Part 1 General

1.1 GENERAL

.1 All drawings and all sections of the Specifications shall apply to and form an integral part of this section.

1.2 WORK INCLUDED

.1 Labour, Materials, plant, tools, equipment and services necessary for and reasonably incidental to completion of following services:
- .1 Glycol heating systems

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 21 05 00 Mechanical General Provisions

.2 Section 21 08 10 Insulation

.3 Section 22 40 10 Plumbing

.4 Section 23 80 10 Air Distribution

.5 Section 25 10 10 Controls/Instrumentation

.6 Section 23 90 10 Testing, Adjusting and Balancing

.7 Section 26 05 00 Common Work Results – For Electrical

Part 2 Products

2.1 PIPE AND FITTINGS

.1 All pipe & fittings shall be manufactured in Canada or the U.S.A.

.2 Glycol Heating
- .1 Pipe Diameter:
  - .1 13mm to 250mm (1/2" to 10")- Schedule 40 carbon steel, continuous weld or electric resistance weld pipe conforming to A.S.T.M. A53 Grade B.
- .2 Fittings
  - .1 Unions to be brass to iron ground joint type. Screwed fittings on steel pipe to be best quality 1034 kPa (150 psi) black malleable iron, banded. Nipples to suit pipe type. Thred-O-Lets and Weld-O-Lets to be manufactured to ASTM A181, Grade 1.
  - .2 Butt welding fittings to be Crane manufactured to ASTM A-234. Flanges to be Anvil forged carbon slip-on welding flanges conforming to ASTM A181, Grade 1. Gaskets to be preformed non-asbestos. Site or shop cut gaskets unacceptable. Use ring gaskets on raised face flanges and full faced gaskets on flat face flanges.

2.2 VALVES

.1 Schedule of Valves

.1 All valves of each type specified shall be of one manufacturer. Submit brochure of valves selected, showing make, figure numbers, Material of construction and use.

.2 All valves shall conform to the requirements of the Manufacturers Standardization Society (MSS).

.2 Butterfly Valves

.1 Valves to be rated at 1034 kPa (150 psig) with cast iron body, aluminum bronze disc, stainless steel shaft, Buna N shaft seals, E.P.D.M. seat, extended neck design allowing valve operator to clear insulation, bubble-tight shut-off to 1034 kPa (150 psig).

.2 Keystone Fig. ARI, Center Line Series 200, Anvil Series 8000 or Nibco Fig. WD-2000.

.3 Valves 200mm (8") and smaller to have lever-lock handles with 10-position throttling plates.

.4 Valves 250mm (10") and larger to have gear operators with position indicator.

.5 Butterfly valves shall be considered equal in accordance with B7 to gate valves for glycol heating installations.

.6 On flanged piping at all equipment (pumps, coils, boilers and the like), use valves conforming to requirements of above with fully tapped body lugs so that valve can be connected individually to adjacent flanges.

.7 Keystone Fig. AR2, Centre Line Series 200 Lug Body, Anvil Series 8000 lug body or Nibco Fig. LD-2000.

.3 Ball Valves

.1 Valves to have brass body, screwed ends, brass ball and stem and teflon seating seal (175 deg. C).

.2 Ball valves shall be considered equal to gate valves for glycol installations.

.3 Toyo Fig. 5044A, Kitz Fig. 58, Anvil Fig. 171N, Nibco Fig. T-FP600, Newman Hattersley Fig. 1969, Victaulic 721, 722 or Jenkins Fig. 201J.

.4 Check Valves

.1 Horizontal Piping

.1 Sizes up to and including 50mm (2") - Crane Fig. 41TF, Toyo Fig. 236T, Anvil Fig. 3310, Kitz Fig. 22, Nibco Fig. T-413-Y, Victaulic 716 or Jenkins Fig. 4041TJ.

.2 Sizes 64mm (2-1/2") and above

.1 862 kPa wafer style with cast iron body, 316 stainless steel disc and stem, E.P.D.M. seat, Inconel-X spring and Teflon bushings, Chek-Rite Model 12-CET, Moyes & Groves Fig. W12A-I6V.

.2 Vertical Piping

.1 Sizes up to and including 50mm (2")

.1 862 kPa Anvil Fig. 3600 bronze body spring loaded check valve with Teflon disc.

.2 Size 64mm (2-1/2") and above

.1 862 kPa Center Line, Series 800, wafer style check valve with ductile iron EPDM lined body, aluminum bronze check valve plates and stainless steel shaft, springs and travel stops.

.5 Drain Valves - 3/4" Toyo Fig. 5046, Kitz Fig. 68C.C. c/w brass cap and chain, Newman Hattersley Fig. 1969 c/w brass cap and chain or Jenkins Fig. 201J c/w brass cap and chain.

.6 Circuit Balancing Valves

.1 13mm (1/2") to 19mm (3/4") soldered.

.1 Provide Armstrong Model CBV-CS solder type Circuit Balancing Valve.

.2 Each valve shall have metering ports incorporating EPT check valves, on both sides of the seat.

.3 "Y" pattern globe style, designed for either presetting with balance schedule or for proportional balancing.

.4 All metal parts bronze copper alloy. Each valve shall provide three functions.

.1 precise flow measurement

.2 precision flow balancing

.3 positive shutoff with no-drip soft seat

.5 Valves shall have one 360 degree adjustment turn of handwheel with positive memory, allowing valve to be shut off and reopened to its balance setpoint.

.6 Ship with pre-formed insulation to meet or exceed ASTM D 1784/cLASS 14253-c, MEA #7-87, ASTM-E-84 and ASTM-E-136 with flame spread rating of 25 or less and smoke development rating of 50 or less.

.2 13mm (1/2") to 50mm (2") Soldered

.1 Provide Armstrong Model CBV-S solder type CBVs or Tour & Andersson.

.2 Each valve shall have metering ports incorporating EPT check valves, on both sides of the seat.

.3 "Y" pattern equal percentage globe style, designed either for presetting with balance schedule or for proportional balancing. All metal parts bronze copper alloy.

.4 Each valve shall provide three functions:

.1 Precise flow measurement.

.2 Precision flow balancing.

.3 Positive shutoff with no-drip soft seat.

.5 Provide 1/4" NPT tapped drain port on each side of valve seat.

.6 Valves shall have four (4) full 360 degree adjustment turns of handwheel (1440 degree) with micrometer type indicator and hidden memory feature to program valve for precise, tamper-proof balanced setting. When installed, handwheel and metering ports shall not be located on bottom of valve to prevent sediment deposits. Position handwheel scale so it may be clearly read without use of mirrors or any special tools.

.7 Metering ports interchangeable with drain ports to allow for read-out flexibility when installed in tight piping locations.

.8 Ship with pre-formed insulation to meet or exceed ASTM D 1784/cLASS 14253-c, MEA #7-87, ASTM-E-84 and ASTM-E-136 with flame spread rating of 25 or less and smoke development rating of 50 or less.

.3 13mm (1/2") to 50mm (2") threaded

.1 Provide Armstrong Model CBV-T threaded type CBV.

.2 Each valve shall have metering ports incorporating EPT check valves, on both sides of the seat.

.3 "Y" pattern equal percentage globe style, designed either for presetting with balance schedule or for proportional balancing. All metal parts bronze copper alloy.

.4 Each valve shall provide three functions:

.1 Precise flow measurement.

.2 Precision flow balancing.

.3 Positive shutoff with no-drip soft seat.

.5 Provide 1/4" NPT tapped drain port on each side of valve seat.

.6 Valves shall have four (4) full 360 degree adjustment turns of handwheel (1440 degree) with micrometer type indicator and hidden memory feature to program valve for precise, tamper-proof balanced setting. When installed, handwheel and metering ports shall not be located on bottom of valve to prevent sediment deposits. Position handwheel scale so it may be clearly read without use of mirrors or any special tools.

.7 Metering ports interchangeable with drain ports to allow for read-out flexibility when installed in tight piping locations.

.8 Ship with pre-formed insulation to meet or exceed ASTM D 1784/cLASS 14253-c, MEA #7-87, ASTM-E-84 and ASTM-E-136 with flame spread rating of 25 or less and smoke development rating of 50 or less.

.4 Size 64mm (2-1/2") to 150mm (6") diameter.

.1 Provide Armstrong Circuit balancing Valves or Tour & Andersson (CBV) as noted. CBVs shall be CBV-G (straight) or CBV-A (angle).

.2 Valve body of ductile iron with grooved ends or with Armgrip non-rotating ductile iron flange adapters.

.3 Valves suitable for working pressures of 150 psi.

.4 Valve to have metering ports with EPT check valves on both sides of seat.

.5 Valves to be "Y" pattern modified equal percentage globe style, designed either for presetting with balancing schedule or for proportional balancing.

.6 Each valve shall perform three functions:

.1 precise flow measurement

.2 precision flow balancing

.3 positive shutoff with no-drip soft seat.

.7 Valves shall have five [63.5mm (2-1/2"); 76mm (3")] or six [100mm (4"); 150mm (6")] full 360 degree adjustment turns of handwheel with micrometer-type indicator and hidden memory feature to program valve for precise, tamper-proof balanced setting. Do not install handwheel and metering ports on bottom of valve to prevent sediment deposits. Position handwheel scale for clear reading without use of mirrors of other special tools.

.8 Install valves at least five pipe diameters downstream from any fitting and at least ten pipe diameters downstream from any pump. Two pipe diameters downstream of CBV shall be free of any fitting.

.9 Furnish CBVs with pre-formed insulation to meet or exceed ASTM D 1784/Class 14253-C, MEA #7-87, ASTM-E-84 and ASTM-E-136 with flame spread rating of 25 or less and smoke development rating of 50 or less.

.10 Valves to be grooved/flanged.

2.3 EXPANSION JOINTS

.1 On piping up to and including 64mm (2-1/2") diameter, FLEXONICS packless expansion compensators, having type 321 stainless steel bellows, suitable for traverse up to 44mm (1-3/4"), c/w guide sleeve and traverse stops. Expansion compensators up to and including 50mm (2") to have screwed ends or flanged ends; expansion compensators of 64mm (2-1/2") in size or larger to have flanged ends. Compensators to be external type 'H'.

.2 On piping of 75mm (3") and above, Flexonics packless self-equalizing single expansion joints, with type 304 stainless steel bellows. Sizes 75mm (3") and above to be externally guided with flanged ends.

.3 Guides to be Flexonics.

.4 Expansion joints shall be selected on the following basis:
.1 Glycol heating system - 100 deg.C temp. rise.

2.4 FLEXIBLE PIPE CONNECTIONS

.1 On "hot" liquid systems provide Hydro Flex flexible braided stainless steel connectors manufactured of 300 series stainless steel convoluted metal bellows and braid with 1034 kPa (150 lb.) forged steel flanges (PCFF) or N.P.T. male ends (PCMX). Connectors to be 454mm (18") long unless noted otherwise on drawings or schedule.

.2 Provide Vibro-Acoustics VH spring hangers.

.3 Location
.1 Suction and discharge piping to pumps

2.5 AIR VENTS

.1 Manual air vents: Dole #14 key-operated air vent rated at 1034 kPa (150 psig) with copper tube extensions or Dole #9 screwdriver operated air vent rated at 1034 kPa (150 psig).

.2 Automatic air vents: Dole #75 automatic float air vent rated at 1034 kPa (150 psig).

2.6 AIR PURGERS

.1 Provide Hamlet and Garneau air purgers designed and fabricated for a working pressure of 1,034 kPa (150 psig).

.2 Sizes up to and including 3" shall be of cast iron and have screwed connections. Sizes 4" and larger shall be of steel construction and have flanged connections.

.3 Purgers shall have a top air vent connection and a bottom drain connection.

.4 Provide a Hamlet and Garneau Model MV-15 float type air vent with each air purger.

2.7 STRAINERS

.1 Strainers shall be Spirax Sarco type YS-250 or Toyo Fig. 380 for sizes up to and including 50mm (2") screwed ends.

.2 On pipe sizes 64mm (2-1/2") and larger, use Spirax Sarco type CI-125 and F-125, Kitz Fig. 80 or Toyo Fig. 381A for systems operating below 689 kPa (100 psig) and use Spirax Sarco extra heavy type CI-250 and F-250 for systems operating at 689 kPa (100 psig) and above.

.3 Screens shall be stainless steel with perforations as follows:

Size	Glycol
Up to 3"	20 MESH
4" to 6"	1/8"

2.8 THERMOMETERS

.1 Ashcroft Series EI bi-metal dial thermometers, having stainless steel cases, rings, and stems, glass covers and adjustable pointers. Accuracy to be 1% of full span.

.1 Glycol heating system - plus 10 deg. C to 150 deg.C.

.2 Thermometers located up to 1.5m (60") above finished floor to have 75mm (3") diameter dials; and located above 1.5m (60") to have 125mm (5") diameter dials. Use back or bottom inlet stems, whichever is best suited for ease of reading. Choice of stem types shall not be made until piping and equipment, etc. has been installed. Stem type to be approved by Contract Administrator.

.3 Brass separable wells to have insulation extensions, where mounted on insulated piping or equipment, to ensure dials are clear. Minimum length of stems to be 150mm (6").

2.9 PRESSURE GAUGES

.1 Ashcroft type 1010 quality gauges having aluminum cases, bronze geared movements, bronze bourdon tube, friction glass cover, steel slip ring, precision type pointer. Accuracy to be 1% of full scale.

.2 Use 113mm (4-1/2") dials. Where mounted above 3m (10') from floor level, use 150mm (6") dial. Gauges to be chosen with indicating needle at 12 o'clock position for normal operating pressure. Gauges shall have dual indication (i.e. kPa, psi) with kPa prominent figure.

.3 Provide Ashcroft Fig. DH-11 brass needle valve on gauges on glycol systems.

.4 Provide Ashcroft Fig. 1/4-1106B pulsation dampener on pump gauges.

2.10 EXPANSION TANKS

.1 Replaceable Bladder Type

.1 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 ethylene glycol.

.2 Vessel to be of vertical configuration with aerated skirt, and bottom connection through skirt.

.3 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).

.4 Piping from the system to the vessel to include a square-head cock and a boiler drain.

.5 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.

.6 Refer to Schedule.

2.11 HEATING PUMP SYSTEM

.1 Pumps

.1 Provide Series 4380 IVS Design Envelope Pumps. The design envelope shall encompass an Initial Design Point as scheduled. The design envelope shall also be capable of supplying Best Efficiency Point capacity.

.2 The Vertical In-Line (VIL) pump, single stage, single suction type, with pump characteristics which provide rising heads to shut off, shall be supplied NEMA Premium® efficiency Motors suitable for Inverter Duty meeting NEMA MG1, Part 31 insulation requirements and an Armstrong NEMA / UL Type-12 enclosure variable speed VFD.

.3 The Variable Frequency Drive shall be factory mounted and integrated with the Pump and Motor for a self-contained Compact Package. Components shall be selected to ensure optimum component matching and protection from motor overloading at any operating point within the design or operating envelope.

.4 Pump Construction: Pump Casing - Cast Iron with ANSI-125 flanges for working pressure to 175 psig at 150°F. Suction and discharge connections shall be flanged and the same size and shall be drilled and tapped for seal flush and gauge connections. The Casing shall be hydrostatically tested to 150% maximum working pressure.

.5 The casing shall be radially split to allow removal of the rotating element without disturbing the pipe connections.

.6 Impeller - Bronze, fully enclosed type, dynamically balanced.

.7 A bronze shaft sleeve, extending the full length of the mechanical seal area, shall be provided.

.8 Mechanical Seals - Shall be Single-spring inside type with silicon carbide faces. EPDM Elastomer with stainless steel spring and hardware shall be provided. Provide factory installed flush line with manual vent to purge air prior to pump start-up, and shall be piped from the seal area to the pump suction connection.

.2 IVS Drives – Integrated Variable Frequency Drive (VFD)

.1 Fundamental Requirements

.1 VFD shall be of the VVC-PWM type providing near unity displacement power factor (cos Ø) without the need for external power factor correction capacitors at all loads and speeds.

.2 VFD shall incorporate DC link chokes for the reduction of mains borne harmonic currents to reduce the DC link ripple current thereby increasing the DC link capacitors lifetime.

.3 VFD shall be UL and C-UL Listed & CE Marked showing compliance with both the EMC Directive 89/336/EEC and the Low Voltage Directive 72/23/EEC.

.4 RFI filters shall be incorporated within the drive to ensure it meets the emission and immunity requirements of EN61800-3 to the 1st Environment Class C1 (EN55011 unrestricted sales class B).

.2 VFD and Motor Protection

.1 VFD and motor protection shall include: motor phase to phase fault, motor phase to ground fault, loss of supply phase, over voltage, under voltage, motor over temperature, inverter overload, over current. Over current is not allowed ensuring 4380 IVS units will not overload the motor at any point in the operating range of the unit.

.3 User Interface

.1 VFD shall incorporate an integrated graphical user interface that shall provide running and diagnostic information and identify faults and status in clear English language. Faults shall be logged / recorded for interrogation at a later date.

.2 It shall be possible to upload parameters from one VFD into the non-volatile memory of a computer and download the parameters into other drives requiring the same settings.

.3 The keypad shall incorporate Hand-Off-Auto pushbuttons to enable switching between BMS and manual control.

.4 Sensorless Control Algorithm

.1 Sensorless control software shall be embedded in the IVS unit to provide automatic speed control in variable volume systems

without the need for pump mounted (internal/external) or remotely mounted differential pressure sensor. The default operating mode under Sensorless Control shall be 'quadratic pressure control' whereby head reduction with reducing flow will be according to a quadratic control curve. Control mode setting and minimum / maximum head set-points shall be user adjustable via the built-in programming interface

.5 Serial Communication

.1 The VFD shall incorporate a USB port for direct connection to a PC and an RS485 connection with BACnet protocol.

.6 Other Control Features

.1 The VFD shall have the following additional features:

- Sensorless override for BMS
- Manual pump control or closed loop PID control
- Programmable skip frequencies and adjustable switching frequency for noise / vibration control
- Auto alarm reset
- Motor pre-heat function
- Six programmable digital inputs (two can be configured as outputs)
- Two analogue inputs
- One programmable analogue / digital output
- Two volt-free contacts
- Warranty: 36 months from date of installation but not more than 42 months from date of manufacture.

.3 Suction Guides

.1 Furnish and install on the suction of each pump an Armstrong Suction Guide, with Outlet Flow Stabilizing Guide Vanes, removable Stainless Steel Strainer and Fine Mesh Start-up Strainer. Supply valve with Cast Iron body with 125 psig flanged ports.

.2 The mechanical subcontractor shall inspect the strainer prior to activating the pump and, further, shall remove the Fine Mesh Start-up Strainer after a short running period. (24 hours maximum). Space shall be provided for removal of the Strainer and connection of a Blow-down Valve.

.4 Flo-Trex Valves

.1 Furnish and install on the discharge side of each pump an Armstrong Model FTV Flo-Trex Combination Valve.

.2 Each valve is to incorporate the following three functions in one body: Tight shut-off, spring-closure type silent non-slam check and effective throttling with flow measurement capability. The body shall have (2) 1/4" NPT connections on each side of the valve seat. Two connections to have brass pressure and temperature metering ports, with Nordel check valves and gasketed caps. Two other connections to be supplied with brass drain plugs. Metering ports are to be interchangeable with drain ports to allow for measurement flexibility when installed in tight locations. The valve disc shall be bronze plug & disc type with high impact engineered resin seat to ensure tight shut-off and silent check operation.

.3 The valve stem shall be stainless steel with flat surfaces provided for adjustment with open-end wrench.

.4 Valve body shall be Cast Iron with 125 psig flanged ports.

.5 The valve shall be selected and installed in accordance with the manufacturer's instructions and be suitable for the pressure and temperature specified.

2.12 BOILER

.1 Furnish an AERCO boiler plant consisting of two (2) model BMK3000 boiler modules, each having an input of 3,000 MBH and a maximum output of 2,610 to 2,880 MBH dependent upon return water temperature.

.2 The boiler modules, shall be a vertical firetube, hydronic, condensing design.

.3 The boiler module heat exchangers shall be constructed of 439 stainless steel fire tubes and tube sheets.

.4 The boiler pressure vessels shall be a thermal shock proof design, capable of handling return water temperatures down to 40 deg. F, without sustaining damage due to thermal shock or fireside condensation.

.5 The boilers will be piped directly into the system, reverse return, without the necessity of dedicated injector pumps.

.6 Each boiler module will be capable of operating with water flows of 25 usgpm to 350 Usgpm. The boiler can be fired with 0 water flow without sustaining damage.

.7 Each pressure vessel / burner / control package shall be provided as a single unit, fully assembled at the factory.

.8 The complete boiler assembly shall be fully contained within in a decorative factory painted metal cabinet.

.9 Overall dimensions of each boiler module assembly will be 28" wide X 56" long X 78" high.

.10 The burner will be of the boiler manufacturers design and an integral component of the boiler packaged assembly.

.11 The burners will be forced draft, full modulation, metal fiber mesh on stainless steel body with spark ignition and flame rectification.

.12 Air and natural gas input shall be controlled by a single point jackshaft, motor actuated air/fuel valve system having one internal linkage which will require no field adjustment.

.13 Air for combustion shall be trimmed through a variable speed fan control.

.14 The boiler / burner controls will be of the manufacturer's design.

.15 The input firing rate burner turndown for each boiler module shall be 15 : 1.

.16 Total plant input turndown will be 30 to 1, when two boilers are operated through the AERCO C-More Controllers with integral Boiler Sequencing Technology.

.17 The integral, factory designed burners shall operate on an adjustable inverse ratio in response to load demand. Thermal efficiency must increase as the boiler plant firing rate is decreased.

.18 Part load value efficiencies, based on third party witnessed testing, shall be published.

.19 Each burner shall produce <30ppm of NOx corrected to 3% oxygen.

.20 Boiler plant outlet header temperature will be controlled to +/- 4° F, at all load conditions.

.21 Each boiler module shall carry ULC/CSD-1/ASME approval as a single factory assembled package.

.22 The pressure vessels/heat exchangers shall be, ASME stamped for a working pressure of 160 psig.

.23 The pressure vessel/heat exchangers shall carry a Canadian Registration Number for the Province of Manitoba.

.24 The exhaust manifold shall be of corrosion resistant cast aluminum with an 8" diameter flue connection.

.25 The exhaust manifold shall have a one pass gravity drain to the collection manifold/s for the elimination of condensation within the collecting reservoir.

.27 The boilers shall be designed for connection to conventional, single or common breeching and stack systems or sidewall venting, utilizing cUL/ULC listed stainless steel AL-29-C positive pressure venting systems.

.28 The AERCO designed, integral boiler control system shall be segregated into three components: "C-More" Control Panel, Power Box and Input/Output Connection Box, mounted and wired on the Boiler.

The C-More control will include the following features:

.1 Six (6) surface mount 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 The combustion safeguard/flame monitoring system shall utilize spark ignition and a rectification type flame sensor.

.3 The controller shall annunciate boiler & sensor status and include 8 separate status and 34 separate fault, self diagnostic messages.

.4 The C-More controls will incorporate:
- .1 PID set point, high limit
- .2 Set point low limit
- .3 Fail safe change over to internal signal, on loss of external signal.
- .4 BST Boiler Sequencing Control

The boiler control system shall provide the following modes of operation:
- .1 Internal set point
- .2 Indoor/outdoor reset
- .3 4ma to 20ma Temperature Setpoint
- .4 Network direct drive through MODBUS protocol.
- .5 4ma to 20 ma Direct Drive
- .6 Network Direct Drive
- .7 Boiler Management System (BST)
- .8 Combination Control System

.29 The AERCO Model BST microprocessor based, Boiler Management System provided with each on board C-MORE boiler control system will control all operation and energy input of the boiler plant to ensure that all boiler modules in the plant. The AERCO BST shall utilize MODBUS Protocol for communication.

1 The controller shall be capable of sequencing the input of the boilers, equally throughout the boiler plant firing range and control system water flow through each boiler, to maximize the condensing capability of the plant. The boiler modules shall operate on an Inverse Efficiency Curve, with

known and published Part Load Value Efficiencies from 100% to 7 % of input.

.2 The BST will be set to operate the boiler plant in one of the following control modes, to control the main supply header temperature to +/- 4 deg F.

.1 Internal Setpoint from an AERCO supplied header temperature sensor.

.2 Adjustable inverse ratio in response to outdoor temperature. Reset ratio to be adjustable from 0.3 to 3.0.

.3 External 4-20ma signal.

.4 External MODBUS communication.

.3 The BST shall provide a "One Boiler Mode" function with motorized boiler flow control valve operation.

.30 Each boiler module will be supplied with

.1 Integral Oxygen (O2) Level combustion gas monitoring system. The combustion gas O2 levels shall be displayed, in real time, on the C-More control panel of each boiler.

.2 Integral electric probe type low water cut off,

.3 Dual over temperature protection including a manual reset

.4 ASME relief valve.

.5 External probe type auxiliary low water cut off with three way test valves shipped loose.

.6 Aluminum condensate drain trap with stainless steel float and seat, shipped loose.

.7 FM Condensate Neutralizers with 3/4" barb hose connections shipped loose.

.8 Size 4" Flg Motor Operated Boiler Flow Control Valves , Power Close – Spring Return with Proof of Open Switch, shipped loose.

.9 First year maintenance parts kit.

.31 The gas train shall be furnished in accordance with CGA/FM requirements for natural gas supply pressure, including manual main lubricated gas shut off valve, gas pressure regulators, air/fuel control valve, high and low gas pressure switches and electro-hydraulic single seated safety shut off valve/regulator, with proof of closure switch.

.32 Each boiler shall operate on a 208/3/60, 5 FLA amp service.

.33 Upon completion of assembly, prior to shipment, each boiler module will be fire tested over the full operating range. A flue gas analysis will be taken and the fuel/air ratios will be factory calibrated, to minimize time expended for on site commissioning.

.34 A copy of the factory commissioning fuel/air ratio setting, flue gas analysis results, will be included in the documentation file cabinet inside of the front door of the

boiler module.

.35 The pressure vessel/heat exchanger of the boiler shall carry a non- prorated 10-year warranty against condensate corrosion, thermal stress, mechanical defects or workmanship. The six individual circuit boards of the "C-More" control panel assembly shall carry a 2-year warranty against failure due to defective materials or workmanship. A warranty Certificate must be issued to the The City from the manufacturer and a copy of warranty must be submitted for the Contract Administrator's approval.

.36 Provide an AERCO ProtoNode Gateway for connection through the AERCO ACS Panel to the Building Automation System or Energy Management System utilizing BACnet protocol to communicate with the boilers which will be connected to the AERCO BMS via Modbus.

2.13 BUFFER TANK

.1 Provide a primary-secondary system AERCO or equal in accordance with B7 buffer tank, having a capacity of 104 us gallons.

.2 The tank shall be of carbon steel having a shell thickness of 0.125" and a head thickenss of 0.135".

.3 The tank shall be constructed in accordance with Section VII of the ASME Boiler & Pressure Vessel Code fro a M.A.W.P of 125 psig @ 450°F and bear a CRN for the Province of Manitoba

.4 The buffer tabk shall have four (4) ports. Size 6" Flg primary side connections, for a maximum flow of 450 usgpm and 4" Flg secondary side connections for a maximum flow of 200 usgpm.

.5 The exterior of the tank shall be factory painted with red oxide primer.

.6 The buffer tank shall carry a 1-year limited warranty that covers defects in materials and/or workmanship. This limited warranty runs from date of shipment.

2.14 CHEMICAL TREATMENT

.1 Glycol Systems Cleanout
- .1 Provide 45 litres of GE Betz Ferroquest FQ7103 preoperational cleaner per 4,500 litres of water in system.
- .2 Provide GE Betz Ferroquest FQ7102 as required.

.2 Glycol Systems Treatment
- .1 Provide a Neptune Type DBF-2 pot feeder on each glycol system to be used for the addition of corrosion inhibitor.

.3 Sidestream Filters
- .1 Provide a sidestream filter on glycol heating system.
- .2 Provide a Filterite Model LM010-3/4" in-line filter and a 3/4" sight flow indicator on each system. Install as per standard detail.
- .3 Provide one carton of thirty (30) 30-micron cotton filter cartridges.

2.15 ETHYLENE GLYCOL SOLUTION

.1 Provide high grade (minimum 99.9% pure by weight) Ucartherm PM 6195 or Dowtherm SR-1 industrial inhibited ethylene glycol. Also provide two additional drums of glycol above quantity required to fill systems.

.2 Pure glycol shall have following physical properties:

- .1 Molecular wt = 62.07
- .2 Specific Gravity at +20 deg.C = 1.130
- .3 Boiling Point at 760mm Hg = 197 deg.C
- .4 Freezing Point = -13 deg.C
- .5 Viscosity at +20 deg.C = 20.93 centipoises
- .6 Specific Heat at 20 deg.C = 0.561 Btu/lb./deg.F

.3 55% aqueous solution by volume shall be made from glycol specified using distilled water, deionized water, or soft water containing less than 25 ppm each of chloride and sulfate ions and 50 ppm each of hard water ions (calcium and magnesium as calcium carbonate) with total hardness not to exceed 100 ppm. Solution shall have freezing point of -36 deg. C and viscosity of 8 centipoises at 0 deg.C. City of Winnipeg water may be used without softening. For all other locations, water analysis shall be submitted to Contract Administrator prior to use.

.4 Glycol shall contain such inhibitors as deemed necessary by manufacturer to provide maximum corrosion protection to system. Manufacturer shall ensure that the glycol used to manufacture the heat transfer fluid is of high quality grade and is not recycled or reclaimed Material. The manufacturer of the fluid must provide written documentation stating the fluid passes ASTM D1384 standards (less than 0.5 mil penetration per year for all system metals).

.5 Provide Contract Administrator with written report indicating methodology and type of treated water used prior to mixing solution.

.6 After the solution has been circulated for 24 hours, a sample shall be tested by the manufacturer and a written report submitted to Contract Administrator.

2.16 GLYCOL FILL PACKAGE

.1 Provide Axiom SF-100 prefabricated glycol fill unit consisting of:

- .1 180 litre (48 gallon) polyethylene solution container with lid and, 1/2 NPT valved outlet.
- .2 Pump: 0.6 l/s at 345 kPa (1.0 gpm at 50 psi) with 1/2 HP, 120V, motor, complete with magnetic starter, adjustable reducing valve and gauge, inlet strainer and valve, thermal cutout and priming valve.
- .3 Pre-charged accumulator tank.
- .4 Low level pump cut-out.
- .5 Low level alarm with remote monitoring dry contacts.

2.17 DIRECT GAS-FIRED MAKE-UP UNIT

.1 General

.1 Supply an ICE direct fired make-up unit designed for outdoor installation. The capacity and configuration shall be as detailed on the drawings. The unit shall be CGA and ETL certified and listed to be in compliance with the current ANSI Z83.18 standard.

.2 The line burner, gas train and controls are to be in accordance with ANSI requirements. Both burner and blower shall be compensated for an altitude of 784 feet above sea level.

.3 The unit is to be completely factory test fired to verify proper operation. The unit capacity is to be validated with an instantaneous flow meter. A complete electrical circuit analysis is to be conducted and all systems operated and measured. A combustion analyzer is to be employed while unit is operating at full capacity to verify combustion emissions. Burner combustion must be clean and odorless and no aliphatic aldahydes are to be detectable. Combustion efficiency must limit the products of combustion to a maximum of 5 ppm carbon monoxide and 0.5 ppm nitrogen dioxide.

.2 Unit Casing

.1 Unit construction is to be of industrial quality heavy gauge bonderized G90 steel. The unit design shall incorporate a full base pan supported by an integral welded channel iron base. Bases are to be of industrial welded structural iron integrity, formed sheet metal bases are unacceptable. All structural iron base supports are to be treated with an industrial epoxy primer enriched with a rust inhibitor.

.2 To ensure the casings are airtight and weatherproof, all panels are to be caulked during assembly. All casings are to be hand fitted and secured with gasketed self-tapping Tek screws. Roof casing are to feature three-break standing seam panel design. Roof casings are to be sloped on outdoor units to prevent standing water. Sloped roofs are to be ¼ in. per foot and feature full drain troughs.

.3 Entire unit casing and accessories are to be insulated with fiberglass insulation with hard neoprene facing. (1 or 2 in. thick 1-1/2# or 2# density) insulation is to be secured with industrial glue and welded pin spots. Insulation is to be certified to fire and flamespread ratings as outlined by the ANSI code. The entire floor of the unit is to feature a steel liner sandwiching the insulation.

.4 Units are to be equipped with access doors to all serviceable components. Access doors are to have full-length stainless steel piano hinges. All access doors are to be equipped with an insulation liner, positive seal latches and gasketing . Access doors are to open outward on negative pressure sections and inward on positive pressure sections. All outdoor unit access doors are to be equipped with drain troughs.

.5 Units are to be finished with an industrial grade chain stop alkyd enamel paint. The medium grey finish coat is to be a mimum of 3 mils thick and provide 100% coverage.

.3 Blower / Motor Section

.1 Unit(s) shall be supplied with AMCA rated centrifugal forward curve DWDI statically and dynamically balanced blower. The fan shall be mounted on a heavy duty machined and polished shaft. The shafts maximum operating speed is not to exceed 75% of its first critical speed. The bearings and motor shall be mounted in the airstream. The T-frame motor shall be mounted in a motor compartment on a fully adjustable base. The bearings are to be industrial pillow block type supplied with extended grease lines. The blower is to be driven with an adjustable 1.25 s.f. V-belt drive package concealed in a belt guard. Outdoor units shall have hinged door(s) to provide easy access to maintain and inspect motor, belts & bearings.

.4 Burner Section

.1 Each unit shall be equipped with a wide range fully modulating direct gas-fired burner capable of 30:1 turndown. The burner shall have stainless steel combustion baffles, non-clogging gas ports, spark-ignited intermittent pilot and flame safeguard system. Burner combustion must be clean and odorless. Combustion efficiency must limit the products of combustion to a maximum of 5 ppm carbon monoxide and 0.5 ppm nitrogen dioxide. The burner profile is to be equipped with adjustable profile plates. A heat treated glass observation port shall provide a full view of flame. Hinged access door(s) are to be provided to allow easy maintaince and inspection for burner, ignitor and flamerod.

.5 Control / Manifold Compartment

.1 Unit control enclosure to have hinged access. Terminal strip and all wiring shall be numbered. The controls for the heater shall include;

- blower motor starter w/ambient compensated overloads and auxiliary contact(s).
- primary to 120v control transformer
- 6,ooo volt ignition transformer
- control circuit breaker and service switch
- manual reset temperature high limit
- flamesafeguard relay w/ LED status and flamerod
- discharge temperature control sensor
- differential air proving safety switch
- automatic low temperature limit

.2 All wiring external to control enclosure shall be run in conduit. The gas manifold shall include;

- main gas pressure regulator
- high gas pressure regulator
- manual shutoff & test firing valve

- main gas automatic shutoff valve
- auxiliary main gas automatic shutoff valve
- modulating control system
- pilot pressure regulator
- pilot automatic shutoff valve
- pilot manual shutoff valve
- pilot needle valve
- multiple test ports

.3 Outdoor units shall have hinged doors to provide easy access to maintain and inspect valves and controls.

2.18 HEATING COILS (GLYCOL)

.1 Supply and install coils with .16mm (5/8") copper tubes and aluminum fins, tested to 1034 kPa (150 psi) air under water. Coils to have manual air vents. Coils shall be installed to insure proper drainage.

.2 Coils used for glycol application shall be suitable to operate with glycol solution specified in Section 23 60 10.

.3 Refer to Heat Recovery Unit Schedule.

Part 3 Execution

3.1 PIPE AND FITTINGS

.1 Inside of all pipe, fittings, traps, valves and all other equipment to be smooth, clean and free from blisters, loose mill scale, sand and dirt when erected.

.2 Install screwed unions or flanges at all equipment connections, elements, traps, valves, etc.

.3 Pipe bending is not permitted.

.4 Pipe and fittings up to and including 50mm (2") diam. to be screw jointed with screwed fittings. Make screw joints iron to iron, with graphite and oil filler or joint compound. Dope male threads only. All fuel oil piping shall be welded.

.5 Pipe and fittings 63mm (2-1/2") diam. and above to be jointed by welding. Branch connections to be welded using butt welding fittings. Use slip-on welding flanges, welded to pipe on which they are fitting, at flange neck and back-welded on pipe end, at inside flange face. Valve companion flanges to be flat or raised face, matching valve flange. Use gaskets on flanged joints.

.6 Branch connections of sizes 13mm (1/2"), 19mm (3/4") and 25mm (1") for radiation may be formed on mains of 50mm (2") diam. and above using carbon steel Thred-O-Let welding fittings.

.7 Branch connections of sizes 31mm (1-1/4"), and larger to be formed using Weld-O-Lets. Reductions in mains to be after branches using butt weld reducing fittings. Site or shop fabricated welding fittings not permitted.

.8 Welding to conform to Provincial Department of Labour Regulations. Welders to be licensed.

.9 Use long radius elbows. For pipe reductions use eccentric reducing sockets.

.10 Keep pipe connections clear for tube removal, etc.

.11 Dielectric Couplings
- .1 Provide where pipes of dissimilar metals are joined.
- .2 Provide unions or flanges for pipe 50mm (2") and smaller and flanges on piping 63mm (2-1/2") and larger.
- .3 Use Style 47 Dielectric Waterway as manufactured by Victaulic.

.12 Branch Connections
- .1 Type 'K' copper soft temper pipe - Silver braze joints using Handy & Harman's silver brazing alloy and flux. Fittings to Emco smooth bore silver braze fittings.

3.2 PIPING SYSTEMS

.1 Glycol Piping Systems
- .1 Grade up in flow direction or as noted so air may pass through connecting risers, etc. Minimum grading to be 1:480.

.2 General
- .1 Install branch riser take-offs to grade up to riser.
- .2 Run piping parallel to walls and as unobtrusive as possible when viewed from inside or outside building.
- .3 Where pipe change in direction is shown to take up expansion, spring piping cold.
- .4 Blow out radiation and coils with compressed air prior to piping connections.
- .5 Use welded piping in concealed areas and as a result inaccessible, i.e. plastered ceilings, etc. Control valves, etc. to be accessible through access doors.
- .6 Install drain cocks on each pump and at system low points. Pipe to nearest floor drain.

3.3 TESTING OF SYSTEMS

.1 Tests to be carried out in accordance with following time-pressure requirements and regulations and requirements of authorities have jurisdiction.

.2 Glycol heating - test at 862 kPa (125 psig), or to pressure 1-1/2 times operating pressure, which ever is greatest, for 12 hrs.

.3 Piping, concealed prior to completion of total service, to be tested in sections prior to concealment. Tests to be witnessed by Contract Administrator's representative. Two working days prior notice to be given Contract Administrator of such tests. Pressures to be as registered at system highest point. When sections are being tested additional pressure developed by static head of remainder of system above, to be added to specified test pressure.

.4 Tests to be with water, unless noted otherwise, prior to insulation being applied.

.5 System tests to be with equipment connected. Trap diaphragms to be removed and systems flushed prior test.

.6 Make good leaks, replace defective parts, flush out defective section, re-test and adjust until system functions correctly.

.7 Prior to The City's takeover, systems to be balanced and ready for operation, with traps, strainers, drip legs, etc. cleaned.

3.4 VALVES

.1 Provide three valve by-passes in the following locations and where shown on drawings. By-pass valves shall be as specified for balancing valves.
- .1 Pressure reducing valves.
- .2 Temp. control valves on heating coils where the inlet air temperatures are 5 deg. C and below.

.2 Provide isolating valves in the following locations and where shown on drawings.
- .1 Suction and discharge of pumps.
- .2 Before all temp. control valves.
- .3 Inlet and outlet of all glycol fed equipment.
  - .1 Inlet valve shall be ahead of control valve to single coils. Provide inlet and outlet valves on all coil sections in multiple coil bank.
  - .2 Where piping detail sheets note balancing valves on leaving side of coils, additional outlet isolating valves not required, unless specifically noted on detail sheet.

.3 Provide check valves on parallel operation pump discharges and also where noted. Install swing type check valves in a horizontal section of piping.

.4 Provide balancing valves in following locations and where noted.
- .1 Pump discharges.
- .2 Outlet piping from all glycol coils.
- .3 Valves on all glycol systems shall be gate type valves except for bypass valves which shall be globe type.

.5 Provide chain wheel operators c/w chain for all valves where the valve operator is higher than 6'-6" above the floor. Where necessary provide shaft extensions c/w brackets and bearing to locate chain wheel operator in accessible location.

.6 Valves installed in concealed locations, i.e. ceiling spaces, to be arranged for ease of access for servicing through access doors.

.7 Provide a union or flange dependent on size of piping between butterfly valves and equipment which they serve to permit isolation and removal of equipment.

.8 Butterfly valves shall be considered equal to gate valves for chilled water, condenser water, glycol and hot water heating installations.

.9 Ball valves shall be considered equal to gate valves for low pressure condensate, hot water heating, chilled water, condenser water and glycol installations.

3.5 SUCTION GUIDES

.1 After initial start-up of system the start-up strainer is to be removed from the unit.

3.6 EXPANSION JOINTS

.1 Use guides on each side of expansion joints and compensators. Support from structural brackets.

.2 When expansion joints are installed at ambient temps. higher than minimum system operating temp. they shall be precompressed prior to installation, to allow for eventual contraction of piping.

3.7 FLEXIBLE PIPE CONNECTIONS

.1 Install as per manufacturer's recommendations.

.2 Provide spring hangers for first three pipe support points from flexible connections.

3.8 ANCHORS

.1 Provide where noted on horizontal piping. Fit anchors on vertical piping to ensure that water or air is not trapped. Fabricate from channels and angles to suit location; brace to building structure.

3.9 AIR VENTS

.1 Provide manual air vents at high points of glycol heating systems.

3.10 AIR PURGERS

.1 On the air vent connection of each air purger install a 2" diameter by 300mm (12") long air accumulation pipe. Reduce pipe to 3/4" diameter, install a shut-off valve and then install a Hamlet and Garneau Model MV-15 float type air vent.

.2 Pipe discharge of air vent to nearest plumbing drain.

3.11 STRAINERS

.1 Provide pipe strainers in following locations and where shown on drawings.
- .1 Pressure reducing valves.
- .2 Pump suctions.

3.12 THERMOMETERS

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

3.13 PRESSURE GAUGES

.1 Use pressure gauges on pressure reducing valve stations, suctions and discharges of pumps and where noted.

.2 Gauges, subject to vibration, to have copper tube extensions to locate away from source of vibration.

3.14 EXPANSION TANKS

.1 Install as per manufacturer's recommendations.

3.15 SAFETY RELIEF VALVES AND DRAINS

.1 On glycol boilers, pipe relief valve discharge to glycol fill tank.

3.16 BOILER

.1 Install in strict accordance with manufacturers recommendations and requirements of authorities having jurisdiction.

.2 Electric wiring to boiler control panels shall be provided by Div. 26. Control wiring from boiler control panel to boiler controls and necessary transformers for boiler controls shall be provided by Section 21. Boiler low water cut-off shall be wired into combustion controls.

.3 Start-Up Services

.1 Boiler manufacturer shall include services of factory- trained representative for period of at least two (2) working days to provide following services:

.1 Open all inspection doors for inspection of refractory. The City's representative and Section 23 60 10 shall be present.

.2 Supervise initial start-up and assist in necessary adjustments to place the equipment in operation.

.3 Provide a “dry run” of the boiler plant control sequences.

.4 Fire the boiler and adjust control and fuel/air ratio settings to optimum operating conditions and record combustion performance and efficiencies over the operating range.

.5 Intergrate operation of the BST control system with the boiler modules.

.6 Provide combustion analysis and commissioning reports for the purchaser and Contractor Administrator.

.7 Provide warranty labour without charge for two years after completion of the start up.

.2 In addition to start-up time, include additional two (2) days to train The City's designated personnel to safely and properly operate and maintain the equipment.

.3 Submit report to Contract Administrator with copy to The City stating above actions have been completed.

3.17 CHEMICAL TREATMENT

.1 General

.1 Provide services of GE Betz Water Treatment Specialist to supply chemicals, accessories and to conduct water treatment analysis; supervise installation of equipment and initial start-up of treatment procedures. If, from analysis, other treatment is required, provide same but submit

proposed treatment to Contract Administrator for approval prior to start-up of any system.

.2 Supplier to provide training in use of test equipment, establish treatment ranges, and provide log sheets with training in their use.

.3 Supplier to make regular call-backs to check on procedures being followed and report each call in writing to Contract Administrator, and The Citys during first year's operation. Call-backs to be in accordance with following:

.1 Heating systems - at the beginning, mid-point and end of the heating season.

.4 Supplier to guarantee all mechanical equipment provided to be free of defects for one year from date of start-up.

.5 Provide operating manual indicating all phases of water conditioning program. Include detailed schematic drawings showing all special fittings, timers, controllers, etc. for each system. Four hard cover binders to be submitted to Contract Administrator for approval.

.6 Supplier to witness cleaning of all strainers.

.7 If system is used for temporary heat, clean it as outlined below prior to use for temporary heat and then clean again before takeover by The Citys. During temporary heat period chemically treat system under Supplier supervision and maintain logs on chemical balances. Chemicals required during temporary heat period are to be in addition to quantities listed below.

.2 Glycol Systems Cleanout

.1 Systems to be cleaned out. Pump on each system may be used to circulate cleaning solution. Balancing valves on pump discharges to be regulated to ensure against operating pumps out of their normal operating range.

.2 Cleaner to be introduced and circulated from 48 to 72 hours and removed from system by Contractor by dumping system.

.3 GE Betz to monitor system pH and add Ferroquest FQ7102 neutralizer as required, to bring pH into the 6.5-7.0 range.

.4 Flush each system until conductivity of water in system is back to conductivity of make-up water. If gland packed or mechanical seal pumps of permanent system are used during cleaning period, replace packing and mechanical seals with new Material.

.5 All strainers to be cleaned by Mechanical Subcontractor.

.6 System to be refilled and required amount of chemical treatment added to provide immediate protection against corrosion.

.7 Supplier to conduct conductivity tests before, during, and after cleaning each system, and report procedures followed and conductivity readings to Contract Administrator and Contractor in writing.

.8 System not to be used until cleaning procedure has been carried out and supervised by Supplier.

.3 Sampling Connections

.1 Provide 19mm (3/4") valved sampling connections where instructed by Supplier representative in the following systems:
  .1 Boilers
  .2 Glycol heating

3.18 GLYCOL SOLUTION

.1 Glycol heating systems to be filled with 55% aqueous glycol solution.

.2 Glycol supplier to report on procedure required for testing inhibitor concentration of glycol.

3.19 GLYCOL FILL PACKAGE

.1 Connect tank to glycol system as indicated on drawings and/or detail sheets.

.2 Glycol recovery line(s) shall be piped from each glycol system relief valve outlet to the solution container, through its lid in such a way that the lid can be removed for filling and mixing.

.3 Package to have 100mm (4") housekeeping base.

.4 Adjust pressure control to system fill pressure plus allowance for fill line pressure drop.

.5 Install unit in strict accordance with manufacturer's published installation manual.

3.20 DIRECT GAS-FIRED MAKE-UP UNIT

.1 Installation to conform to C.G.A. and C.S.A. requirements and manufacturers published recommendations.

.2 Interlock unit with exhaust system so that exhaust must be in operation before make-up air unit can be started.

.3 Mount filter indicator on downstream side of cabinet and field wire to program supervisor.

3.21 VIBRATION CONTROL

.1 Supply drawings of all equipment to be isolated to isolation manufacturer. Manufacturer to submit approval drawings with isolation equipment schedule.

.2 Manufacturer's factory-trained representative to inspect finished job and issue report to Contract Administrator indicating that all isolation equipment has been installed as per manufacturer's recommendations.

3.22 CO-ORDINATE WITH HVAC BALANCE AND TESTING AGENCY

.1 Refer to Section 23 90 10 HVAC Balance and Testing.

.2 Air balancing Work shall not begin until system has been completed and in full working order. Section 23 60 10 shall put all heating, ventilation, and air conditioning systems and equipment into full operation, as season would demand, and shall continue operation of same during each working day of testing and balancing. Co-ordinate Work with Section 23 90 10.

.3 As part of this Contract, Section 23 60 10 shall make any changes in pulleys and belts, and add manual dampers for correct balance as recommended by Section 23 90 10, at no additional cost to The City.

.4 Section 23 60 10 responsible for initial alignment and tension of all fan pulleys and belts of equipment supplied by Section 23 60 10.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 All Drawings and all sections of the Specifications shall apply to and form an integral part of this section.

1.2 WORK INCLUDED

.1 Labour, Materials, plant, tools, equipment and services necessary and reasonably incidental to completion of ventilation Work.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 21 05 00 Mechanical General Provisions

.2 Section 21 08 10 Insulation

.3 Section 22 40 10 Plumbing

.4 Section 23 60 10 Liquid Heat Transfer

.5 Section 25 10 10 Controls/Instrumentation

.6 Section 23 90 10Testing, Adjusting and Balancing

.7 Section 26 05 00 Common Work Results – For Electrical

Part 2 Products

2.1 DUCT OPENINGS

.1 Pack area between ducts and openings with fireproof self-supporting insulation. Seal with 25mm (1") mastic topping.

2.2 DUCT AND EQUIPMENT SUPPORTS, HANGERS AND INSERTS

.1 Support horizontal ducts on maximum 2.4m (8'0") centres by non perforated galv. steel, rivetted strap for ductwork 900mm (36") (either dimension) or less, and minimum 25mm x 25mm x 3mm (1" x 1" x 1/8") galv. angle iron passing under ducts 925mm (37") or over (either dimension) with 9.4mm (3/8") diam. threaded rods suspending angles from structure.

.2 Support vertical ducts at every floor with angle iron collars sized to provide proper bearing.

.3 Use universal concrete type inserts of black malleable iron, for threaded connection with lateral adjustment, top slot for reinforcing rods and lugs for attaching to forms.

2.3 LOW PRESSURE DUCTWORK

.1 Low Pressure Rectangular Ductwork Schedule

Max. Side		Bracing
.1	Up to 600mm (24”)	None
	.1 Gauge: .60mm (24 USSG)	
.2	635mm to 750mm	25mm (1") x 25mm (1") x 3.2mm (1/8") angle,

	Max. Side	Bracing
	(25" to 30")	1.2mm (4'0") from joint.
	.1 Gauge: .60mm (24 USSG)	
.3	785mm to 1000mm (31" to 40")	25mm (1") x 25mm (1") x 3.2mm (1/8") angle, 1.2mm (4'0") from joint.
	.1 Gauge: .80mm (22 USSG)	
.4	1040mm to 1.5m (41" to 60")	37.5mm (1-1/2") x 37.5 (1-1/2") x 3.2mm (1/8") angle, 1.2m (4'0") from joint.
	.1 Gauge: .80mm (22 USSG)	
.5	1.525m to 2.25m (61" to 90")	37.5mm (1-1/2") x 37.5mm (1-1/2") x 3.2mm (1/8") diagonal angles or 37.5mm (1-1/2") x 37.5mm (1-1/2") angles 600mm (2'0") from joint.
	.1 Gauge: 1.0mm (20 USSG)	
.6	2.31m (91") and up	
	Similar to above.	
	.1 Gauge: 1.3mm(18 USSG)	

.2 Round Ductwork Schedule

	Duct Diameter	Gauge
.1	Up to 508mm (20")	0.5mm (26 USSG)
.2	533mm to 1.02m (21" to 40")	0.6mm (24 USSG)
.3	1.04mm to 1.52m (41" to 60")	0.8mm (22 USSG)

.3 Ductwork to be galvanized steel unless noted otherwise.

.4 Outdoor ductwork to be two gauges heavier than directed above.

.5 Turning vanes (Ducturns)

.1 Use duct elbows which have throat radius of 1-1/2" times the diameter.

.2 Where use of above specified item is precluded by space limitations, use duct elbows fabricated square throats and backs and fitted with Rovane turning vanes.

.3 Standard of Acceptance: S.E. Rozell & Sons Limited, Kitchener, Ontario.

2.4 FLEXIBLE DUCTWORK

.1 Flexible air ducts shall conform to UL-181 Standard and NFPA 90A. Flexible air ducts shall have a fire rating of at least one-half hour as measured by UL-181 Standard, paragraph No.7, Flame Penetration Test.

.2 Do not restrict duct free area. Conform to NBFU Pamphlet 90A, paragraph 113, (a) revised to date. Attach with galvanized wire hose clamps and Duro-Dyne S-2 duct sealer. Connections to operate at 10" W.G. without leakage or bursting.

2.5 MANUAL VOLUME DAMPERS

.1 1.2mm (16 ga.) galv. steel stiffened, blades of louvre type. Maximum of 300mm (12") wide and 1.8m (72") long, with one centre and two edge crimps. Damper hardware to be Duro-Dyne KS-145, KS-385 or KS-12 as recommended by manufacturer.

2.6 MOTORIZED DAMPERS

.1 Supplied by Section 25 10 10 for installation by Section 23 80 10, with exception of those supplied with factory assembled heat recovery units and make-up air units.

2.7 FILTERS

.1 General:
- .1 Fan manufacturer to provide filter in filter sections provided with equipment.
- .2 Filter supplier to provide all other filters.
- .3 Provide one spare set of filter media for each filter bank.
- .4 In some instances, filter frames are specified without filters. During cold winter periods, some filters can be relocated by The City to leaving side of preheat coils to minimize possible icing of filters.
- .5 Refer to Equipment Schedules.

2.8 FAN SYSTEMS - GENERAL

.1 Fan Connections
- .1 Duro-Dyne Metal-Fab of neoprene coated fibreglass, airtight, water tight and flameproof, 75mm (3") wide with 75mm (3") galv. metal connections.

.2 V-Belt Fan Drives
- .1 Provide multi-matched set of belts for all fans with motors of 1.12 kW (1-1/2 hp) and larger.
- .2 Provide vari-speed adjustable drive on units with motors of 7.46 kW (10 hp) and less. Drive to allow speed variation of plus or minus 15% of fan speed at specified capacity. Should this variation not be attainable, manufacturer to provide extra fixed pulley and if necessary, matched belts to provide this speed range, if requested by Contract Administrator.
- .3 Provide fixed pitch on units with motors of 7.46 kW (10 hp) and greater. Manufacturer shall include for one change in drive; i.e. allow for additional pulley and matched belts for each air handling unit.
- .4 Fans mounted outside of building to have belt drives capable of operating satisfactorily at -37 deg.C ambient.
  - .1 Vari-pitch type with multi-belt matched set of belts with factor of 1.3 against motor nameplate rating.
  - .2 Drive shall allow speed variation of +/- 15% of fan speed at specified capacity.

.3 Fan Bearings
- .1 Fan bearings shall be selected to have minimum B10 life of 15,000 hours or minimum average life of 75,000 hours.
- .2 All grease lubricated bearings that are not directly accessible shall be fitted with extended grease leads terminating at some convenient accessible location on the fan casing.

.4 Fan Vibration Isolation

.1 Selected and supplied by isolation manufacturer.

.5 Fans to have prime coat finish of red oxide. Wheels and shafts to be statically and dynamically balanced.

.6 Scheduled operating fan speeds and outlet velocities noted in Specification herein and/or in fan schedules shall be maximum acceptable.

.7 Guards

.1 Protect V-belt drives by guards that encompass all sides of the drive. Any expanded mesh or ventilation openings in the guard are to be "finger proof" to meet OSHA requirements.

.2 Mount guards to the fan by bolted clips. They shall be completely removable.

.3 Each guard shall be c/w two 25mm diameter holes opposite both fan and motor shaft for purpose of allowing tachometer readings. Each hole will be covered with gravity-actuated swing cap.

.4 Front face of drive guard shall be hinged and latched for convenient access to interior.

.8 Refer to Fan Schedule for fan sizes, capacities, etc.

2.9 CENTRIFUGAL AIRFOIL FANS

.1 General

.1 Centrifugal Airfoil fans with wheel design of non-overloading type backward curved double-surface airfoil section. Complete fan wheel shall be of welded construction. Fan shafts shall be designed so as to operate at no more than 80% of first critical speed when fan operates at top of the fan class speed range. Fan housing shall be constructed of heavy gauge steel suitable for Class of duty. All seams and joints continuously welded to eliminate leakage. All centrifugal fans provided with access door into fan casing.

.2 Fan equipment in this category shall be fully rated, based on tests performed in accordance with the AMCA standard test codes. The information covering fan performance shall be available in catalogue form and fan performance curves must be submitted for approval prior to acceptance.

.3 Scheduled operating speed and outlet velocities to be maximum permissible.

.2 Mount fan and motor on integral slide-rail base supplied isolation manufacturer.

.3 Fan bearings to have a hours minimum 15,000 hours BioLife.

.4 Refer to Cl. Fan Systems - General for fan drive requirements.

2.10 CHIMNEY AND BREECHING

.1 Chimney and Breeching shall conform to NFPA 211 and manufacturers requirements.

2.11 CLEANING OF H.V.A.C. SYSTEMS

.1 Cleaning of H.V.A.C. systems shall be performed by a competent Subcontractor to Section 23 80 10 - Air Distribution.

.2 Segregate points of access to fan chambers, plenums, larger diameter ducting etc. from adjacent Occupied Areas.

.3 Supply and install access doors in ductwork, plenums, etc. at locations required to complete Work specified.

.4 Work shall include the cleaning of new diffusers, air handling units, fans and all other mechanical equipment which combined forms part of the building's ventilation system. This shall include, but not be limited to the following:

.1 Interior surfaces of supply and exhaust ductwork.

.2 Interior surfaces of supply and exhaust air handling units to include, but not be limited to, plenums, fan(s), fan chambers, coils, dampers, filters, motor(s), louvres, etc.

.3 Surfaces of coils, dampers, louvres, turning vanes, diffusers, registers, grilles and all other equipment present within or which forms part of the supply or exhaust air distribution system.

.5 Schedule Work following the completion of all Work by other trades that may generate airborne construction debris. Ensure Work of this section is completed prior to re-starting or testing of the building ventilation system or re-occupancy by the City.

.6 Ensure electrical power supply to air handling equipment, fans, etc. is locked out and tagged. System is to remain inoperable throughout the cleaning process. Tags shall be labelled as follows:

DANGER
Do Not Operate
Men Working on Equipment

.7 Use of compressed air to aid the cleaning process is only permitted where access by the worker is not possible and the use can safely be controlled by the worker from the exterior of the ducting. Use of compressed air by a worker or while a worker is present within larger diameter ducting, air handling equipment, plenums, etc. is strictly prohibited.

.8 Robotic Brushing System

.1 Brushing system must have the capability to brush all four sides of the duct work regardless of configuration and size.

.2 Brushing system must be capable to turn at a minimum of 400 R.P.M. in order to keep the debris suspended in the air flow, this allows all the contaminants to be propelled toward the vacuum.

.3 Brushing system must be capable of cleaning duct work 2 inches and larger, and yet capable of making all 90 degree turns while in operation.

.4 The cleaning of insulated main ducts and the flex hose on the off shoots must be brushed and kept in its original condition. The system must be able to brush the duct without damage to the insulated duct, as well as not causing further damage to any existing deterioration.

.5 Every foot of the duct work must be brushed in order to ensure proper cleaning.

.6 All equipment should be of a portable nature in order to operate in the Work place with all of the entrances in their usual operating state (i.e. all doors and windows closed) in order to ensure the organizations existing security measures.

.7 Brushing system must have the capability of brushing congruently with the compressed air at a minimum of 150 P.S.I.

2.12 HEAT RECOVERY UNITS (TEMPEFF)

.1 Refer to HRU Schedule.

.2 General Description

.1 Configuration: Fabricate as detailed on drawings.

.2 Performance: As detailed in schedules.

.3 Unit Construction

.1 Fabricate unit with extruded aluminum panels secured with mechanical fasteners. All access doors shall be sealed with permanently applied bulb-type gasket.

.1 Panels and access doors shall be constructed as a 2-inch (50-mm) nominal thick; with injected polyurethane foam insulation. R value shall be 6.5 per inch of wall thickness. The outer panel shall be constructed of G90 galvanized steel. The inner liner shall be constructed of G90 galvanized steel. Module to module assembly shall be accomplished with self adhering foam gaskets. Manufacturer shall supply test data demonstrating less than 0.2” deflection for an unsupported 48x48 panel under 30” W.C pressure. Units that cannot demonstrate this deflection are unacceptable.

.2 Access Doors shall be flush mounted to cabinetry, with minimum of two hinges, locking latch and full size handle assembly.

.3 All outdoor units will have an 18 gauge roof and gutters. The gutters will cover the entire perimeter of the unit.

.4 Supply / Return Fans

.1 Provide DWDI backward incline supply & return fans. Fan assemblies including fan, motor and sheaves shall be dynamically balanced by the manufacturer on all three planes and at all bearing supports. Manufacturer must ensure maximum fan RPM is below the first critical speed.

.2 Bearings shall be self-aligning, grease lubricated, ball or roller bearings with extended copper lubrication lines to access side of unit. Grease fittings shall be attached to the fan base assembly near access door. If not supplied at the factory, contractor shall mount copper lube lines in the field.

.3 Fan and motor shall be mounted internally on a steel base. Provide access to motor, drive, and bearings through hinged access door. Fan and motor assembly shall be mounted on 1" deflection spring vibration type isolators inside cabinetry.

.5 Bearings And Drives

.1 Bearings: Basic load rating computed in accordance with AFBMA - ANSI Standards, L-50 life at 200,000 hours – all DWDI fans, heavy duty pillow block type, self-aligning, grease-lubricated ball bearings.

.2 Shafts shall be solid, hot rolled steel, ground and polished, keyed to shaft, and protectively coated with lubricating oil. Hollow shafts are not acceptable.

.3 V-Belt drives shall be cast iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed. Fixed sheaves, matched belts, and drive rated based on motor horsepower. Variable and adjustable pitch sheaves selected so required RPM is obtained with sheaves set at mid-position and rated based on motor horsepower. Contractor to furnish fixed sheaves at final RPM as determined by balancing contractor. Standard drive service factor shall be 1.1 S.F calculated based on fan brake horsepower.

.6 Electrical

.1 The air handler(s) shall bear an ETL listing label for the entire assembly. Units with only components bearing third party safety listing are unacceptable.

.2 On RG sizes 1000 through 18000 all controls shall be located on the side of the unit for ease of servicing. Alternate manufacturers who supply units with controls on roof must supply a permanently installed ladder to access controls, and appropriate safety rails on roof of unit, meeting all applicable OSHA standards.

.3 Wiring Termination: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. All wires shall be number tagged and cross-referenced to the wiring diagram for ease of troubleshooting.

.4 Fan motors shall be1800 rpm, totally enclosed fan-cooled (TEFC) type. Motors shall be premium efficiency. Electrical characteristics shall be as shown in schedule.

.5 Air handler manufacturer shall provide and mount a damper hand-off-auto (HOA) switch.

.6 Unit is supplied with single point power connection complete with motor starters.

.7 Heating Coil Sections

.1 Provide access to coils from connection side of unit for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior and gasket sleeve between outer wall and liner where each pipe extends through the unit casing to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.

.1 Identify fin, tube & casing material type and thickness.

.2 Show coil weights (shipping & operating).

.3 State air and fluid flow amounts with its associated pressure drops.

.2 Water Coils:

.1 Certification - Acceptable water coils are to be certified in accordance with ARI Standard 410 and bear the ARI label. Coils exceeding the scope of the manufacturer's certification and/or the range of ARI's standard rating conditions will be considered provided the manufacturer is a current member of the ARI Air-Cooling and Air-Heating Coils certification programs and that the coils have been rated in accordance with ARI Standard 410. Manufacturer must be ISO 9002 certified.

.2 Headers shall consist of seamless copper tubing to assure compatibility with primary surface. Headers to have intruded tube holes to provide maximum brazing surface for tube to header joint, strength, and inherent flexibility. Header diameter should vary with fluid flow requirements.

.3 Fins shall have a minimum thickness of 0.0075" of aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.

.4 Coil tubes shall be 5/8 inch (16mm) OD seamless copper, 0.020" nominal tube wall thickness, expanded into fins, brazed at joints. Soldered U-bends shall be provided to minimize the effects of erosion and premature failure having a minimum tube wall thickness of .025".

.5 Coil connections shall be N.P.T. threaded carbon steel with connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain fittings shall be furnished on the connections, exterior to the air handler. Vent connections provided at the highest point

to assure proper venting. Drain connections shall be provided at the lowest point to insure complete drainage and prevent freeze-up.

.6 Coil casings shall be a formed channel frame of galvanized steel. Water heating coils, 1 & 2 row only shall be furnished as uncased to allow for thermal movement and slide into a pitched track for fluid drainage.

.8 Particulate Filters

.1 Filter section with filter racks and guides with hinged and latching access doors on either, or both sides, for side loading and removal of filters.

.2 Filter media shall be UL 900 listed, Class I or Class II.

.3 Flat arrangement with 2", 50mm deep pleated panel filters.

.9 Energy Recovery

.1 Dual CoreTM Energy Recovery

.1 Unit shall be equipped with Dual CoreTM energy recovery technology. The unit shall be 90% efficient (sensible +-5%) at equal airflow in winter and up to 80% sensible in summer. It shall also provide up to 70% latent recovery. Unit shall accomplish this recovery without a defrost cycle that will reduce the effectiveness of the device. Devices employing defrost cycles that bypass the energy recovery device, or reduce the effectiveness are not acceptable. Energy recovery device shall not require frost protection in applications down to -40 degrees.

.2 Energy Cores shall be Generation 3, comprised of precisely corrugated high grade aluminum. Maximum allowable face velocity across heat exchangers shall be 450 fpm. Heat exchanger face velocities exceeding 450 fpm are not acceptable.

.3 Switchover damper section shall be comprised of multi section low leakage dampers operated by fast acting electric actuators. RG 1000-6500 shall have damper switching times of 0.75 seconds. RG 7500-18000 shall have damper switching times of 1.5 seconds. Dampers that do not switch within the specified times without objectionable noise are not acceptable. Single blade damper sections are not acceptable. Each damper shall control one of the 4 airways, upper-horizontal, lower-horizontal, forward-vertical and rear-vertical. Dampers shall be capable of orienting to close off outside air to the building without needing external shut off dampers. Dampers shall also be capable of orienting to allow 100% recirculation of air without using heat recovery device for off peak or unoccupied heating modes. Units incapable of these operations without extra ductwork are not acceptable.

.4 Recovery cycles shall be controlled by internal programmed thermostats measuring both supply and exhaust air, and optimizing performance of both heat recovery and free cooling modes.

.10 External Dampers

.1 External Damper Leakage: Leakage rate shall be less than two tenths of one percent leakage at 2 inches static pressure differential. Leakage rate tested in accordance with AMCA Standard 500.

.11 BMS Controls

.1 Unit shall come with its own controls wired to a terminal strip for connection to the BMS.

.12 Installation

.1 Install in accordance with manufacturer's Installation & Maintenance instructions.

.13 Environmental Requirements

.1 Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

2.13 GRILLES, REGISTERS & DIFFUSERS

.1 Double Deflection Supply Grille, S-1

.1 Furnish and install Price model 920D registers of the sizes and mounting types indicated on the plans and schedules.

.2 Grilles shall be:

.1 Double Deflection

.2 45 degree adjustable spaced ½" (front) and ¾" (back) on centre

.3 14 gauge steel blade and heavy duty steel support bars and frame

.4 Paint finish shall pass 500 hours of salt spray exposure in accordance with ASTM

.5 Cold rolled steel, black, integral volume control damper of opposed blade type operable from the face of the grille.

.2 Exhaust Rail, E-1

.1 Furnish and install Plymovent Flexhood Modular Extraction Hood of the sizes indicated on the plans and schedules.

Part 3 Execution

3.1 DUCT OPENINGS

.1 Locate only openings in walls, floors, partitions, beams, etc. required for ducts, equipment, etc. Contractor to form all openings for same, except as noted below.

3.2 DUCT AND EQUIPMENT SUPPORTS, HANGERS AND INSERTS

.1 Design, Installation

.1 Supports to secure ducts and equipment, prevent vibration and provide for expansion and contraction. Design supports of strength and rigidity in a manner which will not stress the building construction. Use inserts for suspending hangers. Do not use vertical expansion shields without Contract Administrator's approval.

.2 Concrete Inserts

.1 Do not weaken concrete or penetrate waterproofing membrane. Use reinforcing rods through inserts for pipe sizes over 50mm (2"), or equivalent weight. Where concrete slab is finished ceiling, inserts to be flush with surface.

.3 Protect insulation at contact with hangers and support with approved metal shields.

3.3 CO-ORDINATION WITH H.V.A.C. BALANCE AND TESTING AGENCY

.1 Refer to Section 23 90 10 H.V.A.C. Balance and Testing. Co-ordinate Work with Section 25 10 10.

.2 As a part of this Contract, Section 23 80 10 shall make any changes in pulleys and belts, and add manual dampers for correct balance as recommended by 23 90 10, at no additional cost to The City.

.3 Section 23 80 10 responsible for initial alignment and tension of all fan pulleys and belts, of equipment supplied by Section 23 80 10.

3.4 LOW PRESSURE DUCTWORK

.1 Where duct width exceeds 450mm (18") in largest dimension, stiffen by cross breaking sheets diagonally. Beaded ducts as per SMACNA Catalogue Fig. 1.13 acceptable alternative.

.2 Duct sizes are inside dimensions. If ducts are acoustically lined, outside duct size to be increased as required.

.3 Provide ducturns in all elbows of ducts 1200mm (48") wide and greater, in segments of 600mm (24") maximum.

.4 Single thickness partitions between ducts not accepted.

.1 All ductwork shall have seams and joints sealed watertight with Duro-Dyne S-2 duct sealer and FT-2 fibreglass duct tape. Prior to installation ductwork to be clean, dry and free of grease. Apply duct sealer with stiff brush or trowel. Wrap wet seam or joint with duct tape and apply further coat of duct sealer. Duct sealer and glassfiber to extend 25mm (1") on each side of joint or seam. On outside ductwork construct duct so that top of duct slopes 12mm (1/2") per 300mm (12") minimum to ensure that water does not collect on top.

.2 Ductwork exposed in finished rooms do not require duct tape application, but seams and joints shall be sealed with S-2 duct sealer. Sealer must be capable of accepting finish painting.

.3 Ductwork on roof shall have seams and joints sealed by application of TREMCO MONO black acrylic sealant applied with application gun and levelled with putty knife. Material shall be used in accordance with manufacturer's printed recommendations.

.5 Provide openings for thermostats and controllers by Section 25 10 10.

.6 Where ductwork conflicts with mechanical and electrical piping and it is not possible to divert ductwork or piping to stay within allowable space limitations, provide duct easements. Easements not required on pipes 100mm (4") and smaller outside dimension, unless this exceeds 20% duct area. Irregular or flat shaped piping requires duct easement. Hangers and stays in ductwork to be parallel to air flow. If easement exceeds 20% of duct area, duct to be split into two ducts with original duct area being maintained. Easements to be approved by Contract Administrator before installation.

.7 At points within air system where air streams at different temperatures meet, install baffling for a good mix. Baffling to be by Section 23 80 10 in locations recommended by Section 25 10 10, approved by Contract Administrator, and at no additional cost to The City.

.8 If ductwork is not adequately braced and/or supported to provide good installation, additional bracing and/or supports to be provided at no extra cost to The City. Contract Administrator to interpret.

.9 Assemble round duct sections using beaded couplings attached with sheet metal screws.

3.5 FLEXIBLE DUCTWORK

.1 Conform to NBFU Pamphlet 90A 113 (a) revised to date and UL-181 Standard. Connections to operate at 2.49 kPa (10" W.G.) without leakage or bursting. Do not bend to restrict duct free area.

3.6 FLEXIBLE DUCTWORK CONNECTORS

.1 Mount on ducts with mastic seal and sheet metal screws. Formed conical connections approved by Contract Administrator, to be considered equal in accordance with B7.

3.7 DIFFUSER CONNECTIONS

.1 Flex duct connection: align vertically flex connections with diffuser neck with no more than 1/8 duct diameter of deviation to achieve manufacturer's sound level ratings. Otherwise, provide equalizing grid in diffuser's neck.

.2 Hard duct connection: provide min. 3 duct diameters section of straight vertical duct upstream of diffuser to achieve manufacturer's sound level ratings. Otherwise, provide equalizing grid in diffuser's neck.

3.8 MANUAL VOLUME DAMPERS

.1 Install, in manner acceptable to manufacturer, where noted on Drawings.

3.9 MOTORIZED DAMPERS

.1 Units in acoustically lined ducts are to be sized to suit clear dimensions of acoustic insulation and not of size to suit sheet metal duct. Where units are located in acoustic lined ducting, install heavy gauge metal channel and fasten to metal duct to receive damper frame. Space between channel and duct to be filled with flexible insulation.

.2 On plenums and ducts with external insulation, Section 25 10 10 to provide channel mounting frame of same thickness as insulation. Pack channel frame with loose fibreglass insulation.

3.10 MANOMETERS

.1 Mark on installed gauges, point at which filter should be serviced. Obtain this information from successful filter manufacturer.

.2 Manometers are not required on roof-top filter sections.

3.11 FILTERS

.1 During construction period, no air system to be started unless air filters function as specified. At time of building acceptance by The Citys, all filter banks to be in perfectly clean operating condition. There shall be no air bypass around or in filter banks.

.2 Install all filters as per mfg. published installation data.

3.12 FAN SYSTEMS - GENERAL

.1 Use flexible connections at inlets and outlets where ductwork and plenums connect to fans and air-handling equipment.

.2 Fan Vibration Isolation

.1 Fan manufacturer to submit necessary information for proper isolation selection. This information to be incorporated in shop Drawings and shall include fan sizes, fan speeds, equipment weights, etc.

.3 All equipment shall be installed in strict accordance with manufacturer's published data.

.4 Protection of Fan Equipment Before Installation
.1 Grease shafts, sheaves, etc. to prevent corrosion. Fan bearings to be greased or oiled at time of building takeover.

.5 Centrifugal fans located outdoors to have drain holes in casing.

.6 Co-ordinate installation of smoke detectors with Division 26 - Electrical.

3.13 CENTRIFUGAL AIRFOIL FANS

.1 Submit performance curves. Information covering fan performance to be available in catalogue form.

.2 Base
.1 Mount fan and drive on integral slide-rail base, isolated from supporting pad by spring channel frame. Provide reinforcing bars to take concrete, field-pouring into slide-rail base by G.C.

.3 Mount fan and motor on integral slide rail base supplied by Isolation Manufacturer.

.4 Fan Bearings
.1 Fan bearings to have 20,000 hours minimum average life.

.5 Manufacturer to supply V-belt drive to satisfy Specification requirements. After system has been balanced, fan to be checked by manufacturer's representative and pulley satisfying system operating at lowest static pressure to be installed. Manufacturer to provide v-belts to operate with final selected pulley.

3.14 DIFFUSERS, REGISTERS AND GRILLES

.1 Provide sponge gasket behind each outlet or inlet and adequate fastenings to prevent streaking between outlet and duct, wall or ceiling.

.2 Shop Drawings to be accompanied by itemized list indicating unit locations by room number and unit size. Itemized list noted above shall be certified by direct representative.

.3 Submit typical unit c/w all accessories, specified finishes, for all diffusers, grilles and registers, if requested by Contract Administrator. Materials installed on job to be fully equal in accordance with B7 to samples submitted for approval.

.4 Exact dimensions of walls, etc. are as per architectural Drawings. Install diffusers so they fit properly in ceiling suspension system. Co-ordinate with all related Subcontractors.

.5 Should there be any confliction in location of grilles, registers and diffusers with lights, etc. matter to be referred to Contract Administrator for directive. If requested by Contract Administrator, re-locate grilles, diffusers and registers and ductwork attached, within 1.2m (48") of locations noted on Drawings, without extra cost to The City. Refer to Drawings for additional requirements.

3.15 TESTING OF DUCTWORK

.1 Visually and audibly check for air leaks that can be heard or felt under normal operating conditions. Repair all leaks in ductwork.

.1 Tests shall be performed by Section 23 90 10. Refer to Section 23 90 10.
.2 Section 23 80 10 shall provide all necessary temporary connections, blank-offs, tees, required for testing. Section 23 90 10 shall provide all test fans, equipment and labour required for testing.
.3 Section 23 80 10 shall clean all ducts before testing.
.4 During installation of ductwork include separate leakage air tests of each complete air riser; each completed horizontal distribution system, and after ductwork is installed and central station apparatus is erected, leakage testing of pressure side of whole system. Include testing of flexible runouts (where applicable).
.5 After preliminary tests, repair all leaks.
.6 Be responsible for any damage resulting from failure of items under test.
.7 Section 23 80 10 shall repair all leaks in duct system.
.8 Section 23 90 10 shall retest ductwork after leaks have been repaired.
.9 Co-ordinate Work to ensure that all ductwork is tested:
    .1 Before ducts are insulated.
    .2 Before ducts are concealed.

3.16 CHIMNEY AND BREECHING

.1 Provide venting systems for all fired equipment.

.2 Breeching shall slope up to chimney and shall offer no restriction to flow. Provide long sweep elbows. On forced draft breeching provide cleanout at boiler.

.3 The vent connector rise from each piece of equipment shall be the maximum possible to enhance flue gas venting.

.4 Support chimneys and breeching from structure.

.5 Connections to equipment shall be installed as recommended by the equipment manufacturer. Locate chimney minimum of 907mm (3'-0") above highest point of roof including any project and/or rooftop mounted equipment within 3m (10'-0") horizontal from chimney, unless higher chimney is noted on Drawings.

.6 Provide guy wire support as noted or as recommended by manufacturer.

.7 Venting system diameter shown on Drawings represents a minimum size only. Mechanical Subcontractor shall provide adequately sized venting systems, including all vent connections, breeching, vents, chimneys, rain caps and other associated components, for all fuel fired equipment. Sizing of venting systems shall be determined to suit fuel fired equipment and vent system provided, and shall meet requirements of vented equipment manufacturer and vent system manufacturer. In case of a variance in requirements between the two manufacturers, the larger size shall be used. Manufacturer's sizing calculations shall be submitted to the Contract Administrator for review. Performance deficiencies related to inadequate vent sizing shall be corrected at no additional cost to the City.

.8 Manufacturer shall provide a chimney and breeching drawing signed and sealed by a registered engineer as required by the Authority Having Jurisdiction.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 All drawings and all sections of the specifications shall apply to and form an integral part of this section.

.2 Testing, Adjusting and Balancing (TAB) Agency shall be an experienced, independent Contractor specializing in the testing, adjusting and balancing of HVAC systems.

.3 TAB Agency shall be a member of the Associated Air Balance Council (AABC) and Work shall carry standard AABC Certificate of Guarantee.

.4 Include extended service for 90 days after completion of final balancing Work, during which time Contract Administrator at his discretion may request re-check or re-setting of any systems and/or equipment listed in test report

1.2 SCOPE OF WORK

.1 Provide complete testing, adjustment and final balancing of all building air systems.

.2 Provide complete testing, adjustment and final balancing of liquid based building HVAC systems.

.3 Provide complete ductwork leakage testing as specified.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 21 05 00 Mechanical General Provisions

.2 Section 23 60 10 Liquid Heat Transfer

.3 Section 23 80 10 Air Distribution

.4 Section 25 10 10 Controls/Instrumentation

Part 2 Products

2.1 BALANCING REPORTS

.1 Provide two copies of detailed draft balancing report to Contract Administrator for review after completion of all adjustments.

.2 Final balancing report shall incorporate all changes resulting from Contract Administrator's comments and any adjustments undertaken since the draft report was issued.

.3 Provide four copies of final balancing report.

.4 Provide sufficient number of copies of final balancing report to Mechanical Subcontractor for inclusion in Operating & Maintenance Manuals.

2.2 DUCT LEAKAGE TEST REPORTS

.1 Provide two copies of duct leakage test reports to Contract Administrator including test data for all preliminary and final tests.

Part 3 Execution

3.1 GENERAL

.1 All instruments used shall be accurately calibrated and maintained in good working order. If requested, tests shall be conducted in the presence of Contract Administrator and/or his representative.

.2 Schedule all Work to comply with completion date.

.3 Work shall not begin until system has been completed and in full working order. Division 21 shall put all heating, ventilating, and air-conditioning systems and equipment into full operation, as season would demand, and shall continue operation of same during each working day of testing, adjusting and balancing.

3.2 AIR BALANCING

.1 Coordinate with Sections 23 60 10 and 23 80 10 to ensure installation of all manual adjusting dampers and pitot tube enclosures are as indicated, as specified and as required to allow proper adjustment of air systems.

.2 Sections 23 60 10 and 23 80 10 to provide initial alignment and tension of all fan pulleys and belts supplied by them.

.3 Testing Procedure:

.1 Test, adjust and record all fan speeds, motor amperes.

.2 Make pitot tube traverse to main supply and obtain cfm at fan.

.3 Test and record static pressure for each system at fan suction and discharge.

.4 Adjust all supply and exhaust air ducts to proper design cfm.

.5 Test and adjust each diffuser, grille, and register to within 5% of design requirements. Balance as per manufacturer's recommendations.

.6 All outlets shall be adjusted to provide proper throw and distribution, in accordance with architectural requirements.

.7 Fan operating conditions tested shall confirm air delivery within 5% of manufacturer's fan curves.

.8 Systems shall be balanced so that fans operate at lowest possible static pressure.

.9 Inlet vanes shall not be used to reduce fan capacity to achieve balance condition.

.10 Prepare single line diagrams of duct systems indicating terminal outlets identified by number. List on data sheets all such outlets denoted by the same numbers, including the outlet sizes, 'K' factor, location, cubic feet per minute and jet velocity. Provide this data for all supply and exhaust air systems.

.4 As part of Work of this Contract, Sections 23 60 10 and 23 80 10 shall make any changes in the pulleys and belts, and any additional manual dampers for correct balance as

recommended by Section 23 90 10, at no additional cost to The City. Section 23 90 10 shall provide final alignment and tension adjustment of fan pulleys and belts.

.5 100% Outside Air "Blow-through" Units

.1 These requirements apply to all makeup air units and 100% outside air units where the fan is operating in air at ambient temperatures, i.e. heating and cooling sections are downstream of the fan.

.2 Balance to give design cfm at a mid-range air temperature of 0C. Calculate equivalent cfm at temperature prevailing during balancing procedure and balance to this calculated value.

.3 Provide charts and/or calculations in balancing report detailing the calculation of equivalent fan capacity.

3.3 GLYCOL BALANCING

.1 Completely balance pumps and piping systems by adjustments of plug cocks, globe valves or other control devices, to obtain the flow quantities. During balancing set controls for full-flow through coils. Set automatic throttling valves in the full-open position. Close bypass port on automatic 3-way valves.

.2 Balance fluid flow through coils, etc., in accordance with design.

.3 For flow measuring devices, record pipe size, manufacturer and size of device, and direct reading of the differential pressure, and calculated final flow.

.4 Balance flow through equipment and coils by means of flow measuring devices and pressure drop. Obtain curves from equipment manufacturers indicating relationship between flow and pressure drop through coils and equipment. Take readings on calibrated test gauges.

.5 Upon completion of fluid balance, reconcile total heat transfer through all heating and cooling coils by recording entering and leaving water temperatures and entering and leaving air dry bulb and wet bulb temperatures.

.6 Upon completion of balancing, adjust differential bypasses and 3-way valve bypasses for same pressure drop on full bypass as on full flow.

.7 Section 23 60 10 shall supply and install water metering systems and devices. Refer to Section 23 60 10.

.8 Equipment Data

.1 Provide following data on equipment:

.1 Glycol Coils

.1 Equipment information

.2 Air and fluid flow rates

.3 Air and fluid temperatures entering and leaving

.2 Pumps

.1 Equipment information

.2 Fluid flow and head:

.1 at operating capacity
.2 at no flow
.3 at full flow.

.3 Motor bhp and Amperage at above ratings and motor speed.
.4 Marked up pump curves on all pumps.

.2 Equipment lists shall also include all information noted in schedules.

.9 After entire installation has been completed, make required adjustments to balance valves, air vents, automatic controls, pumps until performance requirements are met. Make these adjustments with equipment operating. During such periods of adjustment prior to date of acceptance of mechanical systems, operate equipment. After date of acceptance of mechanical systems, The City's maintenance personnel will operate equipment.

.10 During the first year of operation Section 23 90 10 shall repeat these adjustments for each of immediately following three seasons of the year.

.11 Division 21 Subcontractors to install red valve tags onto all balancing valves, as specified under Section 21 05 00, subsection "Identification of Valves". Section 23 90 10 to add following information onto each balancing valve tag; valve final setting position, date of final adjustment, TAB Agency name and name of individual who made final adjustment.

3.4 SYSTEM CHECK

.1 Provide spot checks of systems if called upon by Contract Administrator. If capacities, fan speeds, ratings, etc. do not agree with submitted balance report, rebalance system or systems in question, until satisfactory results are received.

3.5 LEAK TESTING OF AIR DUCTS

.1 General:

.1 Tests shall be performed by Section 23 90 10.
.2 Section 23 80 10 shall provide all necessary temporary connections, blank-offs, tees, required for testing. Section 23 90 10 shall provide all test fans, equipment and labour required for testing.
.3 Section 23 80 10 shall clean all ducts before testing.
.4 During installation of ductwork include separate leakage air tests of each complete air riser; each completed horizontal distribution system, and after ductwork is installed and central station apparatus is erected, leakage testing of flexible runouts (where applicable).
.5 Perform preliminary tests and repair all leaks before notifying Contract Administrator of final tests.
.6 Maintain log book of all tests showing dates, personnel, observers' initials.
.7 Be responsible for any damage resulting from failure of items under test.
.8 Section 23 80 10 shall repair all leaks in duct systems.
.9 Section 23 90 10 shall retest ductwork after leaks have been repaired.
.10 Coordinate the Work as required with Sections 23 80 10, Mechanical subcontractor and Contractor to ensure that all ductwork is tested:

.1 Before ducts are insulated.

.2 Before ducts are concealed.

.11 Issue report to Contract Administrator after witnessing final tests.

.2 Low Pressure Ductwork Test: (below 50mm water gauge operating pressure)

.1 Visual and audible check for leaks that can be heard or felt under normal operating conditions.

.3 Leakage Testing of Other Systems:

.1 Make tests prior to insulation of system being tested using suitable test equipment, including 'U' tube, orifice, tubing and cocks, arrange to indicate amount of air leakage.

.2 Make leakage test with pressure maintained for minimum of 5 minutes at level of 150% of average operating pressure of duct section under test, obtained by operation of air supply fan, or if fan cannot be operated, by use of test blower. Inspect and check joints for leakage, record and submit results.

.3 Allowable leakage at test pressure: 5% of design maximum flow rate of duct section under test.

END OF SECTION