DIVISION 23

MECHANICAL

USE OF HVAC SYSTEMS DURING CONSTRUCTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Use of mechanical systems during construction.

1.2 USE OF SYSTEMS

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

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

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

.3 There is no possibility of damage.

.4 Supply ventilation systems are protected by 60% filters, inspected daily, changed every week or more frequently as required.

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

.6 Systems will be:

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

.2 Operated by Contractor.

.3 Monitored continuously by Contractor.

.7 Warranties and guarantees are not relaxed.

.8 Regular preventive and other manufacturers recommended maintenance routines are performed by Contractor at own expense and under supervision of Contract Administrator.

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

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

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

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

Part 1 General

1.1 SUMMARY

.1 Section Includes:

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

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

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

.4 Sustainable requirements for construction and verification.

1.2 REFERENCES

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

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

.2 Electrical Equipment Manufacturers' Association Council (EEMAC)

.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

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

.2 Product Data:

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

.3 Closeout Submittals

.1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

Part 2 Products

2.1 GENERAL

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

2.2 MOTORS

.1 Provide motors for mechanical equipment as specified.

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

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

2.3 TEMPORARY MOTORS

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

2.4 BELT DRIVES

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

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

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

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

.5 Correct size of sheave determined during commissioning.

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

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

.8 Supply one set of spare belts for each set installed in accordance with Section 01 78 00 - Closeout Submittals.

2.5 DRIVE GUARDS

.1 Provide guards for unprotected drives.

.2 Guards for belt drives;

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

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

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

.5 Guard for flexible coupling:

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

.6 Unprotected fan inlets or outlets:

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

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Fasten securely in place.

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

3.3 CLEANING

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

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

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

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME).

.1 ASME B40.100-[01], Pressure Gauges and Gauge Attachments.

.2 ASME B40.200-[01], Thermometers, Direct Reading and Remote Reading.

.2 Canadian General Standards Board (CGSB).

.1 CAN/CGSB-14.4-[M88], Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.

.2 CAN/CGSB-14.5-[M88], Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.

1.3 SUBMITTALS

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

.2 Submit shop drawings and product data.

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

.1 Thermometers.

.2 Pressure gauges.

.3 Stop cocks.

.4 Syphons.

.5 Wells.

Part 2 Products

2.1 GENERAL

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

.2 Ranges: as indicated.

2.2 DIRECT READING THERMOMETERS

.1 Industrial, variable angle type, liquid filled, 125 mm scale length: to CAN/CGSB14.4.

2.3 REMOTE READING THERMOMETERS

.1 100 mm diameter mercury-free liquid filled vapour activated dial type: to CAN/CGSB-14.5, accuracy within one scale division, brass movement, stainless steel capillary, stainless steel spiral armour, stainless steel bulb and polished stainless steel case for wall mounting.

2.4 THERMOMETER WELLS

.1 Copper pipe: copper or bronze.

.2 Steel pipe: brass or stainless steel.

2.5 PRESSURE GAUGES

.1 112 mm, dial type: to ASME B40.100, Grade 2A, stainless steel bourdon tube having 0.5% accuracy full scale unless otherwise specified.

.2 Provide:

.1 Siphon for steam service.
.2 Snubber for pulsating operation.
.3 Diaphragm assembly for corrosive service.
.4 Gasketted pressure relief back with solid front.
.5 Bronze stop cock.
.6 Oil filled for high vibration applications.

Part 3 Execution

3.1 GENERAL

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

.2 Install between equipment and first fitting or valve.

3.2 THERMOMETERS

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

.2 Install in locations as indicated.

.3 Use extensions where thermometers are installed through insulation.

3.3 PRESSURE GAUGES

.1 Install in following locations:

.1 Suction and discharge of pumps.
.2 Outlet of boilers.
.3 In other locations as indicated.

.2 Install gauge cocks for balancing purposes, elsewhere.

.3 Use extensions where pressure gauges are installed through insulation.

3.4 NAMEPLATES

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

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

1.2 REFERENCES

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

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

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

.1 ASTM A125-1996(R2001), Specification for Steel Springs, Helical, Heat-Treated.
.2 ASTM A307-04, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
.3 ASTM A563-04a, Specification for Carbon and Alloy Steel Nuts.

.3 Factory Mutual (FM)

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

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

.1 MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.
.2 ANSI/MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
.3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.

.6 Underwriter's Laboratories of Canada (ULC)

1.3 SYSTEM DESCRIPTION

.1 Design Requirements:

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

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

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

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

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

1.4 SUBMITTALS

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

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

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

.3 Closeout Submittals:

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

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

Part 2 Products

2.1 GENERAL

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

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

2.2 PIPE HANGERS

.1 Finishes:

.1 Pipe hangers and supports: galvanized.
.2 Use electro-plating galvanizing process or hot dipped galvanizing process.
.3 Ensure steel hangers in contact with copper piping are copper plated.

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

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

.1 Rod: 9 mm UL listed.

.2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed to MSS-SP58 and MSS-SP69.

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

.1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed to MSS SP69.

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

.4 Upper attachment to concrete:

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

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

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

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

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

.6 Pipe attachments: material to MSS SP58:

.1 Attachments for steel piping: carbon steel galvanized.
.2 Attachments for copper piping: copper plated black steel.
.3 Use insulation shields for hot pipework.
.4 Oversize pipe hangers and supports.

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

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

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

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

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

2.3 RISER CLAMPS

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

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

.3 Bolts: to ASTM A307.

.4 Nuts: to ASTM A563.

2.4 INSULATION PROTECTION SHIELDS

.1 Insulated cold piping:

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

.2 Insulated hot piping:

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

2.5 CONSTANT SUPPORT SPRING HANGERS

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

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

.3 Provide upper and lower factory set travel stops.

.4 Provide load adjustment scale for field adjustments.

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

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

2.6 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.7 HOUSE-KEEPING PADS

.1 Provide 100 mm high concrete housekeeping pads for base-mounted equipment; size pads 50 mm larger than equipment; chamfer pad edges.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Install in accordance with:

.1 manufacturer's instructions and recommendations.

.2 Vibration Control Devices:

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

.3 Clamps on riser piping:

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

.2 Bolt-tightening torques to industry standards.

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

.4 Cast iron pipes: install below joint.

.4 Clevis plates:

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

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

.6 Use approved constant support type hangers where:

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

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

.7 Use variable support spring hangers where:

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

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

3.3 HANGER SPACING

.1 Fire protection: to applicable fire code.

.2 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.

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

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

.5 Within 300 mm of each elbow.

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

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
6	5.1 m	
8	5.7 m	
10	6.6 m	
12	6.9 m	

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

3.4 HANGER INSTALLATION

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

.2 Adjust hangers to equalize load.

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

3.5 HORIZONTAL MOVEMENT

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

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

3.6 FINAL ADJUSTMENT

.1 Adjust hangers and supports:

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

.2 Adjustable clevis:

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

.3 C-clamps:

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

.4 Beam clamps:

.1 Hammer jaw firmly against underside of beam.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

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

1.2 REFERENCES

.1 Canadian Gas Association (CGA)

.1 CSA/CGA B149.1-05, Natural Gas and Propane Installation Code.

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.
.2 CAN/CGSB-24.3-92, Identification of Piping Systems.

.3 National Fire Protection Association (NFPA)

.1 NFPA 13-2002, Standard for the Installation of Sprinkler Systems.
.2 NFPA 14-2003, Standard for the Installation of Standpipe and Hose Systems.

1.3 SUBMITTALS

.1 Product Data:

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

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

Part 2 Products

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

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

.2 Lettering and numbers raised or recessed.

.3 Information to include, as appropriate:

.1 Equipment: manufacturer's name, model, size, serial number, capacity.
.2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 SYSTEM NAMEPLATES

.1 Colours:

.1 Hazardous: red letters, white background.

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

.2 Construction:

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

.3 Sizes:

.1 Conform to following table:

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

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

.4 Locations:

.1 Terminal cabinets, control panels: use size # 5.
.2 Equipment in Mechanical Rooms: use size # 9.

2.3 EXISTING IDENTIFICATION SYSTEMS

.1 Apply existing identification system to new work.

.2 Where existing identification system does not cover for new work, use identification system specified this section.

.3 Before starting work, obtain written approval of identification system from Contract Administrator.

2.4 IDENTIFICATION DUCTWORK SYSTEMS

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

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

2.5 CONTROLS COMPONENTS IDENTIFICATION

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

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

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 NAMEPLATES

.1 Locations:

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

.2 Standoffs:

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

.3 Protection:

.1 Do not paint, insulate or cover.

3.3 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

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

.2 Adjacent to each change in direction.

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

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

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

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

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

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

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

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

END OF SECTION

Part 1 General

1.1 SUMMARY

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

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

1.2 QUALIFICATIONS OF TAB PERSONNEL

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

.2 Provide documentation confirming qualifications, successful experience.

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

.1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.

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

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

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

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

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

.1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.

.2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.3 PURPOSE OF TAB

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

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

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

1.4 EXCEPTIONS

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

1.5 CO-ORDINATION

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

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

1.6 PRE-TAB REVIEW

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

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

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

1.7 START-UP

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

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

1.8 OPERATION OF SYSTEMS DURING TAB

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

1.9 START OF TAB

.1 Notify Contract Administrator 7 days prior to start of TAB.

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

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

.4 Application of weatherstripping, sealing, and caulking.

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

.6 Provisions for TAB installed and operational.

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

.1 Proper thermal overload protection in place for electrical equipment.

.2 Air systems:

.1 Filters in place, clean.

.2 Duct systems clean.

.3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.

.4 Correct fan rotation.

.5 Fire, smoke, volume control dampers installed and open.

.6 Coil fins combed, clean.

.7 Access doors, installed, closed.

.8 Outlets installed, volume control dampers open.

.3 Liquid systems:

.1 Flushed, filled, vented.

.2 Correct pump rotation.

.3 Strainers in place, baskets clean.

.4 Isolating and balancing valves installed, open.

.5 Calibrated balancing valves installed, at factory settings.

.6 Chemical treatment systems complete, operational.

1.10 APPLICATION TOLERANCES

.1 Do TAB to following tolerances of design values:

.1 HVAC systems: plus 5%, minus 5%.

.2 Hydronic systems: plus or minus 10%.

1.11 ACCURACY TOLERANCES

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

1.12 INSTRUMENTS

.1 Prior to TAB, submit to Contract Administrator list of instruments used together with serial numbers.

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

.3 Calibrate within 3 months of TAB. Provide certificate of calibration to Contract Administrator.

1.13 SUBMITTALS

.1 Submit, prior to commencement of TAB:

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

1.14 PRELIMINARY TAB REPORT

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

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

1.15 TAB REPORT

.1 Format in accordance with referenced standard.

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

.1 Project record drawings.
.2 System schematics.

.3 Submit 6 copies of TAB Report to Contract Administrator for verification and approval, in D-ring binders, complete with index tabs.

1.16 VERIFICATION

.1 Reported results subject to verification by Contract Administrator.

.2 Provide personnel and instrumentation to verify up to 30% of reported results.

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

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

1.17 SETTINGS

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

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

1.18 COMPLETION OF TAB

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

1.19 AIR SYSTEMS

.1 Standard: TAB to most stringent of this section or TAB standards of AABC.

.1 Do TAB of systems, equipment, components, controls specified Division 23.

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

.3 Quality assurance: perform TAB under direction of supervisor qualified by AABC.

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

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

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

.2 At controllers, controlled device.

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

.7 Set minimum and maximum operating limits of the VAV boxes in co-ordination with section 230933.

1.20 WATER SYSTEMS

.1 Do TAB on all hydronic systems, equipment, components and controls specified in Division 23 including flows to existing air handling units AHU-1 and AHU-2:

.2 Set water flows as noted. Obtain pump operating pressures, motor amperages and characteristics.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Insulation of the following piping:
.1 New hydronic piping
.2 New refrigerant piping

1.2 REFERENCES

.1 CAN/CGSB-51.9-92, Mineral Fibre Thermal Insulation for Piping and Round Ducting

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

1.3 SUBMITTALS

.1 Product Data:

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

1.4 DEFINITIONS:

.1 For purposes of this section:

.1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
.2 "EXPOSED" - will mean "not concealed" as defined herein.
.3 Insulation systems - insulation material, fasteners, jackets, etc.

Part 2 Products

2.1 GENERAL

.1 Components of insulation system to have maximum flame spread rating of 25 and maximum smoke developed rating of 50 in accordance with CAN/ULC-S102.

.2 Materials to be tested in accordance with ASTM C411.

2.2 P-1 FORMED MINERAL FIBER TO 200°C

.1 Applications: new glycol piping.

.2 Materials:

.1 Rigid, one piece fibreglass pipe insulation with all service jacket of high density white kraft bonded to aluminum foil. Provide all weather protective jacket for outdoor installation.

.2 Acceptable materials: Schuller, Micro-lok, Knauf.

FLUID TEMPERATURE (C)	NOMINAL PIPE SIZES			
	25 mm and Under	32 to 50 mm	63 to 100 mm	125 mm and Over
5 – 29	25 mm	25 mm	25 mm	25 mm
30 – 49	25 mm	25 mm	25 mm	25 mm
50- 90	50 mm	50 mm	25 mm	25 mm

.3 Thermal Conductivity "k" shall not exceed 0.034 W/m.°C at 24°C mean temperature when tested in accordance with ASTM C335.

.4 For refrigerant piping: 25 mm thick flexible closed cell insulation Armaflex or approved equal in accordance with B6.

.5 Outdoor piping: 38 mm thick.

2.3 FASTENINGS

.1 For insulation systems P-1:

.1 Tape: self adhesive, ULC labelled for less than 25 flame spread and less than 50 smoke developed.

.2 Lap seal adhesive: quick-setting for joints and lap sealing of vapour barriers.

.3 Lagging adhesive: fire retardant coating.

2.4 INSULATION CEMENT

.1 To CAN/CGSB-51.12.

2.5 JACKETS

.1 Canvas cover

Part 3 Execution

3.1 APPLICATION

.1 Apply insulation after required tests have been completed and approved by Contract Administrator.

.2 Surfaces shall be warm, clean and dry during application of insulation and finishes.

.3 Apply insulation materials, accessories and finishes in accordance with manufacturer's recommendations and as specified herein.

.4 On piping with insulation and vapour barrier, install high density insulation under hanger shield. Maintain integrity of vapour barrier over full length of pipe without interruption at sleeves, fittings and supports.

3.2 INSTALLATION

.1 Install in accordance with ANSI/NFPA 90A and ANSI/NFPA 90B.

.2 Seal and finish exposed ends and other terminations with insulating cement.

.3 Flanges and unions at equipment, valves, other components requiring regular maintenance: omit insulation and bevel away from studs and nuts to permit use of tools without damage to insulation.

3.3 FASTENINGS

.1 Secure pipe insulation by tape at each end and centre of each section, but not greater than 900 mm on centres.

END OF SECTION

Part 1 General

1.1 REFERENCES

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

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

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

.1 ASTM B209M-02, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).

.2 ASTM C335-95, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.

.3 ASTM C411-97, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.

.4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.5 ASTM C547-00, Specification for Mineral Fiber Pipe Insulation.

.6 ASTM C553-00, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.7 ASTM C612-00a, Specification for Mineral Fiber Block and Board Thermal Insulation.

.8 ASTM C795-92, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.

.9 ASTM C921-92(1998)e1, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.3 Canadian General Standards Board (CGSB)

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

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

.5 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S102-M88(R2000), Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S701-01, Thermal Insulation Polyotrene, Boards and Pipe Covering.

1.2 DEFINITIONS

.1 For purposes of this section:

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

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

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

.2 TIAC Codes:

.1 CRD: Code Round Ductwork,

.2 CRF: Code Rectangular Finish.

1.3 SHOP DRAWINGS

.1 Submit shop drawings in accordance with CW 1110.

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

1.4 MANUFACTURERS' INSTRUCTIONS

.1 Submit manufacturer's installation instructions in accordance with CW 1110.

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

1.5 QUALIFICATIONS

.1 Installer: specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, qualified to standards.

1.6 DELIVERY, STORAGE AND HANDLING

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

.2 Protect from weather and construction traffic.

.3 Protect against damage from any source.

.4 Store at temperatures and conditions recommended by manufacturer.

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 In accordance with CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

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

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

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

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

.1 Mineral fibre: to ASTM C553.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: to ASTM C553.

2.3 JACKETS

.1 Aluminum:

.1 To ASTM B209 with moisture barrier as scheduled in PART 3 of this section.

.2 Thickness: 0.50 mm sheet.

.3 Finish: Stucco embossed.

.4 Jacket banding and mechanical seals: 12 mm wide, 0.5 mm thick stainless steel.

2.4 ACCESSORIES

.1 Vapour retarder lap adhesive:

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

.2 Indoor Vapour Retarder Finish:

.1 Vinyl emulsion type acrylic, compatible with insulation.

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

.4 ULC Listed Canvas Jacket:

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

.5 Outdoor Vapour Retarder Mastic:

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: Fibrous glass, untreated 305 g/m^2.

.6 Tape: self-adhesive, aluminium, reinforced, 75 mm wide minimum.

.7 Contact adhesive: quick-setting

.8 Canvas adhesive: washable.

.9 Tie wire: 1.5 mm stainless steel.

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

.11 Fasteners: 4 mm diameter pins with 35 mm diameter clips, length to suit thickness of insulation.

Part 3 Execution

3.1 PRE-INSTALLATION REQUIREMENTS

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

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

3.2 INSTALLATION

.1 Install in accordance with TIAC National Standards.

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

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

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

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

.5 Supports, Hangers in accordance with Section 23 31 14 - Metal Ducts - Low Pressure To 500 Pa.

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

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

3.3 DUCTWORK INSULATION SCHEDULE

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

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts	C-1	Yes	25
Round cold and dual temperature supply air ducts	C-2	Yes	25
Exhaust duct between fan and louvers	C-1	No	50

END OF SECTION

Part 1 General

1.1 General and Related Work

.1 All work of this Division shall be coordinated and provided by the single Building Management System (BMS) Contractor.

.2 If the Contractor believes there are conflicts or missing information in the Contract Documents then the Contractor shall promptly request clarification and instruction from the Contract Administrator before proceeding.

.3 No LON protocols are accepted.

.4 The Contractor to supply all drawings/graphics/sequence of operations in both a hard and soft copy. Drawings and graphics to be able to be read and modified by City of Winnipeg Staff using Microsoft Visio software.

.5 The Contractor to provide commissioning sheets for all points on field devices as well as head end equipment.

.6 The Contractor shall meet with City of Winnipeg Tech Shop staff to go over naming conventions, graphics, alarms etc. at the start of project. Controller addresses to be coordinated with the Tech Shop.

.7 The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Mechanical Division Sections for details.

.8 The Contractor shall have visited the Project site and obtained information as necessary prior to submittal of the bid to ensure that prevailing physical conditions and Project arrangements that may be material to the performance of the Work have been ascertained and accommodated in the bid. No claims for additional payments will be accepted due to the Contractor’s failure to complete this survey.

.9 If, in order to complete the Work of the Controls Contract, private and/or public telephone lines and connections, including ISDN lines and/or LAN/WAN support and connections, are required then these shall be provided by the City to the Contractor, at the City's direct cost, in a timely manner.

.10 There is an existing central monitoring system in place. The Contractor shall visit the City of Winnipeg tech shop for a walk through of the existing controls prior to bid closing date. Where DDC points are identified as centrally monitored points, the Contractor shall provide and install required hardware and software to interface to the existing Johnson Controls Metasys EA servers and workstations. These are located at the Central Control Offices, 510 Main Street, Winnipeg, Manitoba.

.11 This facility has existing Johnson Controls DDC systems using N2 open communication bus technology. Controls contractor to supply all drawings/graphics/sequence of operations in both a hard and soft copy. Drawings and graphics to be able to be read and modified by City of Winnipeg Staff using Microsoft Visio software.

.12 Provide all required assistance to Section 23 05 93 during TAB and commissioning.

1.2 Control Systems Description

.1 The Building Management System (BMS) shall be a complete system designed for use with the enterprise IT systems in place at the City of Winnipeg. This functionality shall extend into the equipment rooms. Devices residing on the automation network located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure in the facility. Contractor shall be responsible for coordination with the Contract Administrator's IT staff to ensure that the FMS will perform in the Contract Administrator's environment without disruption to any of the other activities taking place on that LAN.

.2 All points of user interface shall be on standard PCs that do not require the purchase of any special software from the BMS manufacturer for use as a building operations terminal. The primary point of interface on these PCs will be a standard Web Browser.

.3 Where necessary and as dictated elsewhere in these Specifications, the City of Winnipeg's existing ADX Server shall be used for the purpose of providing a location for extensive archiving of system configuration data, and historical data such as trend data and operator transactions.

.4 The work of the single BMS Contractor shall be as defined individually and collectively in all Sections of this Division specification together with the associated Point Sheets and Drawings and the associated interfacing work as referenced in the related documents.

.5 The BMS work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned BMS.

.6 Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.

.7 Manage and coordinate the BMS work in a timely manner in consideration of the Project schedules. Coordinate with the associated work of other trades so as to not impede or delay the work of associated trades.

.8 The Controls System as provided shall comprise, at a minimum, the following primary elements:

.1 Network and application nodes.

.2 Field devices.

.3 Control wiring.

.2 Submittals

.1 Shop Drawings, Product Data, and Samples

.1 The BMS contractor shall submit a list of all shop drawings with submittals dates within 30 days of contract award.

.2 Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as approved by the Contract Administrator for Contract compliance.

.3 Allow 15 working days for the review of each package by the Contract Administrator in the scheduling of the total BMS work.

.4 Equipment and systems requiring approval of local authorities must comply with such regulations and be approved. Filing shall be at the expense of the BMS Contractor where filing is necessary. Provide a copy of all related correspondence and permits to the Contract Administrator.

.5 Prepare an index of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.

.6 The BMS Contractor shall correct any errors or omissions noted in the first review.

.7 At a minimum, submit the following:

.1 BMS network architecture diagrams including all nodes and interconnections.

.2 Systems schematics, sequences and flow diagrams.

.3 Points schedule for each point in the BMS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.

.4 Samples of Graphic Display screen types and associated menus.

.5 Detailed Bill of Material list for each system

Part 2 Products

2.1 N2 DDC System Controllers.

Digital Controller w/ eXtension capability (DX)

.1 Each DX shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each DCX shall be a microprocessor-Based, multi-tasking, real-time digital control processor.

.2 DX controllers shall support, but not be limited to, the following configurations of systems to address current requirements described in the “Execution” portion of this Specification, and to address future expansion.

.1 Single boiler or chiller plants with pump logic.

.2 Cooling towers.

.3 Large, built-up Air Handling Units for special applications.

.4 Generic system interlocking through hardware.

.3 Point types – Each DX shall support the following types of point inputs and outputs:

.1 Analog inputs shall monitor the following analog signals:

.1 4-20 mA Sensors

.2 0-10 VDC Sensors

.3 1000ohm RTDs

.2 Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input "bouncing."

.3 Counter inputs shall monitor dry contact pulses with an input resolution of one HZ minimum.

.1 Analog outputs shall provide the following control outputs:

.1 4.20 mA – Sink or Source

.2 0-10 VDC

.2 Binary outputs shall provide SPDT output contacts rated for 2 amps at 24 VAC. Surge and noise suppression shall be provided on all pilot relays. Inductive loads (i.e. solenoids) shall be controlled by pilot relays.

.3 Tri-state outputs shall be paired binary outputs for use as Power Close/Power Open control output contacts rated for 2 amps at 24 VAC. Surge and noise suppression shall be provided on all pilot relays.

.4 Controllers shall have a built-in status, and adjust panel interface to allow for the local adjustment of all setpoints, temporary override of any input or output points, and status of any points in alarm.

.5 Power fail Protection – All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the DX-9100.

.6 The capability to extend the input and output capacity of the DX via Point Expansion Modules shall be provided.

.1 The Point Expansion Modules shall communicate to the DX controller over a local RS-485 expansion bus.

.2 The Point Expansion Modules shall have available a range of configurations of 4, 8, 12, or 16 data points:

.1 Analog Inputs – 0-10V, 4-20mA, 1000 ohm RTD

.2 Analog Outputs – 0-10V, 4-20mA

.3 Digital Inputs w/ digital counter

.4 Digital Outputs – triacs or relay contacts

.3 Expansion module data points shall be available for inclusion in all DX control strategies.

.2 Application Specific Controllers

.1 Air Handling Unit Controllers (AHU)

.1 Each Air Handling Unit controller shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each AHU controller shall be a microprocessor-Based, multi-tasking, real-time digital control processor

.2 AHU controllers shall support, but not be limited to, the following configurations of systems to address current requirements as described in the "Execution" portion of this Specification, and to address future expansion:

.1 Air Handling Units:

.1 Mixed Air-Single Path
.2 Mixed Air-Dual Path
.3 100% Single Path
.4 100% Dual Path

.3 Each AHU controller shall have sufficient memory to support its own operating system and databases, including:

.1 Control Processes
.2 Energy Management Applications
.3 Operator I/O (Portable Service Terminal)

.4 Point types – Each AHU controller shall support the following types of point inputs and outputs:

.1 Analog inputs shall monitor the following analog signals:

.1 4-20 mA Sensors
.2 0-10 VDC Sensors
.3 1000ohm RTDs

.2 Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input "bouncing."

.3 Counter inputs shall monitor dry contact pulses with an input resolution of one HZ minimum.

.4 Analog outputs shall provide the following control outputs:

.1 4.20 mA – Sink or Source
.2 0-10 VDC

.5 Binary outputs shall provide SPDT output contacts rated for 2 amps at 24 VAC. Surge and noise suppression shall be provided on all pilot relays. Inductive loads (i.e. solenoids) shall be controlled by pilot relays.

.6 Tri-state outputs shall be paired binary outputs for use as Power Close/Power Open control output contacts rated for 2 amps at 24 VAC. Surge and noise suppression shall be provided on all pilot relays.

.5 AHU controllers shall have a library of control routines and program logic to perform the sequence of operations specified in the "Execution" portion of this Specification.

.6 AHU controllers shall directly support the temporary use of a portable service terminal that can be connected to the AHU via zone temperature or directly at the controller.

.7 Power fail Protection – All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the AHU.

.2 Unitary Controllers (UNT)

.1 Each Unitary Controller shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each Unitary Controller shall be a microprocessor-Based, multi-tasking, real-time digital control processor.

.2 Unitary Controllers shall support, but not be limited to, the following types of systems to address specific applications described in the "Execution" portion of this Specification, and to address future expansion:

.1 Unit Vents (ASHRAE Cycle, I, II, III, or W).

.2 Heat Pumps (Air-to-Air, Water-to-Air).

.3 Packaged Rooftops.

.4 Fan Coils (Two-Pipe, Four-Pipe).

.3 Point types – Each Unitary Controller shall support the following types of point inputs and outputs:

.1 Analog inputs shall monitor the following analog signals:

.1 0-10 VDC Sensors

.2 1000ohm RTDs

.2 Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input "bouncing."

.3 Counter inputs shall monitor dry contact pulses with an input resolution of one HZ minimum.

.4 Analog outputs shall provide the following control outputs:

.1 0-10 VDC

.5 Binary outputs shall provide SPDT output contacts rated for 2 amps at 24 VAC. Surge and noise suppression shall be provided on all pilot relays. Inductive loads (i.e. solenoids) shall be controlled by pilot relays.

.6 Tri-state outputs shall be paired binary outputs for use as Power Close/Power Open control output contacts rated for 2 amps at 24 VAC. Surge and noise suppression shall be provided on all pilot relays.

.7 Pneumatic outputs shall provide a 3-15 PSI pneumatic output. Gradual override capability and output pressure gauge shall be provided.

.4 Unitary Controllers shall have a library of control routines and program logic to perform the sequence of operations specified in the "Execution" portion of this Specification.

.5 Unitary Controllers shall directly support the temporary use of a portable service terminal that can be connected to the UNT via zone temperature or directly at the controller.

.6 Power fail Protection – All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the UNT.

.3 VAV Modular Assembly (VMA)

.1 The VAV Modular Assembly shall provide both standalone and networked direct digital control of pressure-independent, variable air volume terminal units. It shall address both single and dual duct applications.

.2 The VAV Modular Assembly shall be a configurable digital controller with integral differential pressure transducer and damper actuator. All components shall be connected and mounted as a single assembly that can be removed as one piece.

.3 The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 30 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.

.4 The controller shall determine airflow by dynamic pressure measurement using an integral dead-ended differential pressure transducer. The transducer shall be maintenance-free and shall not require air filters.

.5 Each controller shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.

.6 The controller shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.

.7 Each controller shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. In addition, this tuning reduces commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes.

.8 The controller shall provide the ability to download and upload VMA configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group using a zone schedule generated spreadsheet of controller parameters.

.9 Control setpoint changes initiated over the network shall be written to VMA non-volatile memory to prevent loss of setpoint changes and to provide consistent operation in the event of communication failure.

.10 The controller firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.

.11 The VMA shall include troubleshooting LED indicators to identify the following conditions:

- .1 Power On
- .2 Power Off
- .3 VMA Off Line
- .4 VMA Replacement
- .5 VMA Corrupted Memory

.12 The controller shall provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.

.13 The controller shall interface with balancer tools that allow automatic recalculation of box flow pickup gain ("K" factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow setpoints.

.14 Controller performance shall be self-documenting via on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop's sample interval, which may be used to continuously monitor and document system performance. The VMA shall calculate exponentially weighted moving averages (EWMA) for each of the following. These metrics shall be available to the end user for efficient management of the VAV terminals.

- .1 Absolute temperature loop error.
- .2 Signed temperature loop error.
- .3 Absolute airflow loop error.
- .4 Signed airflow loop error.
- .5 Average damper actuator duty cycle.

.15 The controller shall detect system error conditions to assist in managing the VAV zones. The error conditions shall consist of:

- .1 Unreliable space temperature sensor.
- .2 Unreliable differential pressure sensor.
- .3 Starved box.
- .4 Actuator stall
- .5 Insufficient cooling.
- .6 Insufficient heating.

The controller shall provide a flow test function to view damper position vs. flow in a graphical format. The information would alert the user to check damper position. The VMA would also provide a method to calculate actuator duty cycle as an indicator of damper actuator runtime.

.16 The controller shall provide a compliant interface for ASHRAE Standard 62-1989 (indoor air quality), and shall be capable of resetting the box minimum airflow Based on the percent of outdoor air in the primary air stream.

.17 The controller shall comply with ASHRAE Standard 90.1 (energy efficiency) by preventing simultaneous heating and cooling, and where the control strategy requires reset of airflow while in reheat, by modulating the box reheat device fully open prior to increasing the airflow in the heating sequence.

.18 Inputs:

.1 Analog inputs with user defined ranges shall monitor the following analog signals, without the addition of equipment outside the terminal controller cabinet:

.1 0-10 VDC Sensors
.2 1000ohm RTDs
.3 NTC Thermistors

.2 Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input “bouncing.”

.3 For noise immunity, the inputs shall be internally isolated from power, communications, and output circuits.

.4 Provide side loop application for humidity control.

.19 Outputs

.1 Analog outputs shall provide the following control outputs:

.1 0-10 VDC

.2 Binary outputs shall provide a SPST Triac output rated for 500mA at 24 VAC.

.3 For noise immunity, the outputs shall be internally isolated from power, communications, and other output circuits.

.20 Application Configuration

.1 The VAV Modular Assembly shall be configured with a software tool that provides a simple Question/Answer format for developing applications and downloading.

.21 Sensor Support

.1 The VMA shall support an LCD display room sensor.

.2 The VMA shall also support standard room sensors as defined by analog input requirements.

.3 The VMA shall support humidity sensors defined by the AI side loop.

Part 3 Execution

3.1 Installation

.1 General

.1 The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the Contract Administrator for resolution before rough-in work is started.

.2 The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Contract Administrator for resolution before rough-in work is started.

.3 The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others the contractor shall report these discrepancies to the Contract Administrator and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the contractor to report such discrepancies shall be made by—and at the expense of—this contractor.

.4 All items shall be installed in accordance with manufacturer's instructions. All conduit shall be independently supported from the structure in an approved manner.

.5 The control equipment and connecting conduit and wire shall be installed in a neat and workmanlike manner by personnel skilled in this type of installation. All tubing, conduit and plenum rated cable shall be run in an approved manner; conduit shall be run parallel to or at right angles to the building structure. All conduit, tubing, and plenum cable shall be concealed in all finished spaces. Conduit containing wire or non-metallic tubing may be installed exposed in mechanical rooms or areas where other piping is run exposed.

.6 Non-metallic tubing and plenum cable may be used in concealed accessible spaces provided such installation is allowed by local codes.

.7 All electrical work shall be installed by experienced personnel and conform to CEC and all local codes. Where requirements of Division 26 differ from those contained herein, Division 26 section shall take precedence.

.2 General Workmanship

.1 Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.

.2 Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

.3 Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

.4 All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.2 Cleaning

.1 The contractor shall clean up all debris resulting from his/her activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.

.2 At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.

.3 At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.3 Training

.1 Provide training sessions for personnel designated by the Contract Administrator.

.2 Train the designated staff of The City to enable them to do the following:

.1 Day-to-day Operators:

.1 Proficiently operate the system

.2 Understand system operation, including DDC system control and optimizing routines (algorithms)

.3 Operate the workstation and peripherals

.4 Log on and off the system

.5 Access graphics, point reports, and logs

.6 Adjust and change system set points, time schedules, and holiday schedules

.7 Recognize malfunctions of the system by observation of the printed copy and graphical visual signals

.8 Understand system drawings and Operation and Maintenance manual

.9 Understand the job layout and location of control components

.10 Access data from DDC controllers and ASCs

.2 Advanced Operators:

.1 Make and change graphics on the workstation

.2 Create, delete, and modify alarms, including annunciation and routing of these

.3 Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals
.4 Create, delete, and modify reports
.5 Add, remove, and modify system's physical points
.6 Create, modify, and delete programming
.7 Add panels when required
.8 Add operator interface stations
.9 Create, delete, and modify system displays, both graphical and others
.10 Perform DDC system field checkout procedures
.11 Perform DDC controller unit operation and maintenance procedures
.12 Perform workstation and peripheral operation and maintenance procedures
.13 Perform DDC system diagnostic procedures
.14 Configure hardware including PC boards, switches, communication, and I/O points
.15 Maintain, calibrate, troubleshoot, diagnose, and repair hardware
.16 Adjust, calibrate, and replace system components System

.3 Managers/Administrators:

.1 Maintain software and prepare backups
.2 Interface with job-specific, third-party operator software
.3 Add new users and understand password security procedures

.3 These objectives will be divided into three logical groupings. Participants may attend one or more of these, depending on level of knowledge required.

.1 Day-to-day Operators
.2 Advanced Operators
.3 System Managers/Administrators
.4 Provide course outline and materials. The instructor(s) shall provide one copy of training material per student.
.5 The instructor(s) shall be factory-trained instructors experienced in presenting this material.
.6 Classroom training shall be done using a network of working controllers representative of the installed hardware.

3.4 DDC Controls Sequence Of Operation (Refer to Control Schematics)

.1 DDC system shall control and monitor the air handling units as follows:

.1 New Air Handling Units (AHU-3, and AHU-4): Each air handling unit shall operate on its' own 7 day schedule capable of minimum 4 schedule changes per day.

.1 Occupied Winter Mode – (Below 15 deg. C)

.1 Blowers to operate continuously
.2 Outside air damper and exhaust damper set to minimum position. Outdoor damper minimum setting to be over ridden by CO2 control on return air to bring in more outdoor air as required.
.3 Modulate control valve to maintain discharge air temperature at set point.
.4 Supply air low limit shall close fresh air damper based on low discharge air temperature and after time delay shut down unit and alarm.

.2 Occupied Summer Mode – (15 deg. C and above)

.1 Blowers to operate continuously
.2 Modulate mixed air dampers to maintain discharge air at set temperature for free cooling where outdoor temperatures permit. (When return air temperature is lower than outside air temperature, set outside air damper and exhaust damper to minimum position and the return air damper to maximum position and initiate DX cooling).
.3 Outdoor damper minimum setting to be over ridden by CO2 control on return air to bring in more outdoor air as required.

.3 Un-occupied Winter Mode – (Below 15 deg. C)

.1 Units shall operate to maintain space temperature at set-back point. Blowers to operate as required.
.2 Outside air damper and exhaust damper closed, return damper fully open.
.3 Modulate control valve to maintain discharge air temperature at set point.

.4 Un-occupied Summer Mode – (15 deg. C and above)

.1 Units shall operate to maintain space temperature at set-up point. Blowers to operate as required.

.2 Modulate mixed air dampers to maintain discharge air at set temperature for free cooling where outdoor temperatures permit.

.3 Outside air damper and exhaust damper closed, return damper fully open, when DX cooling is enabled.

.5 AHU supply and return fans shall be VFD controlled. The DDC System shall maintain supply air pressure at set point. (Co-ordinate set point with the Section 23 05 93 and provide all required assistance.)

.6 DDC system shall monitor the following:

.1 AHU blower (supply and return fans) status
.2 Clogged filter
.3 Return Air temperature
.4 Outdoor air temperature
.5 Mixed Air temperature
.6 Supply Air temperature.
.7 Damper positions
.8 CO2 Levels.

.2 Pumps

.1 PU-1 and PU-2

.1 Enable ONE pump during winter mode. (Outdoor temperature below 15 deg. C) The other pump to remain on standby.

.2 In event of a pump failure, the standby pump shall start automatically. An alarm shall be generated to indicate pump failure.

.3 Pumps shall be VFD controlled. The DDC System shall maintain discharge pressure at set point. (Co-ordinate set point with the Section 23 05 93 and provide all required assistance.)

.4 DDC system shall provide automatic duty cycling of the pumps.

.5 DDC System shall monitor pump status.

.6 DDC System shall monitor differential pressure across the pumps.

.3 Glycol Fill Packages:

.1 DDC System shall monitor each glycol fill package level and pressure.

.4 Control Valves (all control valves supplied by 230933 and installed by mechanical).

.1 The control valves shall control glycol flow supplied to the air handler heating coils and re-heat coils.

.5 Zone Control

.1 When in heating mode, the DDC system shall modulate flow to re-heat coils to maintain space temperature at set point. In rooms where supplemental electric baseboard heaters exist (Specific Skills Room, Craft Room, Game Room, Senior Citizen Lounge), the DDC shall turn on the baseboard heaters if the re-heat coil is unable to maintain space temperature set-point. (The existing baseboard heater thermostats shall be removed.)

.2 When in cooling mode, the DDC system shall modulate the VAV boxes to maintain space temperature at set point. VAV operating range shall be set during commissioning in co-ordination with section 230593.

3.5 Alarms and Monitoring

.1 DDC System shall monitor,

.1 Glycol supply temperature

.2 Glycol return temperature

.2 Alarms shall be generated on the DDC system for the following events:

.1 Clogged filters on air handling units (non critical)

.2 Freeze stat on air handling units (critical)

.3 Fan failure on air handling units (critical)

.4 Damper failure on air handling units (critical).

.5 Pump Failures (critical)

.6 Glycol fill package low level and low pressure (critical)

3.6 Thermostats and Temperature Sensors

.1 Provide duct mounted DDC temperature sensors suitable for specified operation.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes.

.1 Materials and installation for steel piping, valves and fittings for hydronic systems.

.2 Related Sections.

.1 Section 01 33 00 - Submittal Procedures.
.2 Section 23 05 00 - Common Work Results - Mechanical.
.3 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME).

.1 ASME B16.1-98, Cast Iron Pipe Flanges and Flanged Fittings.
.2 ASME B16.3-98, Malleable Iron Threaded Fittings.
.3 ASME B16.5-03, Pipe Flanges and Flanged Fittings.
.4 ASME B16.9-01, Factory-Made Wrought Buttwelding Fittings.
.5 ASME B18.2.1-03, Square and Hex Bolts and Screws (Inch Series).
.6 ASME B18.2.2-87(R1999), Square and Hex Nuts (Inch Series).

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

.1 ASTM A47/A47M-99, Standard Specification for Ferritic Malleable Iron Castings.
.2 ASTM A53/A53M-02, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
.3 ASTM A536-84(1999)e1, Standard Specification for Ductile Iron Castings.
.4 ASTM B61-02, Standard Specification for Steam or Valve Bronze Castings.
.5 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
.6 ASTM E202-00, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.

.3 American Water Works Association (AWWA).

.1 AWWA C111-00, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.4 Canadian Standards Association (CSA International).

.1 CSA B242-M1980(R1998), Groove and Shoulder Type Mechanical Pipe Couplings.
.2 CAN/CSA W48-01, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).

.5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS).

.1 MSS-SP-67-025, Butterfly Valves.
.2 MSS-SP-70-98, Cast Iron Gate Valves, Flanged and Threaded Ends.
.3 MSS-SP-71-97, Cast Iron Swing Check Valves Flanged and Threaded Ends.
.4 MSS-SP-80-03, Bronze Gate, Globe, Angle and Check Valves.
.5 MSS-SP-85-02, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SUBMITTALS

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

1.4 MAINTENANCE

.1 Extra Materials.

.1 Provide following spare parts:
.1 Valve seats: one for every ten valves, each size. Minimum one.
.2 Discs: one for every ten valves, each size. Minimum one.
.3 Stem packing: one for every ten valves, each size. Minimum one.
.4 Valve handles: two of each size.
.5 Gaskets for flanges: one for every ten flanges.

Part 2 Products

2.1 PIPE

.1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:

.1 To NPS6: Schedule 40.

2.2 PIPE JOINTS

.1 NPS2 and under: screwed fittings with PTFE tape or lead-free pipe dope.

.2 NPS2-1/2 and over: welding fittings and flanges to CAN/CSA W48.

.3 Flanges: plain, to AWWA C111.

.4 Orifice flanges: slip-on raised face, 2100 kPa.

.5 Flange gaskets: to AWWA C111.

.6 Pipe thread: taper.

.7 Bolts and nuts: to ASME B18.2.1 and ASME B18.2.2.

2.3 FITTINGS

.1 Screwed fittings: malleable iron, to ASME B16.3, Class 150.

.2 Pipe flanges and flanged fittings:

- .1 Cast iron: to ASME B16.1, Class 125.
- .2 Steel: to ASME B16.5.

.3 Butt-welding fittings: steel, to ASME B16.9.

.4 Unions: malleable iron, to ASTM A47/A47M and ASME B16.3.

2.4 VALVES

.1 Connections:

- .1 NPS2 and smaller: screwed ends.
- .2 NPS2.1/2 and larger: Flanged ends.

.2 Ball Valves

- .1 NPS2 and under:
  - .1 To ASTM B62, 4 MPa WOG, bronze body, screwed ends, TFE seal, hard chrome solid ball, Teflon seats and lever handle.
  - .2 Acceptable product: Toyo Figure 5044A, Crane, Grinnell or approved equal in accordance with B6.

.3 Gate valves:

- .1 NPS2 and under:
  - .1 Rising stem: to MSS SP-80, Class 125, 860 kPa, bronze body, solid wedge disc.
  - .2 Acceptable material: Toyo Fig 206A, Crane, Grinnell.
- .2 NPS21/2 and over:
  - .1 Rising stem, OS & Y, bolted bonnet, solid wedge, disc flanged end, to MSS SP-70, cast iron body bronze trim.
  - .2 Acceptable material: Toyo Fig No. 421A, Crane, Grinnell.

.4 Butterfly valves: to MSS-SP-67:

- .1 NPS21/2 and over: Lug type:
- .2 Pressure rating for tight shut-off at temperatures up to maximum for seat material.
  - .1 NPS 2 - 12: 200 psig.
- .3 Minimum seat temperature ratings to 135 degrees C.
- .4 Application: on-off operation.
- .5 Operators:
  - .1 NPS 2 - 6: handles capable of locking in any of ten (10) positions - 0 degrees to 90 degrees. Handle and release trigger - ductile iron.

Return spring and hinge pin: carbon steel. Latch plate and mounting hardware: cadmium plated carbon steel. Standard coating: black laquer.

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

.7 Construction:

.1 Body ductile iron.

.2 Disc: aluminum bronze.

.3 Seat: EPDM.

.4 Shaft: 316 stainless steel.

.5 Taper pin: 316 SS.

.6 Key: stainless.

.7 O-Ring: EPDM.

.8 Bushings: luberized bronze.

.8 Acceptable Product: “Bray” Series 31 or approved equal in accordance with B6.

.5 Balancing, for TAB:

.1 Sizes: Calibrated balancing valves, as specified this section.

.2 NPS2 and under:

.1 Threaded bronze body construction, brass ball, TFE seat rings c/w memory stop, and differential pressure readout ports.

.2 Acceptable product: Bell & Gossett Circuit Setter plus Model CB.

.3 NPS 2 ½ and over:

.1 flanged cast iron body construction, c/w memory stop, and differential pressure readout ports.

.2 Acceptable Product: Bell & Gossett Circuit Setter Model CB.

.6 Air Vents:

.1 Automatic air vent suitable for hot water heating system with semi steel body and stainless steel float. Size = 12 mm.

.2 Acceptable Product: Hamlet and Garneau Model MV-15.

.7 Strainers:

.1 To ASTM B62, bronze body, cover, plug, screwed ends, 20 mesh screen.

.2 Acceptable Product: SF TB300 or approved equal in accordance with B6.

.8 Air Purger:

.1 50 mm air purger suitable for water heating systems with automatic air vent and ball valve on fill connection.

.2 Acceptable Product: Hamlet and Garneau Model P-200 air purger with MV-15 air vent.

.9 Expansion Tank EXP-1:

.1 ASME rated full replaceable bladder expansion tank with pre-charge air connection and 19 mm (3/4") system connection as stated below:

.1	Volume (L)	300
.2	Fluid	50%Prop.Glycol / 50%Water
.3	Height (mm)	1400
.4	Diameter (mm)	610

.2 Acceptable Product: "Hamlet and Garneau" Model: AL-300V.

.10 Heat Transfer Fluid:

.1 Fluid shall be 50% propylene glycol and 50% water.

.2 Provide a high-grade inhibited propylene glycol to ASTM -D1384 standards.

.3 Provide either distilled or deionized water with less than 25 ppm each of chloride and sulphate, and less than 50 ppm each of hard water ions (calcium and magnesium as calcium carbonate) with total hardness not to exceed 100 ppm.

.4 Refer to boiler manufacturer for additional requirements relating to PH levels, etc.

.11 Chemical Pot Feeder:

.1 7.6 L by-pass feeder, 1380 kPa (200 psig) working pressure, construction: 11 gauge steel tank shell and heads, cast iron with Buna N seal tank cap.

.2 Acceptable Product: "BetzDearborn – Neptune Bypass Feeder" Model: BDF-2.

.3 Accessories: Provide initial chemical treatment, test kit, and site inspections as supplied by BetzDearborn.

.12 Filter:

.1 Filter housing and cartridge, cast iron head, carbon steel shell, 19 mm (¾") inlet and outlet, carbon steel capscrew drain.

.2 Acceptable Product: "BetzDearborn – Filterite" Model: LMO10 and 30 micron filter cartridge.

.13 Flow Indicator:

.1 20 mm flow indicator, 304 stainless steel body and internals, fused glass window, metric and U.S. scales (15-30 lpm and 4-8 gpm), stainless steel return spring, 1082 kPa maximum pressure.

.2 Acceptable Product: "BetzDearborn" Model: Filter-Mate ¾

Part 3 Execution

3.1 PIPING INSTALLATION

.1 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.

.2 Install pipe to conserve headroom and space. Run exposed piping parallel to walls. Group piping wherever practical.

.3 Slope piping in direction of drainage and for positive venting.

.4 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.

.5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.

.6 Ream pipes, clean scale and dirt, inside and outside, before and after assembly.

.7 Assemble piping using fittings manufactured to ANSI standards.

3.2 CIRCUIT BALANCING VALVES

.1 Install flow measuring stations and flow balancing valves as indicated.

.2 Remove handwheel after installation and when TAB is complete.

.3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.3 CLEANING, FLUSHING AND START-UP

.1 Flush entire water system after pressure test for a minimum of 4 h.

.2 Fill with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8 h.

.3 Drain and flush for 4 h. Remove strainer screen/basket and clean.

.4 Refill system with clean water and circulate minimum 2 h.

.5 Drain and flush for 2 h. Remove strainer screen/basket and clean. Re-install after obtaining approval.

3.4 TESTING

.1 Test system in accordance with Section 23 05 00 - Common Work Results - Mechanical.

.2 For glycol systems, retest with propylene glycol to ASTM E202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.

3.5 BALANCING

.1 Balance water systems to within plus or minus 5% of design output.

.2 Refer to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for applicable procedures.

3.6 GLYCOL CHARGING

.1 Provide mixing tank and positive displacement pump for glycol charging.

.2 Retest for concentration to ASTM E202 after cleaning.

3.7 AIR VENTS

.1 Install at system high points. Install air vents with isolation ball valve.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials, equipment selection, installation and start up for hydronic system pumps.

1.2 REFERENCES

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

.1 Standard 90.1-2001 Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 Electrical Equipment Manufacturers Advisory Council (EEMAC).

.3 Canadian Standards Association (CSA International).

.1 CAN/CSA-B214-01, Installation Code for Hydronic Heating Systems.

.4 National Electrical Manufacturers Association (NEMA).

.1 NEMA MG 1-2003, Motors and Generators.

1.3 SUBMITTALS

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

.2 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.

.3 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.

.4 Submit product data of pump curves for review showing point of operation.

.5 Indicate piping, valves and fittings shipped loose by packaged equipment supplier, showing their final location in field assembly.

.6 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

Part 2 Products

2.1 INLINE CENTRIFUGAL PUMPS PU-1 & PU-2

.1 Volute: cast iron radially split, flanged design suction and discharge connections.

.2 Impeller: cast bronze

.3 Shaft: alloy steel with aluminium bronze sleeve bearing, integral thrust collar.

.4 Seal assembly: mechanical for service to 135°C.

.5 Coupling: rigid self-aligning.

.6 Motor: Inverter duty rated (suitable for VFD operation) ODP, high efficiency sleeve bearing, 1750 RPM, 2.2 kW (3 HP), 575 V/3 ph.

.7 Capacity: 8.83 l/s at 120 kPa (140 usgpm @ 17.34 psi.)

.8 Design pressure: 1200 kPa (175 psi)

.9 Pump shall not be overloading anywhere on its curve.

.10 Acceptable Product: “ITT Bell & Gossett” Series 80 3 x 3 x 7B c/w Triple Duty Valve and Suction Diffuser.

Part 3 Execution

3.1 INSTALLATION

.1 Do Work in accordance with CAN/CSA-B214.

.2 In line circulators: install as indicated by flow arrows. Support at inlet and outlet flanges or unions. Install with bearing lubrication points accessible.

.3 Base mounted type: supply templates for anchor bolt placement. Furnish anchor bolts with sleeves. Place level, shim unit and grout. Align coupling in accordance with manufacturer's recommended tolerance.

.4 Ensure that pump body does not support piping or equipment. Provide stanchions or hangers for this purpose. Refer to manufacturer's installation instructions for details.

.5 Install volute venting pet cock in accessible location.

.6 Check rotation prior to start-up.

.7 Install pressure gauge test cocks.

3.2 START-UP

.1 General

.1 In accordance with Section 01 91 00 - Commissioning: General Requirements; supplemented as specified herein.

.2 In accordance with manufacturer's recommendations.

.2 Procedures:

.1 Before starting pump, check that cooling water system over-temperature and other protective devices are installed and operative.

.2 After starting pump, check for proper, safe operation.

.3 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.

.4 Check base for free-floating, no obstructions under base.

.5 Run-in pumps for 12 continuous hours.

.6 Verify operation of over-temperature and other protective devices under low- and no-flow condition.

.7 Eliminate air from scroll casing.

.8 Adjust water flow rate through water-cooled bearings.

.9 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.

.10 Adjust alignment of piping and conduit to ensure true flexibility at all times.

.11 Eliminate cavitation, flashing and air entrainment.

.12 Adjust pump shaft seals, stuffing boxes, glands.

.13 Measure pressure drop across strainer when clean and with flow rates as finally set.

.14 Replace seals if pump used to degrease system or if pump used for temporary heat.

.15 Verify lubricating oil levels.

3.3 PERFORMANCE VERIFICATION (PV)

.1 General

.1 In accordance with Section 01 91 00 - Commissioning: General Requirements, supplemented as specified herein.

.2 In accordance with manufacturer's recommendations.

.2 Exclusions:

.1 This paragraph does not apply to small in-line circulators.

.3 Assumptions: these PV procedures assume that:

.1 Manufacturer's performance curves are accurate.

.2 Valves on pump suction and discharge provide tight shut-off.

.4 Net Positive Suction Head (NPSH):

.1 Application: measure NPSH for pumps which operate on open systems and with water at elevated temperatures.

.2 Measure using procedures prescribed in the Standard.

.3 Where procedures do not exist, discontinue PV, report to Contract Administrator and await instructions.

.5 Multiple Pump Installations - Series and Parallel:

.1 Repeat PV procedures specified above for pump performance and pump BHP for combinations of pump operations.

.6 Mark points of design and actual performance at design conditions as finally set upon completion of TAB.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Design, supply, installation and commissioning of the refrigerant piping between air handling unit AHU-3 and condensing unit CU-3.

.2 Related Sections:

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 78 00 - Closeout Submittals.

.3 Section 23 73 11 – Air Handling Units.

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B16.22-[01], Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.

.2 ASME B16.24-[02], Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 400, 600, 900, 1500 and 2500.

.3 ASME B16.26-[88], Cast Copper Alloy Fittings for Flared Copper Tubes.

.4 ASME B31.5-[01], Refrigeration Piping and Heat Transfer Components.

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

.1 ASTM A307-[04], Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.2 ASTM B280-[03], Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

.3 Canadian Standards Association (CSA International)

.1 CSA B52-[99], Mechanical Refrigeration Code.

.4 Environment Canada (EC)

.1 EPS 1/RA/1-[96], Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

.5 Health Canada / Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.

.3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Instructions: submit manufacturer's installation instructions.

.6 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

Part 2 Products

2.1 TUBING

.1 Processed for refrigeration installations, deoxidized, dehydrated and sealed.

.1 Hard copper: to ASTM B280, type ACR or B.

.2 Annealed copper: to ASTM B280, with minimum wall thickness as per CSA B52 and ASME B31.5.

2.2 FITTINGS

.1 Service: design pressure to suite R410A.

.2 Brazed:

.1 Fittings: wrought copper to ASME B16.22.

.2 Joints: silver solder, 15% Ag-80% Cu-5%P or copper-phosphorous, 95% Cu-5%P and non-corrosive flux.

.3 Flanged:

.1 Bronze or brass, to ASME B16.24, Class 150 and Class 300.

.2 Gaskets: suitable for service.

.3 Bolts, nuts and washers: to ASTM A307, heavy series.

.4 Flared:

.1 Bronze or brass, for refrigeration, to ASME B16.26.

2.3 PIPE SLEEVES

.1 Hard copper or steel, sized to provide 6 mm clearance around between sleeve and uninsulated pipe or between sleeve and insulation.

2.4 VALVES

.1 22 mm and under: Class 500, 3.5 Mpa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moisture proof seal for below freezing applications, brazed connections.

.2 Over 22 mm: Class 375, 2.5 Mpa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and bonnet, moisture proof seal for below freezing applications, brazed connections.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 GENERAL

.1 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5 Section

3.3 BRAZING PROCEDURES

.1 Bleed inert gas into pipe during brazing.

.2 Remove valve internal parts, solenoid valve coils, sight glass.

.3 Do not apply heat near expansion valve and bulb.

3.4 PIPING INSTALLATION

.1 General:

.1 Hard drawn copper tubing: do not bend. Minimize use of fittings.

.2 Hot gas lines:

.1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.

.2 Provide trap at base of risers greater than 2400 mm high and at each 7600 mm thereafter.

.3 Provide inverted deep trap at top of risers.

.4 Provide double risers for compressors having capacity modulation.

.1 Large riser: install traps as specified.

.2 Small riser: size for 5.1 m/s at minimum load. Connect upstream of traps on large riser.

3.5 PRESSURE AND LEAK TESTING

.1 Close valves on factory charged equipment and other equipment not designed for test pressures.

.2 Leak test to CSA B52 before evacuation to 2MPa and 1MPa on high and low sides respectively.

.3 Test Procedure: build pressure up to 35 kPa with refrigerant gas on high and low sides. Supplement with nitrogen to required test pressure. Test for leaks with electronic or halide detector. Repair leaks and repeat tests.

3.6 FIELD QUALITY CONTROL

.1 Site Tests/Inspection:

.1 Close service valves on factory charged equipment.

.2 Ambient temperatures to be at least 13 degrees C for at least 12 hours before and during dehydration.

.3 Use copper lines of largest practical size to reduce evacuation time.

.4 Use two-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5Pa absolute and filled with dehydrated oil.

.5 Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed.

.6 Triple evacuate system components containing gases other than correct refrigerant or having lost holding charge as follows:

.1 Twice to 14 Pa absolute and hold for 4 h.

.2 Break vacuum with refrigerant to 14 kPa.

.3 Final to 5 Pa absolute and hold for at least 12 h.

.4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.

.5 Submit test results to Contract Administrator.

.7 Charging:

.1 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.

.2 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.

.3 Re-purge charging line if refrigerant container is changed during charging process.

.8 Checks:

.1 Make checks and measurements as per manufacturer's operation and maintenance instructions.

.9 Manufacturer's Field Services:

.1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.

.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.7 DEMONSTRATION

.1 Instructions:

.1 Post instructions in frame with glass cover in accordance with Section 01 78 00 - Closeout Submittals and CSA B52.

3.8 CLEANING

.1 Perform cleaning operations in accordance with manufacturer's recommendations.

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and installation of low-pressure metallic ductwork, joints and accessories.

1.2 REFERENCES

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

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

.1 ASTM A480/A480M-03c, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.

.2 ASTM A635/A635M-02, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.

.3 ASTM A653/A653M-03, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

.3 Department of Justice Canada (Jus).

.1 Canadian Environmental Protection Act (CEPA), 1999, c. 33 .

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS).

.1 Material Safety Data Sheets (MSDS).

.5 National Fire Protection Association (NFPA).

.1 NFPA 90A-02, Standard for the Installation of Air-Conditioning and Ventilating Systems.

.2 NFPA 90B-02, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.

.3 NFPA 96-01, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

.6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

.1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2nd Edition 1995 and Addendum No. 1, 1997.

.2 SMACNA HVAC Air Duct Leakage Test Manual, 1985, 1st Edition.

.3 IAQ Guideline for Occupied Buildings Under Construction 1995, 1st Edition.

.7 Transport Canada (TC).

.1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

1.3 QUALITY ASSURANCE

.1 Certification of Ratings:

.1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

Part 2 Products

2.1 SEAL CLASSIFICATION

.1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	C
250	C
125	C

.2 Seal classification:

.1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.

.2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant.

.3 Class C: transverse joints and connections made air tight with gaskets, sealant or combination thereof. Longitudinal seams unsealed.

2.2 SEALANT

.1 Sealant: oil resistant, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

2.3 DUCT LEAKAGE

.1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual.

2.4 FITTINGS

.1 Fabrication: to SMACNA.

.2 Radiused elbows.

.1 Rectangular: standard radius or short radius with single thickness turning vanes. Centreline radius: 1.5 times width of duct.

.2 Round: smooth radius. Centreline radius: 1.5 times diameter.

.3 Mitred elbows, rectangular:

.1 To 400 mm: with single thickness turning vanes.

.2 Over 400 mm: with double thickness turning vanes.

.4 Branches:

.1 Rectangular main and branch: with radius on branch 1.5 times width of duct or 45 degrees entry on branch.

.2 Round main and branch: enter main duct at 45 degrees with conical connection.

.3 Provide volume control damper in branch duct near connection to main duct.

.4 Main duct branches: with splitter damper.

.5 Transitions:

.1 Diverging: 20 degrees maximum included angle.

.2 Converging: 30 degrees maximum included angle.

.6 Offsets:

.1 as indicated.

.7 Obstruction deflectors: maintain full cross-sectional area.

.1 Maximum included angles: as for transitions.

2.5 GALVANIZED STEEL

.1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.

.2 Thickness, fabrication and reinforcement: to SMACNA.

.3 Joints: to SMACNA.

2.6 HANGERS AND SUPPORTS

.1 Hangers and Supports:

.1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.

.1 Maximum size duct supported by strap hanger: 500.

.2 Hanger configuration: to ASHRAE and SMACNA.

.3 Hangers: galvanized steel angle with galvanized steel rods to following table:

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

.4 Upper hanger attachments:

.1 For concrete: manufactured concrete inserts.

.2 For steel joist: manufactured joist clamp.

.3 For steel beams: manufactured beam clamps:

Part 3 Execution

3.1 GENERAL

.1 Do work in accordance with SMACNA as indicated.

.2 Do not break continuity of insulation vapour barrier with hangers or rods.

.1 Ensure diffuser is fully seated.

.3 Support risers in accordance with SMACNA.

.4 Install breakaway joints in ductwork on sides of fire separation.

.5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.

3.2 HANGERS

.1 Strap hangers: install in accordance with SMACNA.

.2 Angle hangers: complete with locking nuts and washers.

.3 Hanger spacing: in accordance with SMACNA:

3.3 WATERTIGHT DUCT

.1 Fit base of riser with 150 mm deep drain sump and 32 mm drain connected, with deep seal trap and discharging to open funnel drain or as indicated.

3.4 SEALING AND TAPING

.1 Apply sealant to outside of joint to manufacturer's recommendations.

3.5 LEAKAGE TESTS

.1 In accordance with SMACNA HVAC Duct Leakage Test Manual.

.2 Do leakage tests in sections.

.3 Make trial leakage tests as instructed to demonstrate workmanship.

.4 Do not install additional ductwork until trial test has been passed.

.5 Complete test before performance insulation or concealment Work.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and installation for duct accessories including flexible connections, access doors, vanes and collars.

1.2 REFERENCES

.1 Health Canada/Workplace Hazardous Materials Information System (WHMIS).

.1 Material Safety Data Sheets (MSDS).

.2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

.1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, [95].

1.3 SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and data sheet. Indicate the following:

.1 Flexible connections.

.2 Duct access doors.

.3 Turning vanes.

.4 Instrument test ports.

Part 2 Products

2.1 GENERAL

.1 Manufacture in accordance with SMACNA - HVAC Duct Construction Standards.

2.2 FLEXIBLE CONNECTIONS

.1 Frame: galvanized sheet metal frame with fabric clenched by means of double locked seams.

.2 Material:

.1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of 1.3 kg/m^2.

2.3 ACCESS DOORS IN DUCTS

.1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.

.2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.

.3 Gaskets: neoprene.

.4 Hardware:

.1 Up to 300 x 300 mm: two sash locks.

.2 301 to 450 mm: four sash locks.

.3 451 to 1000 mm: piano hinge and minimum two sash locks.

.4 Doors over 1000 mm: piano hinge and two handles operable from both sides.

2.4 TURNING VANES

.1 Factory or shop fabricated single thickness with trailing edge, to recommendations of SMACNA.

2.5 SPIN-IN COLLARS

.1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.

.2 Sheet metal thickness to co-responding round duct standards.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Flexible Connections:

.1 Install in following locations:

.1 Inlets and outlets of exhaust air fans.

.2 As indicated.

.2 Length of connection: 100 mm.

.3 Minimum distance between metal parts when system in operation: 75 mm.

.4 Install in accordance with recommendations of SMACNA.

.5 When fan is running:

.1 Ducting on sides of flexible connection to be in alignment.

.2 Ensure slack material in flexible connection.

.2 Access Doors and Viewing Panels:

.1 Locations:

.1 Fire and smoke dampers.

.2 Control dampers.

.3 Devices requiring maintenance.

.4 Required by code.

.5 Reheat coils.

.6 Elsewhere as indicated.

.3 Instrument Test Ports:

.1 General:

.1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.

.2 Locate to permit easy manipulation of instruments.

.3 Install insulation port extensions as required.

.4 Locations:

.1 For traverse readings:

.1 Ducted inlets to roof and wall exhausters.

.2 Inlets and outlets of other fan systems.

.3 Main and sub-main ducts.

.4 And as indicated.

.2 For temperature readings:

.1 At outside air intakes.

.2 At inlet and outlet of coils.

.3 Downstream of junctions of two converging air streams of different temperatures.

.4 And as indicated.

.4 Turning vanes:

.1 Install in accordance with recommendations of SMACNA and as indicated.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Balancing dampers for mechanical forced air ventilation and air conditioning systems.

1.2 REFERENCES

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

.1 SMACNA HVAC Duct Construction Standards, Metal and Flexible-1985.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

.1 Product Data:

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

Part 2 Products

2.1 GENERAL

.1 Manufacture to SMACNA standards.

2.2 SINGLE BLADE DAMPERS

.1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.

.2 Size and configuration to recommendations of SMACNA.

.3 Locking quadrant.

.4 Inside and outside nylon end bearings.

.5 Channel frame of same material as adjacent duct, complete with angle stop.

2.3 MULTI-BLADED DAMPERS

.1 Factory manufactured of material compatible with duct.

.2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.

.3 Bearings: self-lubricating nylon.

.4 Linkage: shaft extension with locking quadrant.

.5 Channel frame of same material as adjacent duct, complete with angle stop.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Install where indicated.

.2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.

.3 Locate balancing dampers in each branch duct, for supply, return and exhaust systems.

.4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.

.5 Dampers: vibration free.

.6 Ensure damper operators are observable and accessible.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Mechanical louvers; intakes; vents; and reinforcement and bracing for air vents, intakes and gooseneck hoods.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)/ National Fire Protection Association (NFPA)

.1 ANSI/NFPA 96-04, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

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

.1 ASTM E90-04, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

.4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

.5 Society of Automotive Engineers (SAE)

1.3 SYSTEM DESCRIPTION

.1 Performance Requirements:

.1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

1.4 SUBMITTALS

.1 Product Data:

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

.2 Indicate following:

.1 Pressure drop.

.2 Face area.

.3 Free area.

Part 2 Products

2.1 FIXED LOUVRES - ALUMINUM

.1 Construction: welded with exposed joints ground flush and smooth.

.2 Material: extruded aluminum alloy.

.3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm.

.4 Frame, head, sill and jamb: 100 mm deep one piece extruded aluminum, minimum 3 mm thick with approved caulking slot, integral to unit.

.5 Mullions: at 1500 mm maximum centres.

.6 Fastenings: stainless steel SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.

.7 Screen: 19 mm intake mesh, 2 mm diameter wire aluminum birdscreen on inside face of louvres in formed U-frame.

.8 Finish: factory applied enamel. Colour: to match existing exterior wall.

.9 Acceptable Product: “E.H. Price” per louver schedule on drawings.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 In accordance with manufacturer's and SMACNA recommendations.

.2 Reinforce and brace as indicated.

.3 Anchor securely into opening. Seal with caulking to ensure weather tightness.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Supply, installations and commissioning of high efficiency condensing boilers as specified herein:

1.2 REFERENCES

.1 American National Standards Institute (ANSI)

.1 ANSI Z21.13-2004/CSA 4.9-2004, Gas-Fired Low-Pressure Steam and Hot Water Boilers.

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

.1 ANSI/ASME Boiler and Pressure Vessel Code, Section IV, 2004.

.3 Canadian Gas Association (CGA)

.1 CAN1-3.1-77(R2001), Industrial and Commercial Gas-Fired Package Boilers.

.2 CAN/CSA-B149.1-05, Natural Gas and Propane Installation Code.

.4 Canadian Standards Association (CSA International)

.1 CSA B51-03, Boiler, Pressure Vessel, and Pressure Piping Code.

.5 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)

.6 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

.1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet for fixtures and equipment. Include product characteristics, performance criteria, and limitations.

.2 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in the Province of Manitoba, Canada.

.2 Indicate the following:

.1 General arrangement showing terminal points, instrumentation test connections.

.2 Clearances for operation, maintenance, servicing, tube cleaning, tube replacement.

.3 Foundations with loadings, anchor bolt arrangements.

.4 Piping hook-ups.

.5 Equipment electrical drawings.

.6 Burners and controls.

.7 All miscellaneous equipment.

.8 Flame safety control system.

.9 Breeching and stack configuration.

.10 Stack emission continuous monitoring system to measure C0, 0, N0x, S0, stack temperature and smoke density of flue gases.

.3 Engineering data to include:

.1 Boiler efficiency at 25%, 50%, 75%, and 100% of design capacity.

.2 Radiant heat loss at 100% design capacity.

Part 2 Products

2.1 GAS FIRED CONDENSING BOILERS (B-1 and B-2)

.1 GENERAL

.1 Each factory packaged low pressure hot water boiler shall be complete with all components, accessories and appurtenances necessary for a complete and operable boiler as hereinafter specified. Each unit shall be furnished factory assembled with required wiring and piping as a self-contained unit. Each unit shall be readily transported and ready for installation.

.2 Each boiler, including pressure vessel, trim, valve trains, burner, control system, and all related components, accessories and appurtenances as herein specified shall all be assembled and furnished by the boiler manufacturer. The boiler manufacturer shall provide unit responsibility for the engineering, coordination, workmanship, performance, warranties, and all field services for each factory packaged boiler as specified herein. The boiler manufacturer shall be fully responsible for all components assembled and furnished by him whether or not they are of his own manufacture.

.2 PERFORMANCE

.1 The minimum capacity of each boiler shall be to produce continuously an output of 712,500 BTU's per hour at the water outlet when fired with an input of 750,000 BTU's per hour. Each boiler shall be capable of operating continuously at rated capacity while maintaining a CSA certified efficiency of 95%. Each boiler shall be capable of operating with a minimum outlet water temperature of 68º F.

.2 Boiler shall comply with ASME Section IV for 80 psig (max 200º F)

.3 Boiler relief valve setting shall be 552 kPa (80 psig).

.4 Boiler outlet water temperature shall be 82° C (180° F) (200º F max).

.5 Boiler inlet water temperature shall be 27° C (80° F).

.6 Boiler design water flow rate shall be 4.7 L/s (75 GPM).

.7 Fuel shall be natural gas with an assumed higher heating value of 1,030 Btu/Cu Ft and an assumed specific gravity of 0.60 (relative to air). Natural gas shall be supplied at a pressure of no less than 3.5 in. w.c. to the inlet gas valve. Maximum inlet gas pressure shall not exceed 14 in. w.c.

.8 Power voltage shall be 120 VAC, 1-phase, 60 hertz. Control voltage shall be 24 VAC (transformer to be supplied by boiler manufacturer). In accordance with American Boiler Manufacturers Association (ABMA), or ANSI Z21.13/CSA 4.9 (gas burning) testing procedures.

.3 BOILER DESIGN

.1 Hot water boiler shall consist of a horizontal, cast aluminum heat exchanger complete with trim, valve trains, burner, and boiler control system. The boiler manufacturer shall fully coordinate the boiler as to the interaction of its elements with the burner and the boiler control system in order to provide the required capacities, efficiencies, and performance as specified.

.2 Boiler heat exchanger shall be cast aluminum, counter-flow design for maximum heat transfer with the multiple sections arranged in a reverse return configuration to assure balanced flow through each section.

.3 Contractor must, when filling the system, verify that the pH level is maintained between 6.0 and 8.5.

.4 All boiler pressure parts shall be constructed in accordance with the latest revision of the ASME Boiler and Pressure Vessel Code, Section IV, and shall be so stamped.

.5 Boiler heat exchanger headers shall be fabricated steel and be completely removable for inspection. Seals shall be EPDM, rated for 400 deg F service. Push nipples or gaskets between the sections are not permitted.

.6 Boiler shall be enclosed with a single wall outer casing. It shall be fabricated from a minimum 16 gauge carbon steel. The front and top wall shall be secured in place with ¼ -20 NC bolts (sheet metal screws are not acceptable).The complete outer casing shall be finished, inside and out, with a powder coat finish. The composite structure of the boiler combustion chamber, insulating air gap and outer casing shall be of such thickness and materials to assure an outer casing temperature of not more than 50^{o}F above ambient temperature when the boiler is operated at full rated load.

.7 An observation port shall be located on the boiler to allow for observation of the burner flame.

.8 Flue gas outlet shall be located on the rear of the boiler. Boiler to be certified for installation with Category IV venting (stack) as defined in NFPA 54 (ANSI Z221), latest edition. Contractor must provide venting (stack) certified for installation on a Category IV appliance.

.4 BOILER CONNECTIONS

.1 Boiler shall be provided with all necessary inlet and outlet connections. Boiler connections shall be as follows:

.1 One (1) water supply outlet, 50mm (2”) Victaulic with threaded pipe adapter.

.2 One (1) water return inlet, 50mm (2”) Victaulic with threaded pipe adapter.

.3 One (1) relief valve outlet, 25mm (1”) NPT.

.4 One (1) flue gas vent outlet, 150mm (6”) diameter.

.5 One (1) fuel gas inlet, 25mm (1”) size, FPT.

.5 BOILER TRIM

.1 Boiler shall be provided with all necessary trim. Boiler trim shall be as follows:

.1 Safety relief valve shall be provided in compliance with the ASME code. Contractor to pipe to acceptable drain.

.2 Water pressure-temperature gauge.

.3 Primary low water flow fuel cutoff (probe type with manual reset).

.4 Manual reset high limit water temperature controller.

.5 Operating temperature control to control the sequential operation of the burner.

.6 Separate inlet and outlet water temperature sensors capable of monitoring flow.

.7 Exhaust temperature sensor.

.8 A secondary float type low water cut off shall be supplied by contractor.

.6 BOILER FUEL BURNING SYSTEM

.1 The boiler manufacturer shall furnish each boiler with an integral, power type, straight gas, fully automatic fuel burner. The fuel burner shall be an assembly of gas burner, combustion air blower, valve train, and ignition system. The burner manufacturer shall fully coordinate the burner as to the interaction of its elements with the boiler heat exchanger and the boiler control system in order to provide the required capacities, efficiencies, and performance as specified.

.2 Each burner shall be provided with an integral gas firing combustion head.

.3 Each burner shall provide adequate turbulence and mixing to achieve proper combustion without producing smoke or producing combustibles in the flue gases.

.4 Each boiler shall be provided with an integral variable speed power blower to premix combustion air and fuel within the blower. The combustion air blower shall have sufficient capacity at the rated firing rate to provide air for stoichiometric combustion plus the necessary excess air. Static and total pressure capability shall comply with the requirements of the boiler. The blower shall be a maximum of 300 watts and operate at 6000 RPM maximum without undue vibration and noise and shall be designed and constructed for exposure to temperatures normal to its location on the boiler. The operating fan speed will be tachometer sensed and be capable of being displayed at the LED display.

.5 Each burner shall of the radial-fired (down-fired) type and constructed of steel with a stainless steel inner and stainless steel mesh outer screen.

.6 Each boiler shall be provided with a “Full Modulating” firing control system whereby the firing rate is infinitely proportional at any firing rate between 20% and 100% as determined by the pulse width modulation input control signal. Both fuel input and air input must be sequenced in unison to the appropriate firing rate without the use of mechanical linkage.

.7 The Micro Processor shall use a Proportional Integral Algorithm to determine the firing rate. The control must have the following capabilities:

.1 Maintain single set point

.2 Reset the set point based on outdoor air temperature.

.3 Boiler shutdown based on outdoor air temperature

.4 Internal dual set point program with an external switchover. (e.g. - night setback w/external clock, supplied by others)

.5 Alarm relay for any for any manual reset alarm function.

.6 Programmable Low Fire Delay to prevent short cycling based on a time and temperature factor for release to modulation.

.7 LED Display showing current supply and return temperatures, current set points as well as differential set points. It must also display any fault codes whether automatically reset or manually reset.

.8 Local Manual Operation.

.9 Remote Control System (Building Management / Sequencer Control) - The boiler control shall be capable of accepting a 0 -10vdc remote external analog signal to control the firing rate

.10 On board Domestic Hot Water Priority capable of changing from the heating pump to the DHW pump as well as changing the boiler set point from a heating temperature to a higher set point temperature to satisfy the DHW system and then return to the heating mode.

.11 Computer (PC) interface for programming and monitoring all functions

.7 MAIN GAS VALVE TRAIN

.1 Each boiler shall be provided with an integral main gas valve train. The main gas valve trains shall be factory assembled, piped, and wired. Each gas valve train shall include at least the following:

.1 Two (2) manual shutoff valves.

.2 Two (2) safety shutoff valves. Valves equipped with dual solenoids that can independently energized for leak testing.

.3 Air – Gas ratio control (maximum inlet pressure 14 in. w.c.).

.4 One (1) low gas pressure switch (manual reset).

.5 One (1) high gas pressure switch (manual reset).

.6 Two (2) pressure test ports

.8 IGNITION SYSTEM

.1 Boiler shall be equipped for direct spark ignition

.9 COMBUSTION AIR CONTROL SYSTEM

.1 Boiler shall be provided with an integral combustion air control system. The combustion air system shall be factory assembled. Each combustion air control system shall include at least the following:

.1 The primary control shall vary the speed of the blower based on load demand. The blower shall apply a varying negative pressure on the gas valve which will open or close to maintain zero pressure at the valve orifice, thereby increasing or decreasing the firing rate. Both the air and gas shall be premixed in the blower.

.2 One (1) low airflow differential pressure switch to insure that combustion air is supplied.

.3 High exhaust back pressure switch

.10 BURNER CONTROL SYSTEM

.1 The control system shall be supplied with a 24 VAC transformer (120 VAC, single phase, 60 hertz primary). The 120/1/60 power supply to each boiler shall be protected by a 15 Amp circuit breaker located in the MCC (supplied by contractor).

.2 The boiler shall include an electric spark ignition system. Main flame shall be monitored and controlled by flame rod (rectification) system.

.3 Each boiler shall be provided with all necessary controls, all necessary programming sequences, and all safety interlocks. Each boiler control system shall be properly interlocked with all safeties.

.4 Each boiler control system shall provide timed sequence pre-ignition air purge of boiler combustion chamber. The combustion airflow sensor shall monitor and prove the airflow purge.

.11 BOILER CONTROL PANEL

.1 The boiler manufacturer shall provide each boiler with an integral factory pre-wired control panel. The control panel shall contain at least the following components, all pre-wired to a numbered terminal strip:

.1 One (1) burner "on-off" switch.

.2 One (1) electronic combination temperature control, flame safeguard and system control.

.3 Control circuit breaker, 5 Amp.

.4 All necessary control switches, pushbuttons, relays, timers, terminal strips, etc.

.5 LED Display Panel to adjust set points and control operating parameters. LED display to indicate burner sequence, all service codes (0-65), fan speed, boiler set point, sensor values such as inlet, outlet, flue gas and outdoor air.

.12 FACTORY TESTING – HYDROSTATIC

.1 Boiler shall be hydrostatically tested and bear the ASME "H" stamp.

.13 FACTORY TESTING - FIRE TESTING

.1 Boiler shall be fire tested. The boiler manufacturer shall perform this fire test under simulated operating conditions, with the boiler attached to a working chimney system and with water circulating through the boiler. The manufacturer shall provide a fire test report, including fuel and air settings and combustion test results permanently affixed to the boiler.

.14 Dimensions: 711mm W x 1082mm L x 1387mm H (28" Wx 42 5/8" L x 54 5/8" H) Dimensions shall not be exceeded.

.15 Operating Weight: 315 kg (695 lbs.)

.16 Provide condensate neutralizer kit.

.17 Acceptable Product: "Patterson-Kelley" Model: C-750.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Install in accordance with ANSI/ASME Boiler and Pressure Vessels Code Section IV, regulations of Province having jurisdiction, except where specified otherwise, and manufacturers recommendations.

.2 Make required piping connections to inlets and outlets recommended by boiler manufacturer.

.3 Maintain clearances as indicated or if not indicated, as recommended by manufacturer for operation, servicing and maintenance without disruption of operation of any other equipment/system.

.4 Mount unit level.

.5 Natural gas fired installations - in accordance with CAN/CSA-B149.1.

.6 Pipe condensate through the neutralizer to the drain.

3.3 MOUNTINGS AND ACCESSORIES

.1 Safety valves and relief valves:

.1 Run separate discharge from each valve.

.2 Terminate discharge pipe as indicated.

.3 Run drain pipe from each valve outlet and drip pan elbow to above nearest drain.

.2 Blowdown valves:

.1 Run discharge to terminate as indicated.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Supply, install, and commission air handling unit as specified herein.

1.2 REFERENCES

.1 American National Standards Institute/Air-Conditioning and Refrigeration Institute (ANSI/ARI)

.1 ANSI/ARI 430-99, Central Station Air Handling Units.

.2 Canadian General Standards Board (CGSB)

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

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with CWSCS.

.2 Indicate following: fan, motor drive, voltage, dimensions, total cooling, sensible cooling; include performance data.

1.4 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 EXTRA MATERIALS

.1 Provide list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

.2 Spare filters: in addition to filters installed immediately prior to acceptance by Contract Administrator, supply 5 complete sets of filters for each filter unit or filter bank.

Part 2 Products

2.1 SPLIT SYSTEM AIR HANDLING UNIT (AHU-3 / CU-3)

.1 AIR HANDLING UNIT AHU-3:

.1 Factory assembled, split-system air handling unit. Contained within the unit enclosure shall be supply fan, return fan, coils, filters and dampers.

.2 The unit shall be controlled by a DDC System per Section 230933.

.2 Unit Cabinet:

.1 Unit casing shall be of minimum 18 gauge (1.3mm) satin coat galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two-part acid based etching primer.

Finish coat shall be an electrostatically applied enamel, to all exposed surfaces. All unprotected metal and welds shall be factory coated.

.2 All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and on all outdoor units roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.

.3 Units shall be provided with access doors to the following components: fans and motors, filters, dampers and operators, access plenums, electrical control panels, burner compressor compartments. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.

.4 All units shall be internally insulated with 1"(25mm) thick 1 1/2 lb./cu.ft. (24 kg./cu.m.) density, neoprene coated fibre glass thermal insulation. 1 1/2 lb./cu.ft. (24 kg/cu.m.)insulation shall be secured to metal panels with a fire retardant adhesive and welded steel pins at 16" (400mm) o/c. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges. Drain pans and all floor areas shall be insulated on the underside.

.5 Cooling coil drain pans shall be fabricated of stainless steel and are an integral part of the floor paneling, a minimum of 2" (51mm) deep, with welded corners. Drain pans shall extend a minimum of 6" (152mm) downstream of coil face and be provided with a 1 ½" (38mm) S.S. M.P.T. drain connection. Drain pans must have a fast pan and be sloped and pitched such that there is no standing water. Intermediate fast pans shall be provided between cooling coils where required for effective moisture removal.

.3 Fans:

.1 Centrifugal fans shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be selected for stable operation at least 20% below the first critical RPM. Fan shafts shall be provided with a rust inhibiting coating.

.2 Single low pressure forward curved fans shall be equipped with greaseable pillow block bearings, supported on a rigid structural steel frame.

.3 Provide full section return air fan(s) as scheduled. The use of power exhaust propeller or centrifugal fan arrangements will not be considered.

.1 Allow provisions for variable air volume fan control via adjustable frequency drive (supplied and mounted by others).

.4 Motor, fan bearings and drive assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly, where required. Motor mounting shall be adjustable to allow for variations in belt tension.

.5 Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor, which is welded to the structural frame of the unit. The isolators shall be neoprene-in-shear type for single 9" (230mm) to 15" (380mm) diameters forward curve fans. All other fans shall incorporate vertical spring type isolators with leveling bolts, bridge bearing waffled pads with minimum 1" (25mm) static deflection designed to achieve high isolation efficiency. Fans shall be attached to the discharge

panel by a polyvinyl chloride coated polyester woven fabric, with a sealed double locking fabric to metal connection.

.6 Fan motors shall be ODP super high efficiency type. The motors shall be inverter duty rated suitable for VFD operation.

.4 Coils:

.1 Coils shall be 5/8" or 1/2" O.D. as manufactured by Engineered Air.

.2 Fins constructed of aluminum or copper shall be rippled for maximum heat transfer and shall be mechanically bonded to the tubes by mechanical expansion of the tubes. The coils shall have a galvanized steel casing. All coils shall be factory tested with air at 300 psig (2070 kPa) while immersed in an illuminated water tank.

.3 Refrigerant evaporator type coils shall be equipped with distributors connected to the coil by copper tubes. Where a hot gas bypass is required, the inlet shall be at the refrigerant distributor. Solenoid valves, expansion valves, and related accessories are to be provided and installed by the refrigeration contractor.

.4 Refrigerant coils with multiple compressors shall be alternate tube circuited in order to distribute the cooling effect over the entire coil face at reduced load conditions. Provision for use of thermal expansion valves must be included for variable air volume and/or make-up air applications.

.5 Dampers:

.1 Damper frames shall be U - shaped galvanized metal sections securely screwed or welded to the air handling unit chassis. Pivot rods of 1/2" (13mm) aluminum shall turn in nylon or bronze bushings. Rods shall be secured to the blade by means of straps and set screws.

.2 Blades shall be 18 gauge (1.3mm) galvanized metal with two breaks on each edge and three breaks on centerline for rigidity. The pivot rod shall "nest" in the centerline break. Damper edges shall interlock. Maximum length of damper between supports shall be 48"(1219 mm). Damper linkage brackets shall be constructed of galvanized metal.

.3 Dampers shall include blade ends sealed with an adhesive backed foamed polyurethane gasketting. Outdoor air dampers also include an all weather PVC seal fastened with a positive lock grip and pliable overlap edge on entering air side of interlocking edges. Dampers are interlocked from the center.

.4 Mixing dampers shall be parallel blade type.

.5 Damper actuators and control by section 230933.

.6 Filter Section:

.1 Factory-installed, low velocity, throwaway 50mm (2") thick fibreglass filters, commercially available sizes, use one size filter.

.2 Filter face velocity shall not exceed 1.6 m/s (320 FPM) at nominal airflows.

.3 Filters shall be accessible through access panel with "no-tool" removal.

.7 Factory/Field Supplied Controls

.1 Provide a system of motor control include terminal blocks for wiring of remote VFDs (VFD's supplied by division 26). VFDs shall be powered from the air handling unit (wiring to and from the VFD to the air handling unit is by division 26). VFDs are controlled by section 230933.

.2 Fire alarm circuits (where required) shall be powered from a relay in unit circuitry.

.3 Automatic controls shall be housed in a control panel mounted in or on the air handling unit, which will meet that standard of the specific installation.

.8 ROOF MOUNTED REMOTE CONDENSING UNIT (CU-3)

.1 Compressors shall be hermetic type, 3600 RPM, set on resilient neoprene mounts and complete with line voltage break internal overload protection, internal pressure relief valve and crankcase heater.

.2 Air Cooled Condenser

.1 Condenser coils shall be copper tube type, mechanically expanded into aluminum fins. Coils shall be factory tested with air at 300 psig (2070 kPa) while immersed in an illuminated water tank.

.2 Condenser fans shall be direct driven propeller type arranged for vertical draw through airflow. Motors shall be weather resistant type, with integral overload protection and designed for vertical shaft condenser fan applications. Fan and motor assemblies shall be mounted on a formed orifice plate for optimum efficiency with minimum noise level.

.3 Condenser to form an integral part of the unit.

.3 Split System Condensing Units

.1 Condensing units shall be $_{C}$ETL approved. Condensing units shall be designed for a minimum of 15°F(8°C) liquid subcooling. Condensing units shall operate down to 50°F(10°C) as standard. Multiple compressor/condenser circuits shall be separate from each other. Suction and liquid lines shall be extended to the outside of the cabinet. Service ports fitted with Schraeder fittings shall be connected to the suction and discharge lines for charging or pressure gauge readings. Semi-hermetic units shall also incorporate liquid line service ports and liquid line manual shutoff valves.

.2 Controls for hermetic compressor units shall include compressor and condenser fan motor contactors, control circuit transformer, cooling relays, non-recycling pumpdown relays, ambient compressor lockout, manual reset high pressure controls and automatic reset low pressure controls. Head pressure actuated fan cycling control shall be provided on all multiple condenser fan units.

.3 Provide five minute anti-cycle timers.

.4 Provide interstage time delay timers.

.5 Provide hot gas bypass connection on the lead compressor.

.6 Refrigeration specialties such as solenoid valves, TX valves, etc., to be supplied and installed by refrigeration contractor.

.9 Operating Characteristics:

.1 Unit shall be capable of starting and running at 52ºC ambient outdoor temperature, meeting maximum load criteria of ARI Standard 210/240 or 360 at ±10% voltage.

.10 Electrical:

.1 Unit voltage shall be 575V/3Ph/60Hz single point connection.

.11 Motors:

.1 Compressor Motors: cooled by refrigerant gas passing through motor windings, line break thermal and current overload protection.

.2 Totally-enclosed Condenser-fan Motor: permanently lubricated bearings, inherent automatic-reset thermal overload protection.

.12 Controls:

.1 Two stages of DX cooling controlled through the DDC system by section 230933.

.13 Air Handling Unit Schedule:

AIR HANDLING UNIT SCHEDULE		
FAN NO.		AHU-3 / CU-3
SERVICE		
MANUFACTURER		Engineered Air
MODEL		LM8/C
SUPPLY	L/S (CFM):	3398 (7,200)
	ESP (“WC):	1
	MOTOR (HP):	7.5
	BLOWER:	18/18
	BLOWER SPEED (RPM):	919
RETURN	L/S (CFM):	3398 (7,200)
	ESP (“WC):	0.5
	MOTOR (HP):	5
	BLOWER:	18/18
	BLOWER SPEED (RPM):	712
COOLING	EAT (DB/WB):	26.6/19.4°C (80/67°F)
	LAT (DB/WB):	14.8/14.1°C (58.7/57.4°F)
	TOTAL:	65 kW (222.8 MBH)
	SUCTION (°F):	9.05°C (48.3°F)
HEATING	EAT (DB):	12.7°C (55°F)
	LAT (DB):	38°C (100°F)
	TOTAL (BTU/H):	103 kW (352 MBH)
	Fluid:	50% Prop. Glycol
	EFT:	82.2 °C (180 °F)
	LFT:	59.2 °C (138.5 °F)
	Flow rate:	1.19 L/s (18.9 gpm)
	Pressure Drop:	11.3 kPa (3.8 ft)
Balance with Condenser Model:		CUEB182
Dimensions:		1244mm x 1752mm x 5105 mm (49” x 69” x 201”)
Weight:		1360 kg (3,000 lbs.)
		Dimensions and weight shall not be exceeded.

2.2 PACKAGED AIR HANDLING UNIT (AHU-4)

.1 General:

.1 Factory assembled, single-piece roof mounted air handling unit c/w supply fan, return fan, coils, and dampers. Contained within the unit shall be a condensing unit with all factory wiring, piping, controls, and refrigerant charge (R-410A) and special features required prior to field start-up.

.2 The unit shall be controlled by a DDC System per Section 230933.

.2 Unit Cabinet:

.1 Unit casing shall be of minimum 18 gauge (1.3mm) satin coat galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two-part acid based etching primer. Finish coat shall be an electrostatically applied enamel, to all exposed surfaces. All unprotected metal and welds shall be factory coated.

.2 All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and on all outdoor units roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.

.3 Units shall be provided with access doors to the following components: fans and motors, filters, dampers and operators, access plenums, electrical control panels, burner compressor compartments. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.

.4 All units shall be internally insulated with 1"(25mm) thick 1 1/2 lb./cu.ft. (24 kg./cu.m.) density, neoprene coated fibre glass thermal insulation.

.5 1 1/2 lb./cu.ft. (24 kg/cu.m.)insulation shall be secured to metal panels with a fire retardant adhesive and welded steel pins at 16" (400mm) o/c. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges. Drain pans and all floor areas shall be insulated on the underside.

.6 Cooling coil drain pans shall be fabricated of stainless steel and are an integral part of the floor paneling, a minimum of 2" (51mm) deep, with welded corners. Drain pans shall extend a minimum of 6" (152mm) downstream of coil face and be provided with a 1 ½" (38mm) S.S. M.P.T. drain connection. Drain pans must have a fast pan and be sloped and pitched such that there is no standing water. Intermediate fast pans shall be provided between cooling coils where required for effective moisture removal.

.7 Provide a full height, insulated piping vestibule integral to the unit casing.

.8 Air handling units shall be weatherproofed and equipped for installation outdoors. This shall include generally for the prevention of infiltration of rain and snow into the unit, louvers or hoods on air intakes and exhaust openings with 1"(25mm) galvanized inlet screens; rain gutters or diverters over all access doors; all joints caulked with a water resistant sealant; roof joints turned up 2" (51mm) with three break interlocking design; outer wall panels extend a minimum of ¼”(6mm) below the floor panel; drain trap(s) connections for field supply and installation of drain traps.

Units mounted on roof curbs incorporate welded floor to base construction. Floors are of three break upstanding design with welded corners and free of penetrations. Unit underside joints are caulked.

.9 Provide full perimeter roof mounting curb of heavy gauge sheet metal, minimum of 12”(305mm) high, and complete with wood nailer, neoprene sealing strip, and fully welded "Z" bar with 1" (25mm) upturn on inner perimeter, to provide a complete seal against the elements. External insulation of the roof-mounting curb shall be provided by the Roofing Subcontractor. Hydronic heating coil piping vestibule shall be incorporated into the design of the roof curb.

.3 Fans:

.1 Centrifugal fans shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be selected for stable operation at least 20% below the first critical RPM. Fan shafts shall be provided with a rust inhibiting coating.

.2 Single low pressure forward curved fans shall be equipped with greaseable pillow block bearings, supported on a rigid structural steel frame.

.3 Provide full section return air fan(s) as scheduled. The use of power exhaust propeller or centrifugal fan arrangements will not be considered.

.1 Allow provisions for variable air volume fan control via adjustable frequency drive (supplied and mounted by division 26).

.2 Line and load reactors required for 575 volt applications (by division 26).

.4 Minimum air flow rate of 40% on DX.

.5 Motor, fan bearings and drive assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly, where required. Motor mounting shall be adjustable to allow for variations in belt tension.

.6 Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor, which is welded to the structural frame of the unit. The isolators shall be neoprene-in-shear type for single 9" (230mm) to 15" (380mm) diameters forward curve fans. All other fans shall incorporate vertical spring type isolators with leveling bolts, bridge bearing waffled pads with minimum 1" (25mm) static deflection designed to achieve high isolation efficiency. Fans shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric, with a sealed double locking fabric to metal connection.

.7 Fan motors shall be inverter duty rated ODP super high efficiency type.

.4 COILS

.1 Coils shall be 5/8” or 1/2" O.D. as manufactured by Engineered Air.

.2 Fins constructed of aluminum or copper shall be rippled for maximum heat transfer and shall be mechanically bonded to the tubes by mechanical expansion of the tubes. The coils shall have a galvanized steel casing. All

coils shall be factory tested with air at 300 psig (2070 kPa) while immersed in an illuminated water tank.

.3 Refrigerant evaporator type coils shall be equipped with distributors connected to the coil by copper tubes. Where a hot gas bypass is required, the inlet shall be at the refrigerant distributor. Solenoid valves, expansion valves, and related accessories are to be provided and installed by the refrigeration contractor.

.4 Refrigerant coils with multiple compressors shall be alternate tube circuited in order to distribute the cooling effect over the entire coil face at reduced load conditions. Provision for use of thermal expansion valves must be included for variable air volume and/or make-up air applications.

.5 DAMPERS

.1 Damper frames shall be U - shaped galvanized metal sections securely screwed or welded to the air handling unit chassis. Pivot rods of 1/2" (13mm) aluminum shall turn in nylon or bronze bushings. Rods shall be secured to the blade by means of straps and set screws.

.2 Blades shall be 18 gauge (1.3mm) galvanized metal with two breaks on each edge and three breaks on centerline for rigidity. The pivot rod shall "nest" in the centerline break. Damper edges shall interlock. Maximum length of damper between supports shall be 48”(1219 mm). Damper linkage brackets shall be constructed of galvanized metal.

.3 Dampers shall include blade ends sealed with an adhesive backed foamed polyurethane gasketting. Outdoor air dampers also include an all weather PVC seal fastened with a positive lock grip and pliable overlap edge on entering air side of interlocking edges. Dampers are interlocked from the center.

.4 Mixing dampers shall be parallel blade type.

.5 Gravity relief dampers shall be single blade gasketted design.

.6 Filter Section:

.1 Factory-installed, low velocity, throwaway 50mm (2”) thick fibreglass filters, commercially available sizes, use one size filter.

.2 Filter face velocity shall not exceed 1.6 m/s (320 FPM) at nominal airflows.

.3 Filters shall be accessible through access panel with “no-tool” removal.

.7 MECHANICAL COOLING

.1 Compressors shall be hermetic type, 3600 RPM, set on resilient neoprene mounts and complete with line voltage break internal overload protection, internal pressure relief valve and crankcase heater.

.2 Air Cooled Condenser

.1 Condenser coils shall be copper tube type, mechanically expanded into aluminum fins. Coils shall be factory tested with air at 300 psig (2070 kPa) while immersed in an illuminated water tank.

.2 Condenser fans shall be direct driven propeller type arranged for vertical draw through airflow. Motors shall be weather resistant type, with integral overload protection and designed for vertical shaft condenser fan applications. Fan and motor assemblies shall be

mounted on a formed orifice plate for optimum efficiency with minimum noise level.

.3 Condenser to form an integral part of the unit.

.3 Packaged Air Conditioning Units

.1 Packaged units shall be $_{C}$ETL, ETL$_{US}$ approved and operate down to 50°F(10°C) as standard. Where applicable, multiple refrigeration circuits shall be separate from each other. Refrigeration circuits shall be complete with liquid line filter-driers, and service ports fitted with Schraeder fittings. Units with over 6 Ton hermetic compressors shall also incorporate load compensated thermal expansion valves with external equalizers and combination sight glass moisture indicators. The complete piping system shall be purged and pressure tested with dry nitrogen, then tested again under vacuum. Each system shall be factory run and adjusted prior to shipment.

.2 Packaged units shall be supplied with R-410a refrigerant.

.3 Controls for hermetic compressor units shall include compressor and condenser fan motor contactors, supply fan contactors and overload protection, control circuit transformer, cooling relays, ambient compressor lockout, automatic reset low pressure controls, and manual reset high pressure controls on compressors over 6 tons. Head pressure actuated fan cycling control shall be provided on all multiple condenser fan units.

.4 Provide hot gas bypass on the lead compressor to maintain adequate suction pressure in the event of low loads.

.5 Compressors shall be located on the side of the unit in a service enclosure complete with hinged access doors.

.8 FACTORY/FIELD SUPPLIED CONTROLS

.1 Provide a system of motor control include terminal blocks for wiring of remote VFDs. VFD's supplied by division 26. VFDs shall be powered from the air handling unit (wiring to and from the VFD to the air handling unit is by division 26). VFDs are controlled by section 230933.

.2 Fire alarm circuits shall be powered from a relay in unit circuitry.

.3 Automatic controls shall be housed in a control panel mounted in or on the air handling unit, which will meet that standard of the specific installation.

.4 Modulating damper operator shall be installed by the manufacturer and controlled by section 230933.

.5 Three stages of DX cooling controlled through the DDC system by section 230933.

.9 Electrical:

.1 Unit voltage shall be 575V/3Ph/60Hz single point connection.

.10 Air Handling Unit Schedule:

AIR HANDLING UNIT SCHEDULE		
FAN NO.		AHU-4
SERVICE		
MANUFACTURER		Engineered Air
MODEL		FWEA163/C/O
SUPPLY	L/S (CFM):	2832 (6,000)
	ESP (“WC):	1
	MOTOR (HP):	7.5
	BLOWER:	15/15
	BLOWER SPEED (RPM):	1121
RETURN	L/S (CFM):	2832 (6,000)
	ESP (“WC):	0.5
	MOTOR (HP):	5
	BLOWER:	15/15
	BLOWER SPEED (RPM):	837
COOLING	EAT (DB/WB):	26.6/19.4°C (80/67°F)
	LAT (DB/WB):	13.8/13.6°C (56.9/56.5°F)
	Total Capacity:	61.44 kW (209.7 MBH)
	SUCTION:	10.5°C (51°F)
HEATING	EAT (DB):	12.7°C (55°F)
	LAT (DB):	29.4°C (85°F)
	Total Capacity:	61.2kW (210.6 MBH)
	Fluid:	50% Prop. Glycol
	EFT:	82.2 °C (180 °F)
	LFT:	70.2 °C (158.3 °F)
	Flow rate:	1.36 L/s (21.6 gpm)
	Pressure Drop:	12.3 kPa (4.1 ft)
		Packaged Unit
	Dimensions:	1219mm x 1880mm x 1570mm (48” x 74” x 226”)
	Weight:	5,000 lbs
		Dimensions and weight shall not be exceeded.

Part 3 Execution

3.1 INSTALLATION

.1 Provide appropriate protection apparatus.

.2 Install units in accordance with manufacturer's instructions and as indicated.

.3 Ensure adequate clearance for servicing and maintenance.

3.2 FANS

.1 Provide fan sheaves required for final air balance.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and installation for reheat coil units.

1.2 SUBMITTALS

.1 Product Data:

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

.2 Shop Drawings:

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

Part 2 Products

2.1 REHEAT COILS

.1 Reheat coil, 5/8” (16 mm) tube size outer dimensions, 50% propylene glycol fluid, 82.2 degree C (180 degree F) entering fluid temperature, 60 degree C (140 degree F) leaving fluid temperature, fluid inlet and outlet connections are located on the same end.

.2 Acceptable Product: “Engineered Air” per reheat coil schedule.

.3 Reheat Coil Schedule

Tag	RHC 3-1	RHC 3-2	RHC 3-3	RHC 3-4
Coil Size, in. (H x L x R x FPI)	21 x 30 x 1 / 10	12 x 15 x 3 / 12	18 x 21 x 1 / 12	12 x 15 x 3 / 8
Coil Size, mm (H x L x R x FPI)	532 x 762 x 1 / 10	304 x 381 x 3 / 12	456 x 533.5 x 1 / 12	304 x 381 x 3 / 8
Pass-Circ-Blank	6-2-2	12-2-0	12-1-0	12-2-0
Header Size, in. (mm)	0.75 (19)	0.75 (19)	0 (0)	0.75 (19)
Total Capacity, MBH (kw)	32.4 (9.49)	22.88 (6.7)	37.26 (10.92)	18.09 (5.3)
Sensible Capacity, MBH (kw)	32.4 (9.49)	22.88 (6.7)	37.26 (10.92)	18.09 (5.3)
Air Flow, CFM (l/s)	2000 (944.0)	400 (188.8)	1200 (566.4)	400 (188.8)
Air EDBT, °F (°C)	65.0 (18.3)	65.0 (18.3)	65.0 (18.3)	65.0 (18.3)
Air EWBT, °F (°C)	-	-	-	-
Air LDBT, °F (°C)	80.0 (26.7)	118.0 (47.8)	93.8 (34.3)	106.9 (41.6)
Air LWBT, °F (°C)	-	-	-	-

REHEAT COILS

Tag	RHC 3-1	RHC 3-2	RHC 3-3	RHC 3-4
Leaving Coil Velocity, AFPM (m/s)	478 (2.43)	358 (1.82)	490 (2.49)	351 (1.79)
Coil Pressure Drop, in.wc. (Pa)	0.09 (23.2)	0.18 (45.7)	0.11 (26.4)	0.14 (34.0)
Entering Temperature, °F (°C)	180.0 (82.2)	180.0 (82.2)	180.0 (82.2)	180.0 (82.2)
Leaving Temperature, °F (°C)	140.0 (60.0)	140.8 (60.5)	140.5 (60.3)	139.8 (59.9)
Flow Rate, GPM (l/s)	1.8 (0.114)	1.3 (0.082)	2.1 (0.132)	1.0 (0.063)
Tube Velocity, FPS (m/s)	1.0 (0.30)	0.7 (0.22)	2.3 (0.70)	0.5 (0.17)
Pressure Drop, ft.wc. (kPa)	0.8 (2.2)	0.7 (2.0)	1.6 (4.8)	0.6 (1.8)

Tag	RHC 3-5	RHC 3-6	RHC 3-7	RHC 3-8
Coil Size, in. (H x L x R x FPI)	12 x 22 x 1 / 12	9 x 15 x 2 / 8	18 x 25 x 2 / 10	12 x 15 x 3 / 12
Coil Size, mm (H x L x R x FPI)	304 x 558.75 x 1 / 12	228 x 381 x 2 / 8	456 x 635 x 2 / 10	304 x 381 x 3 / 12
Pass-Circ-Blank	8-1-0	10-1-2	8-3-0	12-2-0
Header Size, in. (mm)	0.75 (19)	0.75 (19)	0.75 (19)	0.75 (19)
Total Capacity, MBH (kw)	18.23 (5.34)	8.84 (2.59)	60.75 (17.8)	22.88 (6.7)
Sensible Capacity, MBH (kw)	18.23 (5.34)	8.84 (2.59)	60.75 (17.8)	22.88 (6.7)
Air Flow, CFM (l/s)	800 (377.6)	400 (188.8)	1600 (755.2)	400 (188.8)
Air EDBT, °F (°C)	65.0 (18.3)	65.0 (18.3)	65.0 (18.3)	65.0 (18.3)
Air EWBT, °F (°C)	-	-	-	-
Air LDBT, °F (°C)	86.1 (30.1)	85.5 (29.7)	100.2 (37.9)	118.0 (47.8)
Air LWBT, °F (°C)	-	-	-	-
Leaving Coil Velocity, AFPM (m/s)	462 (2.35)	451 (2.29)	556 (2.82)	358 (1.82)
Coil Pressure Drop, in.wc. (Pa)	0.10 (24.3)	0.14 (35.0)	0.23 (56.6)	0.18 (45.7)
Entering Temperature, °F (°C)	180.0 (82.2)	180.0 (82.2)	180.0 (82.2)	180.0 (82.2)
Leaving Temperature, °F (°C)	139.5 (59.7)	140.7 (60.4)	141.4 (60.8)	140.8 (60.5)
Flow Rate, GPM (l/s)	1.0 (0.063)	0.5 (0.032)	3.5 (0.221)	1.3 (0.082)
Tube Velocity, FPS (m/s)	1.1 (0.33)	0.5 (0.17)	1.3 (0.39)	0.7 (0.22)
Pressure Drop, ft.wc. (kPa)	0.8 (2.2)	0.6 (1.7)	1.1 (3.3)	0.7 (2.0)

REHEAT COILS

Tag	**RHC 4-1**	**RHC 4-2**	**RHC 4-3**	**RHC 4-4**
Coil Size, in. (H x L x R x FPI)	10.5 x 22 x 2 / 12	18 x 25 x 2 / 8	22.5 x 30 x 2 / 12	18 x 21 x 2 / 12
Coil Size, mm (H x L x R x FPI)	266 x 558.75 x 2 / 12	456 x 635 x 2 / 8	570 x 762 x 2 / 12	456 x 533.5 x 2 / 12
Pass-Circ-Blank	10-1-4	8-3-0	6-5-0	8-3-0
Header Size, in. (mm)	0.75 (19)	0.75 (19)	0.75 (19)	0.75 (19)
Total Capacity, MBH (kw)	28.89 (8.46)	46.71 (13.69)	59.06 (17.31)	43.94 (12.88)
Sensible Capacity, MBH (kw)	28.89 (8.46)	46.71 (13.69)	59.06 (17.31)	43.94 (12.88)
Air Flow, CFM (l/s)	800 (377.6)	1600 (755.2)	2000 (944.0)	1200 (566.4)
Air EDBT, °F (°C)	65.0 (18.3)	65.0 (18.3)	65.0 (18.3)	65.0 (18.3)
Air EWBT, °F (°C)	-	-	-	-
Air LDBT, °F (°C)	98.4 (36.9)	92.0 (33.4)	92.3 (33.5)	98.9 (37.2)
Air LWBT, °F (°C)	-	-	-	-
Leaving Coil Velocity, AFPM (m/s)	540 (2.74)	548 (2.78)	457 (2.32)	495 (2.51)
Coil Pressure Drop, in.wc. (Pa)	0.25 (61.0)	0.19 (47.5)	0.19 (46.9)	0.21 (52.8)
Entering Temperature, °F (°C)	180.0 (82.2)	180.0 (82.2)	180.0 (82.2)	180.0 (82.2)
Leaving Temperature, °F (°C)	139.8 (59.9)	140.0 (60.0)	138.9 (59.4)	140.9 (60.5)
Flow Rate, GPM (l/s)	1.6 (0.101)	2.6 (0.164)	3.2 (0.202)	2.5 (0.158)
Tube Velocity, FPS (m/s)	1.7 (0.53)	0.9 (0.29)	0.7 (0.21)	0.9 (0.28)
Pressure Drop, ft.wc. (kPa)	1.4 (4.2)	0.8 (2.4)	0.8 (2.3)	0.8 (2.3)

Tag	**RHC 4-5**			
Coil Size, in. (H x L x R x FPI)	9 x 15 x 2 / 8			
Coil Size, mm (H x L x R x FPI)	228 x 381 x 2 / 8			
Pass-Circ-Blank	10-1-2			
Header Size, in. (mm)	0.75 (19)			
Total Capacity, MBH (kw)	8.84 (2.59)			
Sensible Capacity, MBH (kw)	8.84 (2.59)			
Air Flow, CFM (l/s)	400 (188.8)			

Tag	**RHC 4-5**			
Air EDBT, °F (°C)	65.0 (18.3)			
Air EWBT, °F (°C)	-			
Air LDBT, °F (°C)	85.5 (29.7)			
Air LWBT, °F (°C)	-			
Leaving Coil Velocity, AFPM (m/s)	451 (2.29)			
Coil Pressure Drop, in.wc. (Pa)	0.14 (35.0)			
Entering Temperature, °F (°C)	180.0 (82.2)			
Leaving Temperature, °F (°C)	140.7 (60.4)			
Flow Rate, GPM (l/s)	0.5 (0.032)			
Tube Velocity, FPS (m/s)	0.5 (0.17)			
Pressure Drop, ft.wc. (kPa)	0.6 (1.7)			

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

1.2 PRODUCT DATA

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

.2 Submit product data sheets for unit heaters. Include:

.1 Product characteristics.
.2 Performance criteria.
.3 Mounting methods.
.4 Physical size.
.5 kW rating, voltage, phase.
.6 Cabinet material thicknesses.
.7 Limitations.
.8 Colour and finish.

.3 Manufacturer's Instructions: Provide to indicate special handling criteria, installation sequence, and cleaning procedures.

1.3 SHOP DRAWINGS

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

.2 Indicate:

.1 Equipment, capacity and piping connections.
.2 Dimensions, internal and external construction details, recommended method of installation with proposed [structural steel] support, sizes and location of mounting bolt holes.

1.4 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for unit heaters for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

Part 2 Products

2.1 CABINET UNIT HEATERS

.1 Cabinet: type surface, wall mount, integral stamped louvers air outlet and inlet, 18-gauge steel with 16 gauge front panels with rounded exposed corners and edges, removable panels.

.2 All painted surfaces shall be treated for corrosion resistance prior to being finished with a tan, baked on polyester powder coat finish. All unpainted steel shall be galvanized. provided in one of 8 optional colors as shown on manufacturer’s

.3 All models shall have two 228mm (9") minimum wide piping end pockets. All wall units shall have safety hinged access panels that can be easily removed during installation Finish with factory applied primer coat.

.4 Coils: aluminum fins mechanically bonded to copper tubes. Hydrostatically tested to 1 MPa. The heating coils shall provide specified capacities and not exceed the pressure drop and GPM listed. Coils shall be suitable for 1378 kPa (200 PSI) working pressure with 115°C (240°F) water.

.5 Fans: centrifugal double width wheels, statically and dynamically balanced, direct driven, sleeve bearings, resilient mounted.

.6 Motor: 120 V / 1 Ph / 60 Hz, multi-speed, tapped wound permanent split capacitor type with sleeve bearings, built-in thermal overload protection and resilient rubber isolation mounting.

.7 Filters: cleanable expanded aluminum filter.

.8 Capacity: as indicated.

.9 Control: thermostat and control wiring by section 230933

.10 Cabinet Unit Heater Schedule:

Tag	**Heating Output** (kW)	**Volts/Ph**	**Flow** (L/s)	**Pressure Drop** (Pa)	**Entering Temp.** (dC)	**Leaving Temp.** (dC)	**Make/ Model**
CUH-1	3.13	120/1/60	0.063	275	82.2	60	Modine / Model: CW Size 2
CUH-2	3.13	120/1/60	0.063	275	82.2	60	Modine / Model: CW Size 2
CUH-3	3.13	120/1/60	0.063	275	82.2	60	Modine / Model: CW Size 2
CUH-4	3.13	120/1/60	0.063	275	82.2	60	Modine / Model: CW Size 2
CUH-5	3.13	120/1/60	0.063	275	82.2	60	Modine / Model: CW Size 2
CUH-6	3.13	120/1/60	0.063	275	82.2	60	Modine / Model: CW Size 2
CUH-7	3.13	120/1/60	0.063	275	82.2	60	Modine / Model: CW Size 2
CUH-8	3.13	120/1/60	0.063	275	82.2	60	Modine / Model: CW Size 2
CUH-9	3.13	120/1/60	0.063	275	82.2	60	Modine / Model: CW Size 2
CUH-10	3.13	120/1/60	0.063	275	82.2	60	Modine / Model: CW Size 2

2.2 HORIZONTAL UNIT HEATERS

.1 Casing: 1.6 mm thick cold rolled steel, gloss enamel finish, with threaded connections for hanger rods.

.2 Coils: seamless copper tubing, silver brazed to steel headers with evenly spaced aluminum fins mechanically bonded to tubing. Hydrostatically test to 1 MPa.

.3 Fan: direct drive propeller type, factory balanced, and fan guard. Fans shall be of aluminum blade, steel hub type designed and balanced to assure maximum air delivery, low motor horsepower requirements and quiet operation. .

.4 Motor: 1/20 HP continuous duty, built-in overload protection, and resilient motor supports.

.5 Power: 120 V / 1Ph/ 60Hz

.6 Air outlet: two-way adjustable louvres.

.7 Capacity: 6.35 kW (21,700BTUH)

.8 Heating Fluid: 50% Prop. Glycol. EFT: 82 dC, Flow: 0.145 L/s, Pressure Drop: 620 Pa.

.9 Controls: thermostat and control wiring by section 230933.

.10 Acceptable Product: “Modine” Model: HC-33

Part 3 Execution

3.1 INSTALLATION

.1 Install in accordance with manufacturer's instructions.

.2 Provide double swing pipe joints as indicated.

.3 Check final location with Contract Administrator if different from that indicated prior to installation.

.1 Should deviations beyond allowable clearances arise, request and follow Contract Administrator's directive.

.4 Hot water units: for each unit, install isolation, control and balancing valves on as indicated on drawings for each unit. Install drain valve at low point.

.1 Install manual air vent at high point.

.5 Clean finned tubes and comb straight.

.6 Provide supplementary suspension steel as required.

.7 Before acceptance, set discharge patterns and fan speeds to suit requirements.

END OF SECTION