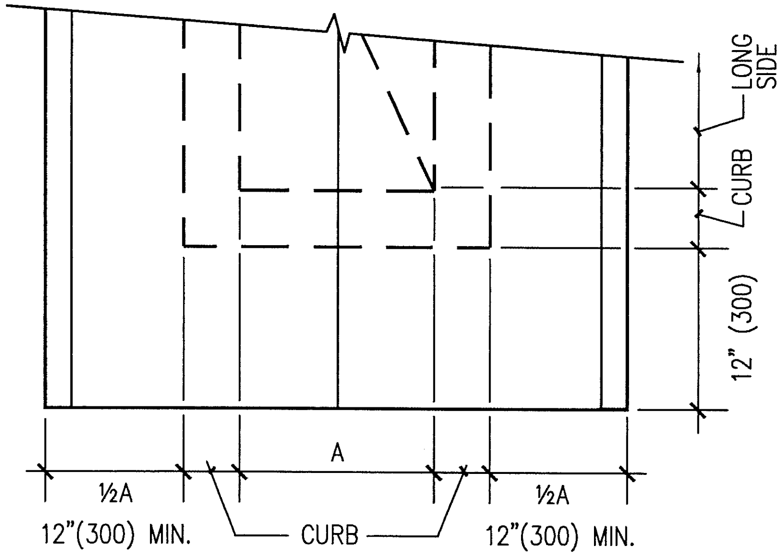
SPECIFICATION DETAIL

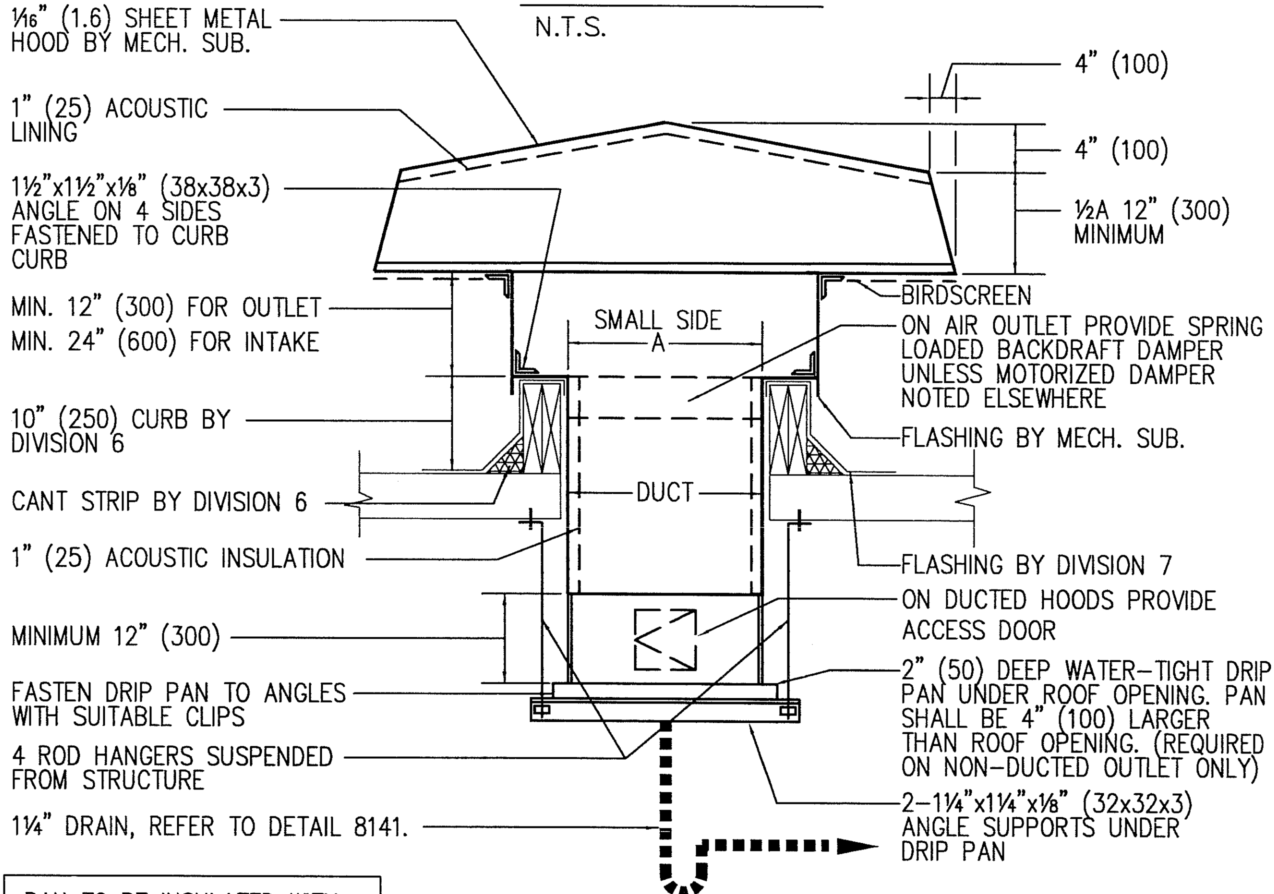
ROOF EXHAUST FAN

Drawn By	Approved By	Reference
SMS	SMS	8150
File No.	Date	Detail Sheet
04-214-01	MARCH 2007	MD-19



PLAN OF HOOD

N.T.S.



*PAN TO BE INSULATED WITH 2" (50) RIGID INSULATION C/W VAPOUR BARRIER

ELEVATION OF HOOD

N.T.S.

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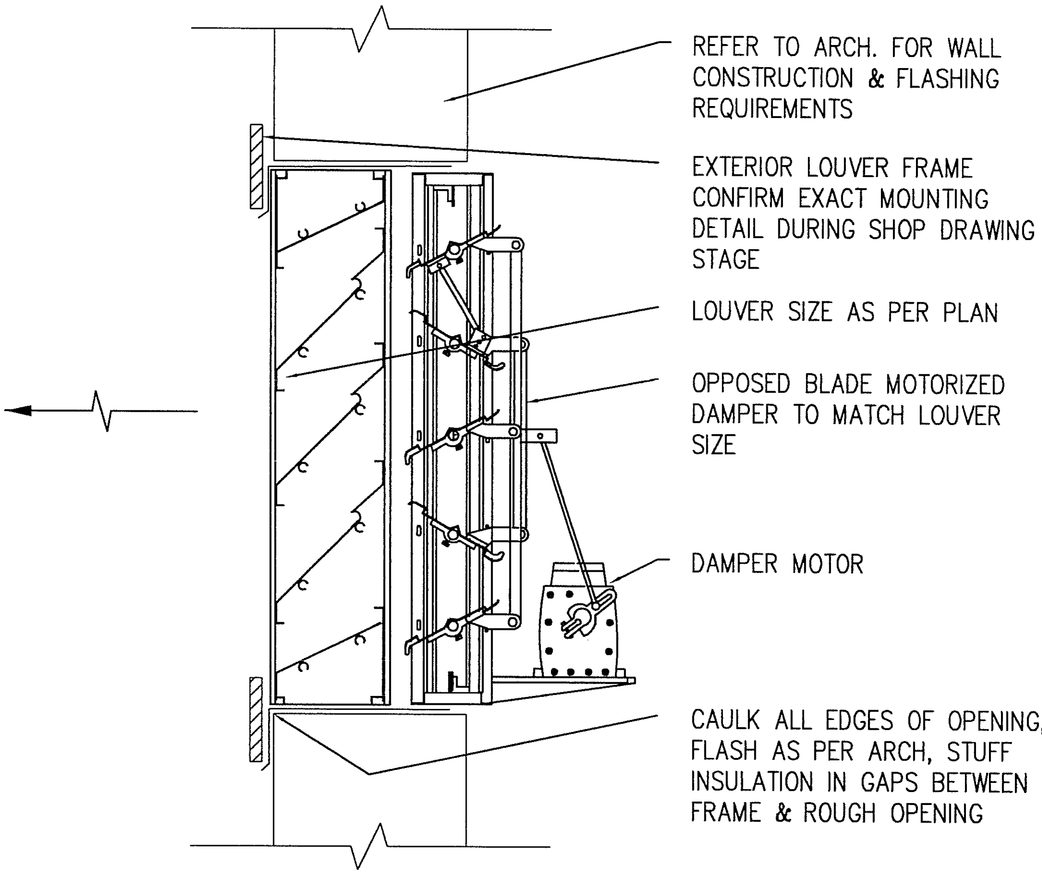
SPECIFICATION DETAIL

INLET OR OUTLET AIR HOOD

Drawn By	Approved By	Reference
SMS	SMS	8190
File No.	**Date**	**Detail Sheet**
04-214-01	MARCH 2007	MD-20



MOTORIZED LOUVER

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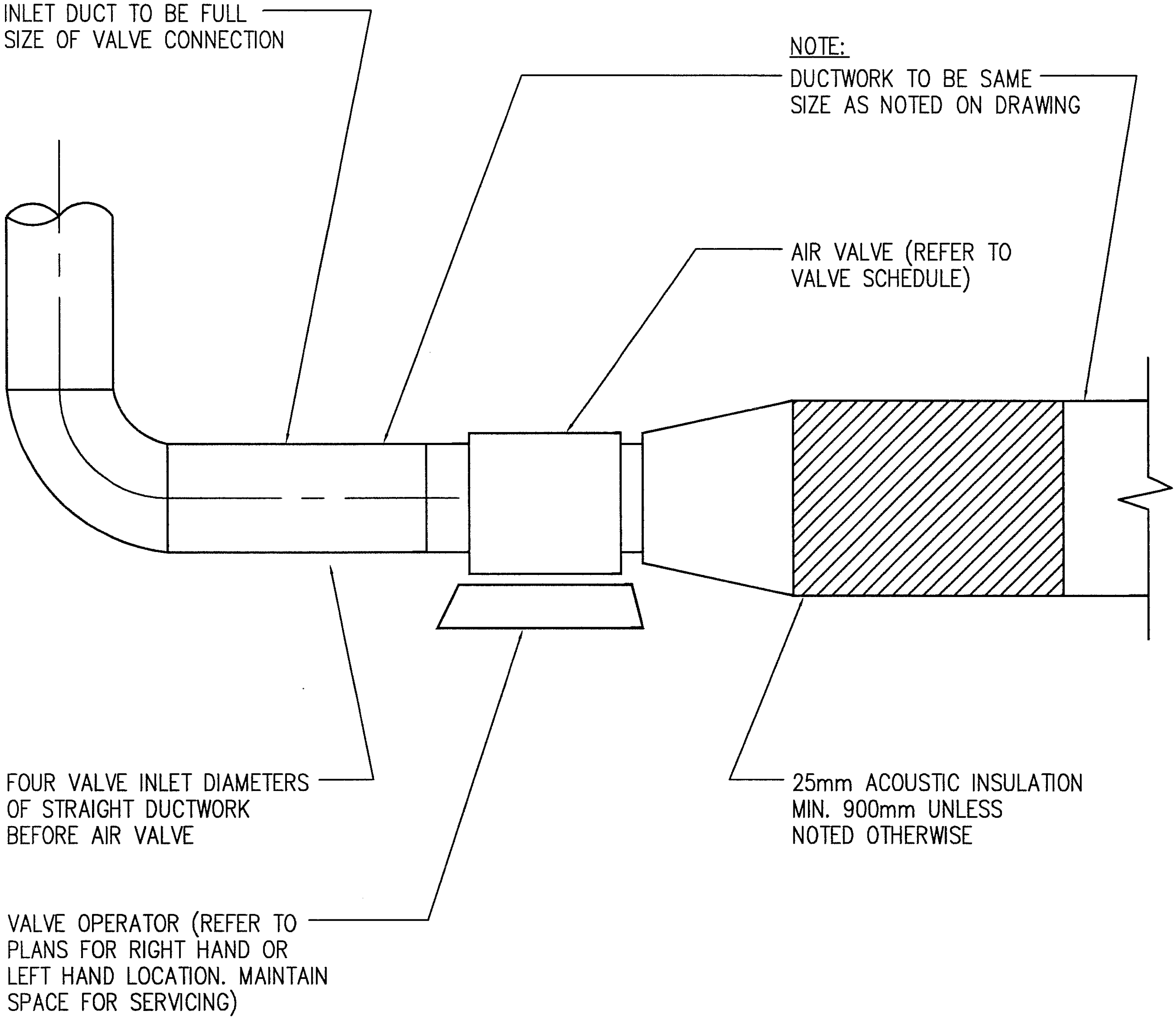
SPECIFICATION DETAIL

MOTORIZED LOUVRE

Drawn By	Approved By	Reference
SMS	SMS	8310
File No.	Date	Detail Sheet
04-214-01	MARCH 2007	MD-21



AIR VALVE DETAIL

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SPECIFICATION DETAIL

AIR VALVE DETAIL

Drawn By	Approved By	Reference
SMS	SMS	8550
File No.	Date	Detail Sheet
04-214-01	MARCH 2007	MD-22

Air Handling Units

AIR HANDLING UNIT No.	**AHU-1**			
SERVICE	Supply			
MODEL	McQuay CAH017			
SUPPLY FAN - SIZE/TYPE	Centrifugal FC 18.03 Class 2			
AIRFLOW RATE (l/s) (cfm)	**4248**		9000	
EXTERNAL STATIC REQUIRED (Pa) (in.)	**500**		2.00	
MOTOR (bkW/kW) (Bhp/Hp)	**6.62**	**11.19**	8.88	15.00
SPEED (rpm)	1750			
RETURN FAN - SIZE/TYPE	Centrifugal FC 18.03 Class 1			
AIRFLOW RATE (l/s) (cfm)	**4248**		9000	
EXTERNAL STATIC REQUIRED (Pa) (in.)	**200**		0.80	
MOTOR (bkW/kW) (Bhp/Hp)	**3.20**	**5.59**	4.29	7.50
SPEED (rpm)	1750			
PRE-FILTER SECTION	n/a			
FILTER NUMBER & SIZE (mm)	n/a			
FINAL FILTER SECTION	Strion Air Filter			
FILTER NUMBER & SIZE (mm)	Refer to specifications			
HEATING COIL SIZE (h x l)(mm) (in.)	**914**	**1626**	36	64
MEDIUM	Water			
ENTERING GLYCOL TEMP. (°C) (°F)	**71.11**		160	
LEAVING GLYCOL TEMP. (°C) (°F)	**48.22**		119	
ENTERING AIR TEMP. (°C) (°F)	**-6.67**		20.0	
LEAVING AIR TEMP. (°C) (°F)	**12.78**		55.0	
MAX. AIR PRESSURE DROP (Pa) (in.)	**90**		0.36	
MAX. WATER PRESSURE DROP (kPa) (ft.)	**13**		4	
MAX. FACE VELOCITY (m/s) (fpm)	**2.86**		563	
COOLING COIL SIZE (h x l)(mm) (in.)	**914**	**1854**	36	73
MEDIUM	R407c			
ENTERING FLUID TEMP. (°C) (°F)	**n/a**		n/a	
LEAVING FLUID TEMP. (°C) (°F)	**n/a**		n/a	
ENTERING AIR TEMP. db/wb (°C) (°F)	**26.67**	**19.44**	80.0	67.0
LEAVING AIR TEMP. db/wb (°C) (°F)	**11.78**	**11.67**	53.2	53.0
MAX. AIR PRESSURE DROP (Pa) (in.)	**283**		1.13	
MAX. WATER PRESSURE DROP (kPa) (ft.)	**0**		n/a	
MAX. FACE VELOCITY (m/s) (fpm)	**2.50**		493	
UNIT WEIGHT (kg) (lbs)	**4318**		9500.00	
UNIT ACCESSORIES				
	Side inlet/relief openings			
	VFD by controls contractor			

SMS ENGINEERING

Air Handling Unit Schedule

Project:	**Winnipeg Police Service**		
	East District Police Station		
File:	04-214-01	Designer:	VSW
Date:	Mar-07	Sheet:	**MS-1A**

Air Handling Units

AIR HANDLING UNIT No.	**AHU-2**			
SERVICE	Supply			
MODEL	McQuay CAH017			
SUPPLY FAN - SIZE/TYPE	Centrifugal FC 18.03 Class 2			
AIRFLOW RATE (l/s) (cfm)	**4248**		9000	
EXTERNAL STATIC REQUIRED (Pa) (in.)	**500**		2.00	
MOTOR (bkW/kW) (Bhp/Hp)	**6.62**	**11.19**	8.88	15.00
SPEED (rpm)	1750			
RETURN FAN - SIZE/TYPE	Centrifugal FC 18.03 Class 1			
AIRFLOW RATE (l/s) (cfm)	**4248**		9000	
EXTERNAL STATIC REQUIRED (Pa) (in.)	**200**		0.80	
MOTOR (bkW/kW) (Bhp/Hp)	**3.20**	**5.59**	4.29	7.50
SPEED (rpm)	1750			
PRE-FILTER SECTION	n/a			
FILTER NUMBER & SIZE (mm)	n/a			
FINAL FILTER SECTION	Strion Air Filter			
FILTER NUMBER & SIZE (mm)	Refer to specifications			
HEATING COIL SIZE (h x l)(mm) (in.)	**914**	**1626**	36	64
MEDIUM	Water			
ENTERING GLYCOL TEMP. (°C) (°F)	**71.11**		160	
LEAVING GLYCOL TEMP. (°C) (°F)	**48.22**		119	
ENTERING AIR TEMP. (°C) (°F)	**-6.67**		20.0	
LEAVING AIR TEMP. (°C) (°F)	**12.78**		55.0	
MAX. AIR PRESSURE DROP (Pa) (in.)	**90**		0.36	
MAX. WATER PRESSURE DROP (kPa) (ft.)	**13**		4	
MAX. FACE VELOCITY (m/s) (fpm)	**2.86**		563	
COOLING COIL SIZE (h x l)(mm) (in.)	**914**	**1854**	36	73
MEDIUM	R407c			
ENTERING FLUID TEMP. (°C) (°F)	**n/a**		n/a	
LEAVING FLUID TEMP. (°C) (°F)	**n/a**		n/a	
ENTERING AIR TEMP. db/wb (°C) (°F)	**26.67**	**19.44**	80.0	67.0
LEAVING AIR TEMP. db/wb (°C) (°F)	**11.78**	**11.67**	53.2	53.0
MAX. AIR PRESSURE DROP (Pa) (in.)	**283**		1.13	
MAX. WATER PRESSURE DROP (kPa) (ft.)	**0**		n/a	
MAX. FACE VELOCITY (m/s) (fpm)	**2.50**		493	
UNIT WEIGHT (kg) (lbs)	**4318**		9500.00	
UNIT ACCESSORIES				
	Top inlet/relief openings			
	VFD by controls contractor			
	Unit Mounted on AHU-1			

Air Handling Unit Schedule

SMS ENGINEERING

Project:	**Winnipeg Police Service**		
	East District Police Station		
File:	04-214-01	Designer:	VSW
Date:	Mar-07	Sheet:	**MS-1B**

Condensing Units

NO.	LOC.	TYPE / MODEL	SAT. SUCT. °F **°C**	OUT-DOOR °F **°C**	REFRIG. CAPACITY MBH **Kw**	CAPACITY MODULATION	REMARKS
CU 1	At Grade	McQuay ACZ-035B	44.0 **6.7**	95.0 **35.0**	411.0 **120.4**	Hot gas bypass on one stage	
CU 2	At Grade	McQuay ACZ-035B	44.0 **6.7**	95.0 **35.0**	411.0 **120.4**	Hot gas bypass on one stage	

Expansion Tanks

TANK NO.	TANK SERVICE	LOCATION	ACCEPTANCE VOLUME (litres) (gallons)	MODEL NUMBER	TANK SIZE (mm) (inches) DIA x HEIGHT	PRECHARGE PRESSURE (kPa) (psig)
ET-1	Hot Water Heating	Penthouse Mech Rm	**257.4** 68	D120	**610 X 1156** 24 X 46	**28** 12

Expansion Tank Schedule

SMS ENGINEERING

Project: **Winnipeg Police Service**
East District Police Station

File: 04-214-01 Designer: VSW

Date: Mar-07 Sheet: **MS-3**

Fan Schedule

FAN NO.	SERVICE	FAN TYPE	LOCATION	FAN MODEL	CAP. (cfm) (l/s)	E.S.P. (in. W.G.) (Pa)	SPD. (rpm)	OUT. VEL. (fpm) (m/s)	BRK. (HP) (BkW)	MTR. (HP) (kW)	REMARKS
F-1	Meeting Rm Transfer	Inline Cabinet Fan	G193A	Greenheck CSP A700	**700** 330	**0.20** 50	1037	**673** 3.42	 0.00	**0.47** 0.35	c/w wall mounted speed switch
F-2	Meeting Rm Transfer	Ceiling Cabinet Fan	G200	Greenheck SP A250	**250** 118	**0.20** 50	1000	**1640** 8.33	 0.00	**0.11** 0.082	c/w wall mounted speed switch
F-3	Washroom Exhaust	Ceiling Cabinet Fan	G102	Greenheck SP B110	**75** 35	**0.25** 63	950	**510** 2.59	 0.00	**0.10** 0.08	
F-4	Interview Exhaust	Rooftop Downblast	Roof	Greenheck GB 101	**500** 236	**0.35** 88	992	**556** 2.82	**0.05** 0.04	**0.25** 0.19	
F-5	Detention Exhaust	Rooftop Downblast	Roof	Greenheck GB 101	**742** 350	**0.40** 100	1199	**824** 4.19	**0.10** 0.07	**0.25** 0.19	
F-6	Officer Decontam Exhaust	Rooftop Downblast	Roof	Greenheck GB 91	**300** 142	**0.40** 100	989	**312** 1.58	**0.05** 0.04	**0.25** 0.19	
F-7	Locker Rm Exhaust	Rooftop Upblast	Roof	Greenheck CUBE 161	**3000** 1416	**0.70** 175	1283	**1744** 8.86	**0.80** 0.60	**1.00** 0.75	
F-8	Crawlspace Exhaust	Rooftop Upblast	Roof	Greenheck CUBE 101	**1000** 472	**0.50** 125	1486	**781** 3.97	**0.18** 0.13	**0.50** 0.37	
F-9	Electrical Rm Ventilation	Cabinet Fan	Corridor Ceiling	Delhi 210	**1300** 614	**0.40** 100	676	**1254** 6.37	**0.19** 0.14	**0.25** 0.19	
F-10	Ceiling Fan	Recirculation	Exercise Room	Canarm CP-36	**7100** 3351	**0.00** 0	380	**750** 3.81	 0.00	**0.04** 0.03	wall mounted speed control
F-11	Ceiling Fan	Recirculation	Exercise Room	Canarm CP-36	**7100** 3351	**0.00** 0	380	**750** 3.81	 0.00	**0.04** 0.03	wall mounted speed control
F-12	Ceiling Fan	Recirculation	Exercise Room	Canarm CP-36	**7100** 3351	**0.00** 0	380	**750** 3.81	 0.00	**0.04** 0.03	wall mounted speed control
F-13	Ceiling Fan	Recirculation	Exercise Room	Canarm CP-36	**7100** 3351	**0.00** 0	380	**750** 3.81	 0.00	**0.04** 0.03	wall mounted speed control

Fan Schedule

SMS ENGINEERING

Project: **Winnipeg Police Service**
East District Police Station

File: 04-214-01
Designer: VSW

Date: Mar-07
Sheet: **MS-4A**

Fan Schedule

FAN NO.	SERVICE	FAN TYPE	LOCATION	FAN MODEL	CAP. (cfm) (l/s)	E.S.P. (in. W.G.) (Pa)	SPD. (rpm)	OUT. VEL. (fpm) (m/s)	BRK. (HP) (BkW)	MTR. (HP) (kW)	REMARKS
F-14	Ceiling Fan	Recirculation	Atrium	Canarm CP-36	**7100** 3351	**0.00** 0	380	**750** 3.81	0.00	**0.04** 0.03	wall mounted speed control
F-15	Ceiling Fan	Recirculation	Atrium	Canarm CP-36	**7100** 3351	**0.00** 0	380	**750** 3.81	0.00	**0.04** 0.03	wall mounted speed control
F-16	Ceiling Fan	Recirculation	Atrium	Canarm CP-36	**7100** 3351	**0.00** 0	380	**750** 3.81	0.00	**0.04** 0.03	wall mounted speed control
F-17	Ceiling Fan	Recirculation	Atrium	Canarm CP-36	**7100** 3351	**0.00** 0	380	**750** 3.81	0.00	**0.04** 0.03	wall mounted speed control
F-18	Garage Supply										Refer to Heat Recovery Schedule
F-19	Garage Exhaust										Refer to Heat Recovery Schedule
F-20	Evidence Drying Exhaust	Rooftop Downblast	Roof	Greenheck GB 71	**100** 47	**0.30** 75	926	**106** 0.54	**0.02** 0.01	**0.17** 0.12	wall mounted Switch
F-21	Evidence Drying Exhaust	Rooftop Downblast	Roof	Greenheck GB 71	**100** 47	**0.30** 75	926	**106** 0.54	**0.02** 0.01	**0.17** 0.12	wall mounted Switch
F-22	Garage Electrical Rm Ventilation	Ceiling Exhaust	G155	Greenheck SP B150	**150** 71	**0.30** 75	1050	**796** 4.04	0.00	**0.16** 0.12	
F-23	Washroom Exhaust	Ceiling Exhaust	G146	Greenheck SP B110	**75** 35	**0.30** 75	950	**499** 2.53	0.00	**0.11** 0.08	wall mounted Switch
F-24	Washroom Exhaust	Ceiling Exhaust	G147	Greenheck SP B110	**75** 35	**0.30** 75	950	**499** 2.53	0.00	**0.11** 0.08	wall mounted Switch
F-25	Ceiling Fan	Recirculation	Atrium	Canarm CP-48	**13000** 6135	**0.00** 0	320	**700** 3.56	0.00	**0.04** 0.03	wall mounted speed control
F-26	Ceiling Fan	Recirculation	Atrium	Canarm CP-48	**13000** 6135	**0.00** 0	320	**700** 3.56	0.00	**0.04** 0.03	wall mounted speed control

Fan Schedule

FAN NO.	SERVICE	FAN TYPE	LOCATION	FAN MODEL	CAP. (cfm) (l/s)	E.S.P. (in. W.G.) (Pa)	SPD. (rpm)	OUT. VEL. (fpm) (m/s)	BRK. (HP) (BkW)	MTR. (HP) (kW)	REMARKS
F-27	Equipment Decontam Exhaust	Ceiling Exhaust	G144	Greenheck SP B110	**75** 35	**0.30** 75	950	**499** 2.53	0.00	**0.11** 0.08	wall mounted Switch
F-28	Vestibule Exhaust	Rooftop Downblast	Roof	Greenheck GB 71	**75** 35	**0.30** 75	926	**78** 0.40	**0.01** 0.01	**0.17** 0.12	wall mounted Switch
F-29	Ceiling Fan	Recirculation	G146	Canarm CP-36	**7100** 3351	**0.00** 0	380	**750** 3.81	0.00	**0.04** 0.03	wall mounted speed control
					0	0		0.00	0.00	0.00	
					0	0		0.00	0.00	0.00	
					0	0		0.00	0.00	0.00	
					0	0		0.00	0.00	0.00	
					0	0		0.00	0.00	0.00	
					0	0		0.00	0.00	0.00	
					0	0		0.00	0.00	0.00	
					0	0		0.00	0.00	0.00	
					0	0		0.00	0.00	0.00	
					0	0		0.00	0.00	0.00	

Fan Schedule

SMS ENGINEERING

Project: **Winnipeg Police Service**
East District Police Station

File: 04-214-01 Designer: VSW

Date: Mar-07 Sheet: **MS-4C**

Fan Coils

NO.	MODEL / SIZE	LOCATION	OUTPUT (mbh)		FLOW GPM		AIR (cfm)	EXT. S.P.	SPD. (rpm)	MOTOR (HP)
			COOL.	HTG.	COOL.	HTG.	@ 21 °C	(in. W.G.)		
FC 1	HFC 8	Crawlspace	N/a	14.8	-	0.5	800	0.08		0.1
FC 2	HFC 8	Crawlspace	N/a		-	0.5	800	0.08		0.1
FC 3	HFC 8	Crawlspace	N/a		-	0.5	800	0.08		0.1
FC 4	HFC 8	Crawlspace	N/a		-	0.5	800	0.08		0.1
FC 5	HFC 8	Crawlspace	N/a		-	0.5	800	0.08		0.1
FC 6	HFC 8	Crawlspace	N/a		-	0.5	800	0.08		0.1
FC 7	HFC 8	Crawlspace	N/a		-	0.5	800	0.08		0.1
FC 8	HFC 8	Crawlspace	N/a		-	0.5	800	0.08		0.1
FC 9	HFC 8	Crawlspace	N/a		-	0.5	800	0.08		0.1
FC 10	HFC 8	Crawlspace	N/a		-	0.5	800	0.08		0.1
FC 11	HFC 8	Crawlspace	N/a		-	0.5	800	0.08		0.1
FC 12	HFC 8	Vestibule	N/a		-	0.5	800	0.08		0.1
FC 13	HFC 8	Vestibule	N/a		-	0.5	800	0.08		0.1
FC 14	HFC 8	Vestibule	N/a		-	0.5	800	0.08		0.1

SMS ENGINEERING

Fan Coil Schedule

Project: **Winnipeg Police Service**
East District Police Station

File: 04-214-01 Designer: VSW

Date: Mar-07 Sheet: **MS-5**

Grilles, Registers and Diffusers

TYPE	MANUFAC-TURER	MODEL	BOR-DER	CORE	VOLUME CONT.	FRAME	FASTNG.	FINISH	REMARKS
A	PRICE	SPD	600x600		VCR 8E	600x600 Panel		B12	Fastening to suit ceiling type
B	PRICE	Series 80						B12	Fastening to suit ceiling type
C	PRICE	TBDI6 H/C						B12	Automatic heat/cool changeover *no equals*
D	PRICE	SPD	300x300		VCR 8E	600x300 Panel		B12	Fastening to suit ceiling type
E	PRICE	520	F					B12	Front Blades parallel to long dimension
F	PRICE	530	F					B12	Front Blades parallel to long dimension
G	PRICE	RPD			VCR 8E			B12	
H	PRICE	LBP	500	15A				B12	
J	PRICE	MSPG						B12	Security Grille Supply or return
K	PRICE	HCD		HCD1				B12	
L	PRICE	AS	31					B12	As noted on plans

SMS ENGINEERING

Grille, Register and Diffuser Schedule

Project: **Winnipeg Police Service**
East District Police Station

File: 04-214-01 Designer: VSW
Date: Mar-07 Sheet: **MS-6**

Heat Recovery Ventilator

NO.	MODEL	TOTAL AIR FLOW cfm l/s	OUTSIDE AIR FLOW cfm l/s	SUPPLY FAN HP	EXH. FAN HP	DX COOLING COIL TONS	ELECTRIC HEATING COIL Kw	HOT WATER HEATING COIL MBH	ACCESSORIES
F-18 F-19	RegenAir RG9000	**4000** 1888	**4000** 1888	2 hp	2 hp	n/a	n/a	45	

SMS ENGINEERING

Heat Recovery Ventilator Schedule

Project: **Winnipeg Police Service**
East District Police Station

File: 04-214-01 Designer: VSW
Date: Mar-07 Sheet: **MS-7**

Humidifiers

NO.	DESCRIPTION	LOCATION	CAPACITY (L/S) (CFM)	% O/A	ROOM % RH & °C	ABSORPTION DISTANCE (m) (ft.)	STEAM LOAD (Kg / hr) (PPH)	NORTEC HUMIDIFIER MODEL	DISPERSION METHOD DUCT SIZE
H-1	AHU-1 & AHU-2	Penthouse Mech Rm	**8495** 18000	25	30 70	**0.2** 0.7	**180.0** 396.0	GSTC 400	Short Absorption Manifold

SMS ENGINEERING

Humidifier Schedule

Project: **Winnipeg Police Service**
East District Police Station

File **04-214-01** Designer: VSW

Date: Mar-07 Sheet: **MS-8**

Pump Schedule

NO.	SERVICE	LOCATION	MODEL / SIZE	CAP. (gpm) (l/s)	HEAD (ft) (m)	MTR. (HP) (kW)	SPD. (rpm)	REMARKS
P-1	Heating Pump	Mechanical Penthouse	Armstrong 4380 2x2x10	**126** 7.94	**90** 27.44	**7.5** 5.59	1740	VFD Controlled Duty/Standby with P-2
P-2	Heating Pump	Mechanical Penthouse	Armstrong 4380 2x2x10	**126** 7.94	**90** 27.44	**7.5** 5.59	1740	VFD Controlled Duty/Standby with P-1
P-3	Open Number							
P-4	Open Number							
P-5	AHU-1 Coil Pump	Mechanical Penthouse	Armstrong S45	**20** 1.26	**14** 4.27	**0.25** 0.19	1740	
P-6	Open Number							
P-7	Domestic Water Recirculation Pump	Mechanical Penthouse	Armstrong S35 BF	**5** 0.32	**10** 3.05	**0.167** 0.12	1740	
P-8	Sump Pump	Crawlspace	MONARCH BE-S33	**20** 1.26	**35** 10.67	**0.33** 0.25	3450	DUTY/STANDBY W/ P-9
P-9	Sump Pump	Crawlspace	MONARCH BE-S33	**20** 1.26	**35** 10.67	**0.33** 0.25	3450	DUTY/STANDBY W/ P-8
P-10	Sump Pump	Crawlspace	MONARCH BE-S33	**20** 1.26	**35** 10.67	**0.33** 0.25	3450	DUTY/STANDBY W/ P-11
P-11	Sump Pump	Crawlspace	MONARCH BE-S33	**20** 1.26	**35** 10.67	**0.33** 0.25	3450	DUTY/STANDBY W/ P-10
P-12	Garage Coil Pump	Garage	Armstrong H32	**4.5** 0.28	**8** 2.44	**0.167** 0.12	1740	
P-13	AHU-2 Coil Pump	Mechanical Penthouse	Armstrong S45	**20** 1.26	**14** 4.27	**0.25** 0.19	1740	

SMS ENGINEERING

Pump Schedule

Project: **Winnipeg Police Service**
East District Police Station

File: 04-214-01 Designer: VSW

Date: Mar-07 Sheet: **MS-9A**

Pump Schedule

NO.	SERVICE	LOCATION	MODEL / SIZE	CAP. (gpm) (l/s)	HEAD (ft) (m)	MTR. (HP) (kW)	SPD. (rpm)	REMARKS
P-14	Domestic Storage Pump	Mechanical Penthouse	Armstrong S35 BF	**5** 0.32	**10** 3.05	**0.167** 0.12	1740	

Relief Valves

VALVE NO.	LOCATION	CAPACITY (usgpm) (l/s)	SET PRES. (psig) (kPa)	SIZE	TYPE
RV-1	Mechanical Room Boiler B-1	**84** 5.29	**50** 344.7	1"	
RV-1	Mechanical Room Boiler B-2	**84** 5.29	**50** 344.7	1"	
RV-1	Mechanical Room Expansion Tank	**66** 4.16	**70** 482.58	3/4"x3/4"	

Relief Valve Schedule

SMS ENGINEERING

Project: **Winnipeg Police Service**
East District Police Station

File: 04-214-01 Designer: VSW
Date: Mar-07 Sheet: **MS-10**

Silencers

NO.	SYSTEM	MODEL & LENGTH (in.) (mm)	DUCT SIZE (in.) (mm)	X	(in.) (mm)	PRES. DROP (in. W.G.) (Pa)	CAP-ACITY (cfm) (l/s)	CLASS	I.L. (db) 63	125	250	500	1K	2K	4K	8K
Sil-1	Supply	**60**	**20**	**X**	**40**	**0.6**	**9000**	MP	4	8	16	25	25	24	21	17
	Elbow	1500	500	X	1000	150	4247.5									
Sil-2	Supply	**60**	**20**	**X**	**40**	**0.6**	**9000**	MP	4	8	16	25	25	24	21	17
	Elbow	1500	500	X	1000	150	4247.5									
Sil-3	Return	**36**	**30**	**X**	**30**	**0.19**	**9000**	LP	4	7	15	21	30	28	19	14
	Rectang	900	750	X	750	47.5	4247.5									
Sil-4	Return	**36**	**30**	**X**	**30**	**0.19**	**9000**	LP	4	7	15	21	30	28	19	14
	Rectang	900	750	X	750	47.5	4247.5									
Sil-5	Cross	**24**		**X**		**-**	**-**									
	Talk	600	0	X	0											
Sil-6	Cross	**24**		**X**		**-**	**-**									
	Talk	600	0	X	0											
Sil-7	Cross	**24**		**X**		**-**	**-**									
	Talk	600	0	X	0											

Silencer Schedule

SMS ENGINEERING

Project: **Winnipeg Police Service**
East District Police Station

File: 04-214-01 Designer: VSW

Date: Mar-07 Sheet: **MS-11**

Unit Heaters

NO.	LOCATION	MODEL	OUTPUT (mbh) **(kW)**	LIQUID (usgpm) **(l/s)**	CAP. (cfm) **(l/s)**	SPD. **(rpm)**	MOTOR (HP) **(kW)**	REMARKS
UH-1	Garage	H7	70.0 **20.51**	8.00 **0.50**	1760 **831**	1500	0.167 **0.12**	
UH-2	Garage	H7	70.0 **20.51**	8.00 **0.50**	1760 **831**	1500	0.167 **0.12**	
UH-3	Garage	H7	70.0 **20.51**	8.00 **0.50**	1760 **831**	1500	0.167 **0.12**	
UH-4	Penthouse Mechanical Room	HI	15.0 **4.39**	1.50 **0.09**	550 **260**	1500	0.05 **0.04**	
	BASED ON ENGINEERED AIR **WATER 140°F (60°C) EWT, 20°F (11.1°C) D T, 60°F (15.55°C) EAT**							

Unit Heater Schedule

Project: **Winnipeg Police Service**
East District Police Station

File: 04-214-01 Designer: VSW
Date: Mar-07 Sheet: **MS-12**

Variable Volume Air Valves

NO.	AIR CAPACITY (cfm) (l/s) MIN. SUMM.	MIN. WINT.	DESIGN	VALVE RANGE (cfm) (l/s)			MIN S.P. (in. W.G.) (Pa)	MODEL	LOCATION	REMARKS
VAV 1	**650** 307	**1300** 614	**1300** 614	**650** 307	x	**1300** 614	**0.25** 62.5	SDV Size 16	as per plans	cw/ with reheat coil 4 row 69 MBH
VAV 2	**30** 14	**30** 14	**100** 47	**30** 14	x	**100** 47	**0.25** 62.5	SDV Size 6	as per plans	cw/ with reheat coil 1 HC 2 MBH
VAV 3	**30** 14	**30** 14	**100** 47	**30** 14	x	**100** 47	**0.25** 62.5	SDV Size 6	as per plans	cw/ with reheat coil 1 HC 2 MBH
VAV 4	**30** 14	**40** 19	**100** 47	**30** 14	x	**100** 47	**0.25** 62.5	SDV Size 6	as per plans	cw/ with reheat coil 1 row 2 MBH
VAV 5	**30** 14	**40** 19	**100** 47	**30** 14	x	**100** 47	**0.25** 62.5	SDV Size 6	as per plans	cw/ with reheat coil 1 row 1.9 MBH
VAV 6	**102** 48	**170** 80	**340** 160	**102** 48	x	**340** 160	**0.25** 62.5	SDV Size 10	as per plans	cw/ with reheat coil 2 HC 10.3 MBH
VAV 7	**90** 42	**150** 71	**300** 142	**90** 42	x	**300** 142	**0.25** 62.5	SDV Size 8	as per plans	cw/ with reheat coil 2 row 7.7 MBH
VAV 8	**117** 55	**195** 92	**390** 184	**117** 55	x	**390** 184	**0.25** 62.5	SDV Size 10	as per plans	cw/ with reheat coil 2 row 10.2 MBH
VAV 9	**351** 166	**585** 276	**1170** 552	**351** 166	x	**1170** 552	**0.25** 62.5	SDV Size 12	as per plans	cw/ with reheat coil 1 row 15 MBH
VAV 10	**117** 55	**195** 92	**390** 184	**117** 55	x	**390** 184	**0.25** 62.5	SDV Size 8	as per plans	cw/ with reheat coil 3 row 12 MBH
VAV 11	**20** 9	**20** 9	**130** 61	**20** 9	x	**130** 61	**0.25** 62.5	SDV Size 6	as per plans	cw/ with reheat coil 1 row 1.3 MBH
VAV 12	**60** 28	**60** 28	**200** 94	**60** 28	x	**200** 94	**0.25** 62.5	SDV Size 6	as per plans	cw/ with reheat coil 1 row 2.5 MBH
VAV 13	**16** 8	**28** 13	**55** 26	**16** 8	x	**55** 26	**0.25** 62.5	SDV Size 6	as per plans	cw/ with reheat coil 1 row 1.6 MBH
VAV 14	**15** 7	**25** 12	**50** 24	**15** 7	x	**50** 24	**0.25** 62.5	SDV Size 6	as per plans	cw/ with reheat coil 1 row 1.5 MBH
VAV 15	**35** 17	**35** 17	**70** 33	**35** 17	x	**70** 33	**0.25** 62.5	SDV Size 6	as per plans	cw/ with reheat coil 1 row 1.8 MBH
VAV 16	**16** 8	**28** 13	**55** 26	**16** 8	x	**55** 26	**0.25** 62.5	SDV Size 6	as per plans	cw/ with reheat coil 1 HC 1.8 MBH
VAV 17	**72** 34	**120** 57	**240** 113	**72** 34	x	**240** 113	**0.25** 62.5	SDV Size 9	as per plans	cw/ with reheat coil 1 row 4.8 MBH
VAV 18	**270** 127	**450** 212	**900** 425	**270** 127	x	**900** 425	**0.25** 62.5	SDV Size 12	as per plans	cw/ with reheat coil 2 row 17.3 MBH
VAV 19	**60** 28	**60** 28	**200** 94	**60** 28	x	**200** 94	**0.25** 62.5	SDV Size 6	as per plans	cw/ with reheat coil 1 row 2.4 MBH
VAV 20	**96** 45	**160** 76	**320** 151	**96** 45	x	**320** 151	**0.25** 62.5	SDV Size 8	as per plans	cw/ with reheat coil 3 row 9.5 MBH

Variable Volume Air Valves

NO.	AIR CAPACITY (cfm) (l/s) MIN. SUMM.	MIN. WINT.	DESIGN	VALVE RANGE (cfm) (l/s)			MIN S.P. (in. W.G.) (Pa)	MODEL	LOCATION	REMARKS
VAV	**30**	**30**	**100**	**30**		**100**	**0.25**	SDV	as per	cw/ with reheat coil
21	14	14	47	14	x	47	62.5	Size 6	plans	1 row 1.7 MBH
VAV	**213**	**355**	**710**	**213**		**710**	**0.25**	SDV	as per	cw/ with reheat coil
22	101	168	335	101	x	335	62.5	Size 12	plans	2 row 15 MBH
VAV	**306**	**510**	**1020**	**306**		**1020**	**0.25**	SDV	as per	cw/ with reheat coil
23	144	241	481	144	x	481	62.5	Size 14	plans	3 row 30 MBH
VAV	**64**	**108**	**215**	**64**		**215**	**0.25**	SDV	as per	cw/ with reheat coil
24	30	51	101	30	x	101	62.5	Size 8	plans	2 row 6.2 MBH
VAV	**42**	**42**	**140**	**42**		**140**	**0.25**	SDV	as per	cw/ with reheat coil
25	20	20	66	20	x	66	62.5	Size 6	plans	1 row 2.1 MBH
VAV	**42**	**42**	**140**	**42**		**140**	**0.25**	SDV	as per	cw/ with reheat coil
26	20	20	66	20	x	66	62.5	Size 6	plans	1 row 2.1 MBH
VAV	**42**	**42**	**140**	**42**		**140**	**0.25**	SDV	as per	cw/ with reheat coil
27	20	20	66	20	x	66	62.5	Size 6	plans	1 row 2.1 MBH
VAV	**21**	**35**	**70**	**21**		**70**	**0.25**	SDV	as per	cw/ with reheat coil
28	10	17	33	10	x	33	62.5	Size 6	plans	4 row 3.1 MBH
VAV	**16**	**28**	**55**	**16**		**55**	**0.25**	SDV	as per	cw/ with reheat coil
29	8	13	26	8	x	26	62.5	Size 6	plans	1 row 1.6 MBH
VAV	**16**	**28**	**55**	**16**		**55**	**0.25**	SDV	as per	cw/ with reheat coil
30	8	13	26	8	x	26	62.5	Size 6	plans	1 row 1.6 MBH
VAV	**16**	**28**	**55**	**16**		**55**	**0.25**	SDV	as per	cw/ with reheat coil
31	8	13	26	8	x	26	62.5	Size 6	plans	1 row 1.6 MBH
VAV	**16**	**28**	**55**	**16**		**55**	**0.25**	SDV	as per	cw/ with reheat coil
32	8	13	26	8	x	26	62.5	Size 6	plans	1 row 1.6 MBH
VAV	**16**	**28**	**55**	**16**		**55**	**0.25**	SDV	as per	cw/ with reheat coil
33	8	13	26	8	x	26	62.5	Size 6	plans	1 row 1.6 MBH
VAV	**60**	**100**	**200**	**60**		**200**	**0.25**	SDV	as per	cw/ with reheat coil
34	28	47	94	28	x	94	62.5	Size 6	plans	1 row 3 MBH
VAV	**51**	**85**	**170**	**51**		**170**	**0.25**	SDV	as per	cw/ with reheat coil
35	24	40	80	24	x	80	62.5	Size 6	plans	1 row 3 MBH
VAV	**39**	**70**	**130**	**39**		**130**	**0.25**	SDV	as per	cw/ with reheat coil
36	18	33	61	18	x	61	62.5	Size 6	plans	4 row 3 MBH
VAV	**15**	**25**	**50**	**15**		**50**	**0.25**	SDV	as per	cw/ with reheat coil
37	7	12	24	7	x	24	62.5	Size 6	plans	2 row 2 MBH
VAV	**90**	**150**	**300**	**90**		**300**	**0.25**	SDV	as per	cw/ with reheat coil
38	42	71	142	42	x	142	62.5	Size 6	plans	1 row 3.5 MBH
VAV	**105**	**175**	**350**	**105**		**350**	**0.25**	SDV	as per	cw/ with reheat coil
39	50	83	165	50	x	165	62.5	Size 8	plans	1 HC 6 MBH
VAV	**38**	**62**	**125**	**38**		**125**	**0.25**	SDV	as per	cw/ with reheat coil
40	18	29	59	18	x	59	62.5	Size 6	plans	1 HC 3 MBH

SMS ENGINEERING

Variable Volume Air Valve Schedule

Project: **Winnipeg Police Service**
East District Police Station

File: 04-214-01 Designer: VSW

Date: Mar-07 Sheet: **MS-13B**