Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals: in accordance with E3 – Shop Drawings.

.2 Shop drawings to show:

- .1 Mounting arrangements.
- .2 Operating and maintenance clearances.

.3 Shop drawings and product data accompanied by:

- .1 Detailed drawings of bases, supports, and anchor bolts.
- .2 Acoustical sound power data, where applicable.
- .3 Points of operation on performance curves.
- .4 Manufacturer to certify current model production.
- .5 Certification of compliance to applicable codes.

.4 Closeout Submittals:

- .1 Provide operation and maintenance data for incorporation into manual specified in E5 - Operation and Maintenance Manuals.
- .2 Operation and maintenance manual approved by, and final copies deposited with, Contract Administrator before final inspection.
- .3 Operation data to include:
  - .1 Control schematics for systems including environmental controls.
  - .2 Description of systems and their controls.
  - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
  - .4 Operation instruction for systems and component.
  - .5 Description of actions to be taken in event of equipment failure.
  - .6 Valves schedule and flow diagram.
  - .7 Colour coding chart.
- .4 Maintenance data to include:
  - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
  - .2 Data to include schedules of tasks, frequency, tools required and task time.
- .5 Performance data to include:
  - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
  - .2 Equipment performance verification test results.
  - .3 Special performance data as specified.

.4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.6 Approvals:

.1 Submit 1 copies of draft Operation and Maintenance Manual to Contract Administrator for approval. Submission of individual data will not be accepted unless directed by Contract Administrator.

.2 Make changes as required and re-submit as directed by Contract Administrator.

.7 Additional data:

.1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.

.8 Site records:

.1 Contract Administrator will provide mechanical drawings in portable document format (PDF). Contractor shall provide one set of reproducibles and additional sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur.

.2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.

.3 Use different colour waterproof ink for each service.

.4 Make available for reference purposes and inspection.

.9 As-built drawings:

.1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.

.2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Mechanical Subcontractor) (Date).

.3 Submit to Contract Administrator for approval and make corrections as directed.

.4 Perform testing, adjusting and balancing for HVAC using as-built drawings.

.5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.

.10 Submit copies of as-built drawings for inclusion in final TAB report.

1.2 MAINTENANCE

.1 Provide one set of special tools required to service equipment as recommended by manufacturers.

.2 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

Part 2 Products (Not Used)

Part 3 Execution

3.1 PAINTING REPAIRS AND RESTORATION

.1 Prime and touch up marred finished paintwork to match original.

.2 Restore to new condition, finishes which have been damaged.

3.2 CLEANING

.1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.

3.3 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.

.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.

3.4 DEMONSTRATION

.1 Contract Administrator will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.

.2 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.

.3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.

.4 Instruction duration time requirements as specified in appropriate sections.

.5 Contract Administrator may record these demonstrations on video tape for future reference.

3.5 PROTECTION

.1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian General Standards Board (CGSB)

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

.2 Canadian Standards Association (CSA International)

.1 CSA B139-04, Installation Code for Oil Burning Equipment.

.3 Green Seal Environmental Standards (GSES)

.1 Standard GS-11-2008, 2nd Edition, Environmental Standard for Paints and Coatings.

.4 National Fire Code of Canada (NFCC 2005)

.5 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards

.1 SCAQMD Rule 1113-A2007, Architectural Coatings.

.2 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with E3 – Shop Drawings.

.2 Product Data:

.1 Provide manufacturer's printed product literature, specifications and datasheets for piping and equipment and include product characteristics, performance criteria, physical size, finish and limitations.

Part 2 Products

2.1 MATERIAL

.1 Paint: zinc-rich to CAN/CGSB-1.181.

.1 Primers, paints and coatings: in accordance with manufacturer's recommendations for surface conditions.

.2 Fire Stopping: in accordance with Section 07 84 00 - Fire Stopping.

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 CONNECTIONS TO EQUIPMENT

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

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

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

3.3 CLEARANCES

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

.2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer without interrupting operation of other system, equipment, components.

3.4 DRAINS

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

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

.3 Pipe each drain valve discharge separately to above floor drain.

.1 Discharge to be visible.

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

3.5 AIR VENTS

.1 Install automatic air vents to at high points in piping systems.

.2 Install isolating valve at each automatic air valve.

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

3.6 DIELECTRIC COUPLINGS

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

.2 Locations: where dissimilar metals are joined.

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

.4 Over NPS 2: isolating flanges.

3.7 PIPEWORK INSTALLATION

.1 Install pipework to CSA B139.

.2 Screwed fittings jointed with Teflon tape.

.3 Protect openings against entry of foreign material.

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

.5 Assemble piping using fittings manufactured to ANSI standards.

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

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

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

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

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

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

.11 Group piping wherever possible and as indicated.

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

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

.14 Provide for thermal expansion as indicated.

.15 Valves:

.1 Install in accessible locations.

.2 Remove interior parts before soldering.

.3 Install with stems above horizontal position unless indicated.

.4 Valves accessible for maintenance without removing adjacent piping.

.5 Install globe valves in bypass around control valves.

.16 Check Valves:

.1 Install silent check valves on discharge of pumps.

3.8 SLEEVES

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

.2 Material: schedule 40 black steel pipe.

.3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.

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

.5 Installation:

.1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.

.2 Other floors: terminate 25 mm above finished floor.

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

.6 Sealing:

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

.2 Elsewhere:

.1 Provide space for firestopping.

.2 Maintain fire rating integrity.

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

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

3.9 ESCUTCHEONS

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

.2 Construction: one piece type with set screws.

.1 Chrome or nickel plated brass or type 302 stainless steel.

.3 Sizes: outside diameter to cover opening or sleeve.

.1 Inside diameter to fit around pipe or outside of insulation if so provided.

3.10 PREPARATION FOR FIRE STOPPING

.1 Install firestopping within annular space between pipes, ducts, insulation and adjacent fire separation.

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

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

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

3.11 FLUSHING OUT OF PIPING SYSTEMS

.1 Before start-up, clean interior of piping systems as specified in relevant mechanical sections.

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

3.12 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

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

.2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.

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

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

.5 Conduct tests in presence of Contract Administrator.

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

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

3.13 EXISTING SYSTEMS

.1 Be responsible for damage to existing plant by this work.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

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

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

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

.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 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals: in accordance with E3 – Shop Drawings.

.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 E5 - Operation and Maintenance Manuals.

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.

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.

.1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.

.2 Securely fasten in place.

.3 Removable for servicing.

.5 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.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B31.1-07, Power Piping.

.2 ASTM International

.1 ASTM A125-1996(2007), Standard Specification for Steel Springs, Helical, Heat-Treated.

.2 ASTM A307-07b, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.3 ASTM A563-07a, Standard Specification for Carbon and Alloy Steel Nuts.

.3 Factory Mutual (FM)

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

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

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

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

.5 Underwriter's Laboratories of Canada (ULC)

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Sec E3 – Shop Drawings.

.2 Shop Drawings:

.1 Submit shop drawings for:

.1 Bases, hangers and supports.

.2 Connections to equipment and structure.

.3 Structural assemblies.

1.3 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for incorporation into manual specified in E5 - Operations and Maintenance Manuals.

Part 2 Products

2.1 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.

2.2 GENERAL

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

2.3 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.

2.4 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.

2.5 INSULATION PROTECTION SHIELDS

.1 Insulated cold piping:

.1 64 kg/m³ 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.

2.6 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.

2.7 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.8 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 4 minimum concrete inserts, one at each corner.

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

.6 Use approved constant support type hangers where:

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

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

.7 Use variable support spring hangers where:

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

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

3.3 HANGER SPACING

.1 Fire protection: to applicable fire code.

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

.3 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.

.4 Within 300 mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.4 m	1.8 m
1-1/2	3.0 m	2.4 m
2	3.0 m	2.4 m
2-1/2	3.7 m	3.0 m
3	3.7 m	3.0 m
3-1/2	3.7 m	3.3 m
4	3.7 m	3.6 m
5	4.3 m	
6	4.3 m	
8	4.3 m	
10	4.9 m	
12	4.9 m	

.5 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 equipment, 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.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.2 Submittals: in accordance with E3 – Shop Drawings.

.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 IDENTIFICATION OF PIPING SYSTEMS

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

.2 Pictograms:

.1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.

.3 Legend:

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

.4 Arrows showing direction of flow:

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

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

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

.5 Extent of background colour marking:

.1 To full circumference of pipe or insulation.

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

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

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

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

.7 Colours and Legends:

.1 Where not listed, obtain direction from Contract Administrator.

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

Background colour:	**Legend, arrows:**
Green	WHITE

.3 Background colour marking and legends for piping systems:

Contents	**Background colour marking**	**Legend**
Domestic hot water supply	Green	D.H.W.
Domestic tempered water supply	Green	D.T.W
Domestic cold water supply	Green	D.C.W.
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT

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 VALVES, CONTROLLERS

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

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

2.6 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.

3.4 VALVES, CONTROLLERS

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

.2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Contract Administrator. Provide one copy (reduced in size if required) in each operating and maintenance manual.

.3 Number valves in each system consecutively.

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.

.3 The TAB Subcontractor shall carefully review all drawings and specifications and bring any issues pertaining to TAB to the attention to the Contract Administrator prior to Bid period closing.

.4 Test all fire dampers.

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

.1 TAB of all air systems.

.2 Testing of Fire and Smoke dampers.

.3 Coordinate work with all applicable sections including Section 23 09 33 Electric and Electronic Control for HVAC.

.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 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 ACTION AND INFORMATIONAL 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 one copy of TAB Report to Contract Administrator for verification and approval, in English in electronic (PDF) format.

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.

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

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

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

.5 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.

.6 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.

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

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 REFERENCES

.1 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" - means "not concealed" as previously defined.

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

.2 TIAC Codes:

.1 CRD: Code Round Ductwork,

.2 CRF: Code Rectangular Finish.

.2 Reference Standards:

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

.1 ANSI/ASHRAE/IESNA 90.1-04, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 ASTM International Inc.

.1 ASTM B209M-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

.2 ASTM C335-05ae1, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.

.3 ASTM C411-05, Standard 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 C547-07e1, Standard Specification for Mineral Fiber Pipe Insulation.

.6 ASTM C553-02e1, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.7 ASTM C612-04e1, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

.8 ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.9 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.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 Green Seal Environmental Standards (GSES)

.1 Standard GS-36-00, Commercial Adhesives.

.5 South Coast Air Quality Management District (SCAQMD), California State

.1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

.6 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).

.7 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S102-03, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with E3 – Shop Drawings.

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.

.1 Description of equipment giving manufacturer's name, type, model, year and capacity.

.2 Details of operation, servicing and maintenance.

.3 Recommended spare parts list.

.3 Manufacturers' Instructions:

.1 Provide manufacture's written duct insulation jointing recommendations and special handling criteria, installation sequence, and cleaning procedures.

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 To 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 degrees 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/m² 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/m².

.6 Tape: self-adhesive, aluminum, 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 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 PRE-INSTALLATION REQUIREMENTS

.1 Pressure test ductwork systems complete, witness and certify.

.2 Ensure surfaces are clean, dry, and free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards.

.2 Apply materials in accordance with manufacturer's instructions and as indicated.

.3 Use 2 layers with staggered joints when required nominal thickness exceeds 75 mm.

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

.1 Ensure hangers, and supports are outside vapour retarder jacket.

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

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

.6 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum 2 rows each side.

3.4 DUCTWORK INSULATION SCHEDULE

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

	TIAC Code	**Vapour Retarder**	**Thickness (mm)**
Round cold and dual temperature supply air ducts	C-2	yes	50
Outside air ducts	C-1	yes	50
Exhaust duct between dampers and louvres	C-1	no	50
Supply, return and exhaust ducts exposed in space being served	none		

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

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

.1 Finishes: conform to following table:

	TIAC Code	
	Rectangular	**Round**
Indoor, exposed within mechanical room	CRF/1	CRD/2
Indoor, exposed elsewhere	CRF/2	CRD/3

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Thermal insulation for piping and piping accessories in commercial type applications.

.2 Include domestic water piping, and air handling unit drain piping.

1.2 REFERENCES

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

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

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

.1 ASTM B209M-04, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.

.2 ASTM C335-04, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.

.3 ASTM C411-04, Standard 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 C533-2004, Calcium Silicate Block and Pipe Thermal Insulation.

.6 ASTM C547-2003, Mineral Fiber Pipe Insulation.

.7 ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.8 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.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.

.2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketting Sheet, for Insulated Pipes, Vessels and Round Ducts

.4 Department of Justice Canada (Jus)

.1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.

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

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

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

.1 Material Safety Data Sheets (MSDS).

.6 Manufacturer's Trade Associations

.1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).

.7 Underwriters' Laboratories of Canada (ULC)

.1 CAN/ULC-S102-03, Surface Burning Characteristics of Building Materials and Assemblies.

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

.3 CAN/ULC-S702-1997, Thermal Insulation, Mineral Fibre, for Buildings

.4 CAN/ULC-S702.2-03, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.3 DEFINITIONS

.1 For purposes of this section:

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

.2 "EXPOSED" - will mean "not concealed" as specified.

.2 TIAC ss:

.1 CRF: Code Rectangular Finish.

.2 CPF: Code Piping Finish.

1.4 ACTION AND INFORMATIONAL 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 E3 – Shop Drawings.

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 specified includes glass fibre, rock wool, slag wool.

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

.3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S702.

.2 Maximum "k" factor: to CAN/ULC-S702.

.4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S702.

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

.3 Maximum "k" factor: to CAN/ULC-S702.

.5 TIAC Code C-2: mineral fibre blanket faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).

.1 Mineral fibre: to CAN/ULC-S702.

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

.3 Maximum "k" factor: to CAN/ULC-S702.

.6 TIAC Code A-6: flexible unicellular tubular elastomer.

.1 Insulation: with vapour retarder jacket.

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

.3 Maximum "k" factor: to CAN/ULC-S702.

.4 Certified by manufacturer: free of potential stress corrosion cracking corrodants.

.7 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.

.1 Insulation: to ASTM C533.

.2 Maximum "k" factor: to CAN/ULC-S702.

.3 Design to permit periodic removal and re-installation.

2.3 INSULATION SECUREMENT

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

.2 Contact adhesive: quick setting.

.3 Canvas adhesive: washable.

.4 Tie wire: 1.5 mm diameter stainless steel.

.5 Bands: stainless steel, 19 mm wide, 0.5 mm thick.

2.4 CEMENT

.1 Thermal insulating and finishing cement:

.1 Hydraulic setting on mineral wool, to ASTM C449/C449M.

2.5 VAPOUR RETARDER LAP ADHESIVE

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

2.6 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

2.7 OUTDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: fibrous glass, untreated 305 g/m².

2.8 JACKETS

.1 Provide PVC jacket in mechanical rooms and canvas jacket elsewhere.

.2 Polyvinyl Chloride (PVC):

.1 One-piece moulded type to CAN/CGSB-51.53 with pre-formed shapes as required.

.2 Colours: to match adjacent finish paint.

.3 Minimum service temperatures: -20 degrees C.

.4 Maximum service temperature: 65 degrees C.

.5 Moisture vapour transmission: 0.02 perm.

.6 Fastenings:

.1 Use solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks.

.3 Pressure sensitive vinyl tape of matching colour.

.3 Canvas:

.1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.

.2 Lagging adhesive: compatible with insulation.

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 PRE-INSTALLATION REQUIREMENT

.1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.

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

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards.

.2 Apply materials in accordance with manufacturer's instructions and this specification.

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

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

.1 Install hangers, supports outside vapour retarder jacket.

.5 Supports, Hangers:

.1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 Application: at expansion joints, valves, flanges and unions at equipment.

.2 Design: to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.

.3 Insulation:

.1 Insulation, fastenings and finishes: same as system.

.2 Jacket: PVC.

3.5 INSTALLATION OF ELASTOMERIC INSULATION

.1 Insulation to remain dry. Overlaps to manufacturer's instructions. Ensure tight joints.

.2 Provide vapour retarder as recommended by manufacturer.

3.6 PIPING INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

.2 Thickness of insulation as listed in following table.

.1 Run-outs to individual units and equipment not exceeding 4000 mm long.

.2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	**Temp [° C]**	**TIAC code**	**Pipe sizes (NPS) and insulation thickness (mm)**					
			Run out	**to 1**	**1 1/4 to 2**	**2 1/2 to 4**	**5 to 6**	**8 & over**
Domestic HWS		A-1	25	25	38	38	38	38
Domestic TWS		A-1	25	25	38	38	38	38
Domestic CWS		A-3	15	15	25	25	25	25
Plumbing Vent		C-2	25	25	25	25	25	25

.3 Finishes:

.1 Exposed indoors: canvas jacket.

.2 Exposed in mechanical rooms: canvas.

.3 Concealed, indoors: canvas on valves, fittings. No further finish.

.4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.

.5 Outdoors: water-proof aluminum jacket.

.6 Finish attachments: SS bands, at 150 mm on centre.

.7 Installation: to appropriate TIAC code CRF/1 through CPF/5.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL

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

.2 Wherever words "shall be capable of" appear in specifications, interpret as meaning that; where feature or performance referred to is being applied, that feature or performance shall be provided. Where feature or performance is not applied now, but will be applied in future (i.e. Card Access Control), system shall be provided with all necessary central hardware and software required to support that feature or performance, with only addition of field hardware being required at that future time.

.3 Controls Subcontractor to provide commissioning sheets for all points on field devices as well as head end equipment.

.4 Controls Subcontractor to communicate with equipment provider to ensure proper field point integration as well as controllability of the equipment, if not package controls.

.5 Controls Subcontractor to supply all drawings/sequence of operations in both a hard and soft copy. Drawings to be able to be read and modified by City of Winnipeg Staff. Controls Subcontractor to supply As-Built drawings in an editable format, able to be easily edited by City of Winnipeg Staff.

.6 The Controls Subcontractor shall meet with City of Winnipeg Tech Shop staff to go over naming conventions, alarms etc. at the start of project.

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

1.2 WORK INCLUDED

.1 Labour, material, plant, tools, equipment and services necessary and reasonably incidental to completion of temp. control/instrumentation systems as noted herein and/or on the drawings.

.2 Control equipment to be product of one manufacturer unless otherwise specified.

.3 Pre-wired or pre-piped controls on package equipment specified, is not included in this Section.

.4 Include complete design, supply, installation and commissioning of microprocessor based hardware and software. Components and interconnecting systems to be installed by trained control mechanics, regularly employed by this Section.

.5 Co-ordinate and provide all assistance required by section 230593 during balancing.

.6 Demonstrate operation of control system to Contract Administrator.

.7 Provide control system training to Contract Administrator's personnel.

1.3 RELATED WORK SPECIFIED ELSEWHERE

.1 Section 23 05 00 – Common Work Results for HVAC

.2 Section 23 05 93 – Testing, Adjusting and Balancing for HVAC

.3 Section 26 05 01 – Common Work Results for Electrical

.4 Section 26 05 20 - Wiring and Box Connectors 0-1000V

.5 Section 26 05 21 - Wires and Cables (0-1000V)

.6 Section 26 05 29 – Hangers and Supports for Electrical Systems

.7 Section 26 05 31 – Splitters. Junctions, Pull Boxes and Cabinets

.8 Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings

.9 Section 26 05 34 – Conduit Fastenings and Fittings

.10 Section 26 27 26 - Wiring Devices

1.4 WORK BY OTHER SECTIONS

.1 The following shall be supplied and installed by Division 26 – Electrical:

.1 Division 26 – Electrical to supply and install all conduit, conductors and connections from the distribution panels to line side of magnetic starters, thermal overload devices and variable speed drives, and from load side of starters and devices to motors.

.2 Division 26 – Electrical to supply and install conduit, conductors and connection for line voltage control devices on single phase equipment such as:

.1 Electric thermostats, pressure switches, and force flow heating units.

.2 Float switches, pressure switches, alternators for sump pumps, etc. and other mechanical wiring required but not specified in this section of the specifications.

.3 All safety controls must be wired in series with both "HAND" and "AUTO" starter switch positions to ensure equipment will shutdown during a fire alarm condition and against damage to equipment and/or system.

.4 Normal and/or emergency power source wiring to Section 230933 systems panels and other devices or groups of devices requiring 120 volt normal and/or emergency power source.

1.5 **ELECTRICAL WIRING PREFORMED BY SECTION 230933**

.1 Supply and installation of all wire, electric relays, transformers, connections and other devices required for control circuit wiring for systems as specified in Section 23 09 33 –

Control Systems for HVAC, whether line or low voltage, shall be responsibility of Section 23 09 33 – Control Systems for HVAC.

.2 Section 23 09 33 – Control Systems for HVAC shall either use own electricians, retain and pay for services of successful Division 26, or use an electrical sub-trade acceptable to Contract Administrator to supply and install all conduit and wiring for systems as specified in this Section.

.3 Factory trained servicemen in employ of manufacturer, shall make final wiring connections on all components, mount and electrically connect all controls.

.4 Electrical wiring shall be installed in conformance with CEC, CSA, ULC, Manitoba Building Code, National Building Code of Canada 1990 and standards set is Division 26 of this specification.

.5 Ensure that adequate conduit is installed during initial phases of construction, to accommodate total systems requirements.

.6 Wire all safety controls in series with both 'Hand' and 'Auto' control positions to ensure that safeties are always enabled.

.7 Section 23 09 33 – Control Systems for HVAC shall provide all other conduit and wiring required for Section 23 09 33 – Control Systems for HVAC systems operation, including tie-ins from Section 23 09 33 – Control Systems for HVAC supplied relays to motor starting circuits.

.8 As a minimum, provide separate, dedicated conduit system for each of following. Conduit to be minimum 21mm EMT.

.1 C.C.M.S. transmission wiring.

.2 All other wiring connected to an electronic control system including sensor and control wiring associated with DDC panels, DGP's, Card Access Panels, etc., which are connected to the C.C.M.S. system or are capable of being connected at some future date.

.9 If approved by system manufacturer, cable up to 30 Volts may be installed in extra-low voltage communication cable tray.

.10 Refer to Division 26 for conduit and cable identification requirements.

.11 Section 23 09 33 – Control Systems for HVAC shall provide detailed wiring diagrams for remote supervisory panels supplied with air handling equipment, connections between Section 230933 supplied equipment and DX cooling equipment.

.12 The Control Subcontractor will specifically read all mechanical and electrical drawings, specifications, and addenda and determine the controls Work provided by the Mechanical Subcontractor, his Subcontractors, and the Electrical Subcontractor. The Controls Subcontractor is expected to have expertise to co-ordinate the Work of other Contractors and to make a completely co-ordinated mechanical control system. The controls specifications are specifically written to co-ordinate the mechanical and electrical systems. Where others are specifically specified to allow for controls Work, then the Controls Subcontractor will not allow for that Work. This clause is not intended to make

the Controls Subcontractor responsible for examining the specifications for contradictions and overlap.

.13 Section 23 09 33 – Control Systems for HVAC shall provide 2 slot DIN rail mounted patch panel within controller enclosure. Patch panel shall be as specified within Section 27 10 05 – Structured Cabling for Communications. Section 23 09 33 – Control Systems for HVAC shall also provide interconnecting Category 5E cable between patch panel and controller communication port. Division 26 shall connect Ethernet network Category 5E cable within controller enclosures to DIN rail mounted patch panels.

1.6 QUALITY ASSURANCE

.1 Contractor/Manufacturer Qualifications

.1 The Installer shall have an established working relationship with the Control System Manufacturer of not less than three years.

.2 The Installer shall have successfully completed Control System Manufacturer's classes on the control system. The Installer shall present for review the certification of completed training, including the hours of instruction and course outlines upon request.

1.7 SYSTEM PERFORMANCE

.1 Performance Standards: The system shall conform to the following:

.1 Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be less than 2 seconds. Analog objects should start to adjust within 2 seconds.

.2 Object Scan. All changes of state and change of analog values will be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will have been current within the previous 6 seconds.

.3 Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 45 seconds.

.4 Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. The Control Subcontractor shall be responsible for selecting execution times consistent with the mechanical process under control.

.5 Performance. Programmable controllers shall be able to execute PID control loops at a selectable frequency of at least once per second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.

.6 Multiple Alarm Annunciation. All workstations on the network must receive alarms within 5 seconds of each other.

.7 Reporting Accuracy. The system shall report all values with an end-to-end accuracy as listed or better than those listed in Table 1.

.8 Stability of Control. Control loops shall maintain measured variable at set point within the tolerances listed in Table 2.

TABLE 1
Reporting Accuracy

Measured Variable	Reported Accuracy
Space Temperature	+/-0.5°C (+/- 1°F)
Ducted Air	+/-0.5°C (+/- 1°F)
Outside Air	+/-1.0°C (+/- 2°F)
Dew Point	+/-1.5°C (+/- 3°F)
Water Temperature	+/-0.5°C (+/- 1°F)
Delta-T	+/-0.15°C (+/- 0.25°F)
Relative Humidity	+/-5% RH
Water Flow	+/-5% full scale
Airflow (terminal)	+/-10% of full scale (see Note 1)
Airflow (measuring stations)	+/-5% full scale
Airflow (pressurized spaces)	+/-3% full scale
Air Pressure (ducts)	+/-25 Pa (+/-0.1 in. w.g.)
Air Pressure (space)	+/-3 Pa (+/-0.01 in. w.g.)
Water Pressure	+/-2% of full scale (see Note 2)
Electrical (A, V, W, Power Factor)	5% of reading (see Note 3)
Carbon Monoxide (CO)	+/-5% of reading
Carbon Dioxide (CO_2)	+/-50 ppm
Note 1: 10% - 100% of scale	
Note 2: For both absolute and differential pressure	
Note 3: Not including utility-supplied meters	

TABLE 2
Control Stability and Accuracy

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	+/-50Pa (+/-2in.w.g.) +/-3Pa(+/-0.01in.w.g.)	0–1.5 kPa (0–6 in. w.g.)
Airflow	+/-10% of full scale	
Space Temperature	+/-1.0°C (+/-2.0°F)	
Duct Temperature	+/-1.5°C (+/-3.0°F)	
Humidity	+/-5% RH	
Fluid Pressure	+/-10 kPa (+/-1.5 psi) +/-250Pa(+/-1.0in.w.g.)	0–1 Mpa (1–150 psi) 0–12.5 kPa (0–50 in. w.g.) differential

1.8 SUBMITTALS

.1 Product Data and Shop Drawings: Meet requirements of Section 230500 on Shop Drawings, Product Data, and Samples. In addition, Contractor shall provide shop drawings or other submittals on all hardware, software, and installation to be provided. No Work may begin on any segment of this project until submittals have been successfully reviewed for conformity with the design intent. Six copies are required. All drawings shall be prepared on a CAD system that produces drawing files compatible with

AutoCAD Release 14 or higher and be provided on magnetic/optical disk and as full-size drawings. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Submittals shall include:

.1 A complete bill of materials of equipment to be used indicating quantity, manufacturer, model number, and other relevant technical data.

.2 Manufacturer's description and technical data, such as performance curves, product specification sheets, schematic diagrams, and installation/maintenance instructions for the items listed below and other relevant items not listed below:

Direct Digital Controller (controller panels)

Transducers/Transmitters

Sensors (including accuracy data)

Actuators

Valves

Relays/Switches

Control Panels

Power Supply

Batteries

Interface Equipment Between CPU and Control Panels

Third-Party Software

.3 Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.

.4 A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.

.5 A point list for each system controller including both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, and the location of the I/O device. Software flag points, alarm points, etc.

.2 Project Record Documents: Upon completion of installation, submit three copies of record (as-built) documents. The documents shall be submitted for approval prior to final completion and shall include:

.1 Project Record Drawings. These shall be asbuilt versions of the submittal shop drawings. One set of magnetic media including CAD, .DWG, or .DXF drawing files also shall be provided.

.2 Testing and Commissioning Reports and Checklists.

.3 Operation and Maintenance (O & M) Manual.

.3 Training Manuals.

1.9 WARRANTY

.1 Labor and materials for the control system specified shall be warranted free from defects for a period of 12 months after final completion and acceptance. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Contract Administrator. The Contractor shall respond to the Contract Administrator's request for warranty service within 24 hours during normal business hours.

.2 All Work shall have a single warranty date, even when the Contract Administrator has received beneficial use due to an early system start-up. If the Work specified is split into multiple Contracts or a multi-phase Contract, then each Contract or phase shall have a separate warranty start date and period.

.3 At the end of the final start-up, testing, and commissioning phase, if equipment and systems are operating satisfactorily to the Contract Administrator, the Contract Administrator shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of acceptance shall be the start of warranty.

.4 Exception: The Control Subcontractor shall not be required to warrant reused devices, except for those that have been rebuilt and/or repaired. The Controls Subcontractor shall warrant all installation labor and materials, however, and shall demonstrate that all reused devices are in operable condition at the time of Contract Administrator's acceptance.

1.10 OWNERSHIP OF PROPRIETARY MATERIAL

.1 All project-developed software and documentation shall become the property of the Contract Administrator. These include, but are not limited to:

.1 Record drawings

.2 Project database

.3 Project-specific application programming code

.4 All documentation

PART 2 PRODUCTS

2.1 MATERIALS

.1 All products used in this project installation shall be new and currently under manufacture and shall have been applied in similar installations for a minimum of two years. This installation shall not be used as a test site for any new products unless explicitly approved by the Contract Administrator's representative in writing. Spare parts shall be available for at least five years after completion of this Contract.

2.2 COMMUNICATION

.1 The Contractor shall provide all communication media, connectors, repeaters, hubs, and routers necessary for the internetwork.

.2 Communication services over the internetwork shall result in operator interface and value passing that is transparent to the internetwork architecture as follows:

.1 Connection of an operator interface device to any one controller on the internetwork will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the internetwork.

.2 All database values (e.g., objects, software variables, custom program variables) of any one controller shall be readable by any other controller on the internetwork. This value passing shall be automatically performed by a controller when a reference to an object name not located in that controller is entered into the controller’s database. An operator/installer shall not be required to set up any communication services to perform internetwork value passing.

.3 The time clocks in all controllers shall be automatically synchronized daily via the internetwork. An operator change to the time clock in any controller shall be automatically broadcast to all controllers on the internetwork.

.4 The internetwork shall have the following minimum capacity for future expansion:

.1 Each building controller shall have routing capacity for 50 controllers.

.2 The building controller network shall have capacity for 50 building controllers.

.3 The system shall have an overall capacity for 12,500 building controller, custom application controller, and application specific controller input/output objects.

2.3 CONTROLLER SOFTWARE

.1 Furnish the following applications software for building and energy management. All software applications shall reside and operate in the system controllers. Editing of applications shall occur at the operator workstation.

.2 System Security

.1 User access shall be secured using individual security passwords and user names.

.2 Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.

.3 User Log On/Log Off attempts shall be recorded.

.4 The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.

.3 Scheduling. Provide the capability to schedule each object or group of objects in the system. Each schedule shall consist of the following:

.1 Weekly Schedule. Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, stop, optimal start, optimal stop, and night economizer. Each schedule may consist of up to 10 events. When a group of objects are scheduled together, provide the capability to adjust the start and stop times for each member.

.2 Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by the standard schedule for that day of the week.

.3 Holiday Schedules. Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.

.4 System Coordination. Provide a standard application for the proper coordination of equipment. This application shall provide the operator with a method of grouping together equipment based on function and location. This group may then be used for scheduling and other applications.

.5 Binary Alarms. Each binary object shall be set to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.

.6 Analog Alarms. Each analog object shall have both high and low alarm limits. Alarming must be able to be automatically and manually disabled.

.7 Alarm Reporting. The operator shall be able to determine the action to be taken in the event of an alarm. Alarms shall be routed to the appropriate workstations based on time and other conditions. An alarm shall be able to start programs, print, be logged in the event log, generate custom messages, and display graphics.

.8 Remote Communication. The system shall have the ability to dial out in the event of an

alarm using BACnet PTP.

.9 Maintenance Management. The system shall monitor equipment status and generate maintenance messages based upon user-designated run-time, starts, and/or calendar date limits.

.10 Sequencing. Provide application software based upon the sequences of operation specified to properly sequence chillers, boilers, and pumps.

.11 PID Control. A PID (proportional-integral-derivative) algorithm with direct or reverse action and anti-windup shall be supplied. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, set point, and PID gains shall be user-selectable.

.12 Staggered Start. This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts, shall be user-selectable.

.13 Anti-Short Cycling. All binary output objects shall be protected from short cycling. This feature shall allow minimum on-time and off-time to be selected.

.14 On/Off Control with Differential. Provide an algorithm that allows a binary output to be cycled based on a controlled variable and set point. The algorithm shall be direct-acting or reverse-acting and incorporate an adjustable differential.

.15 Run-Time Totalization. Provide software to totalize run-times for all binary input objects. A high runtime alarm shall be assigned, if required, by the operator.

2.4 BUILDING CONTROLLERS

.1 General. Provide an adequate number of building controllers to achieve the performance specified in the Part 1 Article on “System Performance.” Each of these panels shall meet the following requirements.

.1 The Building Automation System shall be composed of one or more independent, standalone, microprocessor-based building controllers to manage the global strategies described in the System Software section.

.2 The building controller shall have sufficient memory to support its operating system, database, and programming requirements.

.3 Data shall be shared between networked building controllers.

.4 The operating system of the building controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.

.5 Controllers that perform scheduling shall have a real-time clock.

.6 The building controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall

Assume a predetermined failure mode,

Generate an alarm notification.

.7 The Building Controller shall communicate with other BACnet devices on the internetwork using the Read (Execute and Initiate) and Write (Execute and Initiate) services as defined in ASHRAE Standard 135-1995 for BACnet.

.2 Communication.

.1 Each building controller shall reside on a BACnet network using the ISO 8802-3 (Ethernet) Data Link/Physical layer protocol. Each building controller also shall perform BACnet routing if connected to a network of custom application and application specific controllers.

.2 The controller shall provide a service communication port using BACnet Data Link/Physical layer protocol for connection to a portable operator's terminal.

.3 Environment. Controller hardware shall be suitable for the anticipated ambient conditions.

.1 Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at minus 40°C to 65°C (-40°F to 150°F).

.2 Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

.3 Keypad. A local keypad and display shall be provided. The keypad shall be provided for interrogating and editing data. An optional system security password shall be available to prevent unauthorized use of the keypad and display. If the manufacturer does not provide this keypad and display, provide a portable operator terminal.

.4 Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.

.5 Memory. The building controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

.6 Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

2.5 CUSTOM APPLICATION CONTROLLERS

.1 General. Provide an adequate number of Custom Application Controllers to achieve the performance specified in the Part 1 Article on "System Performance." Each of these panels shall meet the following requirements.

.1 The custom application controller shall have sufficient memory to support its operating system, database, and programming requirements.

.2 Data shall be shared between networked custom application controllers.

.3 The operating system of the controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms.

.4 Controllers that perform scheduling shall have a real-time clock.

.5 The custom application controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall

Assume a predetermined failure mode and

Generate an alarm notification.

.6 The custom application controller shall communicate with other BACnet devices on the internetwork using the Read (Execute and Initiate) and Write (Execute and Initiate) services as defined in ASHRAE Standard 135-1995 for BACnet.

.2 Communication.

.1 Each custom application controller shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol.

.2 The controller shall provide a service communication port using BACnet Data Link/Physical layer protocol for connection to a portable operator's terminal.

.3 Environment. Controller hardware shall be suitable for the anticipated ambient conditions.

.1 Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at minus 40°C to 65°C (-40°F to 150°F).

.2 Controllers used in conditioned space shall be mounted in dustproof enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

.4 Keypad. A local keypad and display shall be provided. The keypad shall be provided for interrogating and editing data. An optional system security password shall be available to prevent unauthorized use of the keypad and display.

.5 Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.

.6 Memory. The custom application controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

.7 Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

2.6 APPLICATION SPECIFIC CONTROLLERS

.1 General. Application specific controllers (ASCs) are microprocessor-based DDC controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. They are not fully user-programmable but are customized for operation within the confines of the equipment they are designed to serve. Application specific controllers shall communicate with other BACnet devices on the internetwork using the Read (Execute) service as defined in ASHRAE Standard 135-1995 for BACnet.

.1 Each ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.

.2 Each ASC will contain sufficient I/O capacity to control the target system.

.2 Communication.

.1 The controller shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol. Each network of controllers shall be connected to one building controller.

.2 Each controller shall have a BACnet Data Link/Physical layer compatible connection for a laptop computer or a portable operator’s tool. This connection shall be extended to a space temperature sensor port if required.

.3 Environment. The hardware shall be suitable for the anticipated ambient conditions.

.1 Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at minus 40°C to 65°C (-40°F to 150°F).

.2 Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).

.3 Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.

.4 Memory. The application specific controller shall use nonvolatile memory and maintain all BIOS and programming information in the event of a power loss.

.5 Immunity to power and noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%. Operation shall be protected against electrical noise of 5-120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

.6 Transformer. Power supply for the ASC must be rated at a minimum of 125% of ASC power consumption and shall be of the fused or current limiting type.

2.7 INPUT/OUTPUT INTERFACE

.1 Hardwired inputs and outputs may tie into the system through building, custom application, or application specific controllers.

.2 All input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground will cause no damage to the controller. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no damage to the controller.

.3 Universal type input/output points shall be designated (in software) as either a binary or analog type point with appropriate properties. Application specific controllers are exempted from this requirement.

.4 Binary inputs shall allow the monitoring of On/Off signals from remote devices. The binary inputs shall provide a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against the effects of contact bounce and noise. Binary inputs shall sense “dry contact” closure without external power (other than that provided by the controller) being applied.

.5 Pulse accumulation input objects. This type of object shall conform to all the requirements of binary input objects and also accept up to 10 pulses per second for pulse accumulation.

.6 Analog inputs shall allow the monitoring of low-voltage (0 to 10 VDC), current (4 to 20 mA), or resistance signals (thermistor, RTD). Analog inputs shall be compatible with— and field configurable to— commonly available sensing devices.

.7 Binary outputs shall provide for On/Off operation or a pulsed low-voltage signal for pulse width modulation control. Binary outputs on building and custom application controllers shall have three-position (On/Off/Auto) override switches and status lights. Outputs shall be selectable for either normally open or normally closed operation.

.8 Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide either a 0 to 10 VDC or a 4 to 20 mA signal as required to provide proper control of the output device. Analog outputs on building or custom application controllers shall have status lights and a two-position (AUTO/MANUAL) switch and manually

adjustable potentiometer for manual override. Analog outputs shall not exhibit a drift of greater than 0.4% of range per year.

.9 System Object Capacity. The system size shall be expandable to at least twice the number of input/output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The operator interfaces installed for this project shall not require any hardware additions or software revisions in order to expand the system.

2.8 POWER SUPPLIES AND LINE FILTERING

.1 Control transformers shall be CSA approved. Furnish Class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits for Class 2 service in accordance with CEC requirements. Limit connected loads to 80% of rated capacity.

.2 Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component.

2.9 AUXILIARY CONTROL DEVICES

.1 Motorized control dampers, unless otherwise specified elsewhere, shall be as follows:

.1 Control dampers shall be the parallel or opposed blade type as below or as scheduled on drawings.

.1 Outdoor and/or return air mixing dampers and face and bypass (F&BP) dampers shall be parallel blade, arranged to direct airstreams toward each other.

.2 Other modulating dampers shall be the opposed blade type.

.3 Two-position shutoff dampers may be parallel or opposed blade type with blade and side seals.

.2 Damper frames shall be 13 gauge galvanized steel channel or 1/8 in. extruded aluminum with reinforced corner bracing.

.3 Damper blades shall not exceed 20 cm (8 in.) in width or 125 cm (48 in.) in length. Blades are to be suitable for medium velocity performance (10 m/s [2000 fpm]). Blades shall be not less than 16 gauge.

.4 Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze or better.

.5 All blade edges and top and bottom of the frame shall be provided with replaceable butyl rubber or neoprene seals. Side seals shall be spring-loaded stainless steel. The blade seals shall provide for a maximum leakage rate of 50 L/s·m2 (10 cfm per ft2) at 1000 Pa (4 in. w.g.) differential pressure. Provide airfoil blades suitable for a wide-open face velocity of 7.5 m/s (1500 fpm).

.6 Individual damper sections shall not be larger than 125 cm × 150 cm (48 in. × 60 in.). Provide a minimum of one damper actuator per section.

.7 Modulating dampers shall provide a linear flow characteristic where possible.

.8 Dampers shall have exposed linkages.

.2 Electric damper/valve actuators.

.1 The actuator shall have mechanical or electronic stall protection to prevent damage to the actuator throughout the rotation of the actuator.

.2 Where shown, for power-failure/safety applications, an internal mechanical, spring-return mechanism shall be built into the actuator housing.

.3 Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range.

.4 All 24 VAC/VDC actuators shall operate on Class 2 wiring

.5 All non-spring-return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring-return actuators with more than 7 Nm (60 in.-lb) torque capacity shall have a manual crank for this purpose.

.3 Binary Temperature Devices

.1 Low-voltage space thermostat shall be 24 V, bimetal-operated, mercury-switch type, with either adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C to 30°C (55°F to 85°F) set point range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

.2 Line-voltage space thermostat shall be bimetal-actuated, open contact type, or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, CSA approved for electrical rating, concealed setpoint adjustment, 13°C to 30°C (55°F to 85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

.3 Low-limit thermostats. Low-limit air stream thermostats shall be CSA approved, vapor pressure type, with an element of 6 m (20 ft) minimum length. Element shall respond to the lowest temperature sensed by any 30 cm (1 ft) section. The low-limit thermostat shall be manual reset only.

.4 Temperature sensors.

.1 Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor.

.2 Duct sensors shall be single point or averaging. Averaging sensors shall be a minimum of 1.5 m (5 ft) in length per 1 m^2 (10 ft^2) of duct cross section.

.3 Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed. The well must withstand the flow velocities in the pipe.

.4 Space sensors shall be equipped with set point adjustment, override switch, display, and/or communication port.

.5 Provide matched temperature sensors for differential temperature measurement.

.5 Flow switches.

.1 Flow-proving switches shall be either paddle or differential pressure type, as shown.

.2 Paddle type switches (water service only) shall be CSA approved, SPDT snap-acting with pilot duty rating (125 VA minimum) and shall have adjustable sensitivity with NEMA 1 enclosure unless otherwise specified.

.3 Differential pressure type switches (air or water service) shall be CSA approved, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application or as specified.

.6 Relays.

.1 Control relays shall be CSA approved plug-in type with dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.

.2 Time delay relays shall be CSA approved solid-state plug-in type with adjustable time delay. Delay shall be adjustable ±200% (minimum) from set point shown on plans. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure when not installed in local control panel.

.7 Override timers.

.1 Override timers shall be spring-wound line voltage, CSA approved, with contact rating and configuration as required by application. Provide 0-to-6-hour calibrated dial unless otherwise specified. Timer shall be suitable for flush mounting on control panel face and located on local control panels or where shown.

.8 Current switches.

.1 Current-operated switches shall be self-powered, solid-state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

.9 Pressure transducers.

.1 Transducer shall have linear output signal. Zero and span shall be field adjustable.

.2 Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.

.3 Water pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and block and bleed valves.

.4 Water differential pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Overrange limit (differential pressure) and maximum static pressure shall be 300 psi. Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and five-valve manifold.

.10 Differential pressure type switches (air or water service) shall be CSA approved, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application or as shown.

.11 Pressure-Electric (PE) Switches.

.1 Shall be metal or neoprene diaphragm actuated, operating pressure rated 0-175 kPa (0-25 psig), with calibrated scale setpoint range of 14-125 kPa (2-18 psig) minimum, CSA approved.

.2 Provide one- or two-stage switch action SPDT, DPST, or DPDT, as required by application. Electrically rated for pilot duty service (125 VA minimum) and/or for motor control.

.3 Shall be open type (panel-mounted) or enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified.

.4 Shall have a permanent indicating gauge on each pneumatic signal line to PE switches.

.12 Local control panels.

.1 All indoor control cabinets shall be fully enclosed NEMA 1 construction with (hinged door) key-lock latch and removable subpanels. A single key shall be common to all field panels and subpanels.

.2 Interconnections between internal and face-mounted devices shall be pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be CSA approved for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.

.3 Provide ON/OFF power switch with overcurrent protection for control power sources to each local panel.

2.10 WIRING AND RACEWAYS

.1 General: Provide copper wiring, plenum cable, and raceways as specified in the applicable sections of Division 26.

.2 All insulated wire to be copper conductors, UL labeled for 90°C minimum service.

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 Control Subcontractor 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 Control Subcontractor 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 Control Subcontractor's Work and the plans and the Work of others the Control Subcontractor shall report these discrepancies to the Contract Administrator and shall obtain written instructions for any changes necessary to accommodate the Control Subcontractor'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 Control Subcontractor to report such discrepancies shall be made by—and at the expense of—this Control Subcontractor.

.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.

3.2 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.

3.3 WIRING

.1 All control and interlock wiring shall comply with the CEC and local electrical codes and Division 26 of this specification. Where the requirements of this section differ from those in Division 26, the requirements of this section shall take precedence.

.2 All CSA Class 1 (line voltage) wiring shall be CSA approved in approved raceway according to CSA and Division 26 requirements.

.3 All low-voltage wiring shall meet CSA Class 2 requirements. (Low-voltage power circuits shall be sub fused when required to meet Class 2 current limit.)

.4 Where CSA Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are CSA approved for the intended application. For example, cables used in ceiling plenums shall be CSA approved specifically for that purpose.

.5 All wiring in mechanical, electrical, or service rooms—or where subject to mechanical damage shall be installed in raceway at levels below 3 m (10 ft).

.6 Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

.7 Do not install wiring in raceway containing tubing.

.8 Where Class 2 wiring is run exposed, wiring is to be run parallel along a surface or perpendicular to it and *neatly* tied at 3 m (10 ft) intervals.

.9 Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.

.10 All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.

.11 All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

.12 Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the Control Subcontractor shall provide step-down transformers.

.13 All wiring shall be installed as continuous lengths, with no splices permitted between termination points.

.14 Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.

.15 Size of raceway and size and type of wire shall be the responsibility of the Control Subcontractor, in keeping with the manufacturer’s recommendations and CSA requirements, except as noted elsewhere.

.16 Include one pull string in each raceway 2.5 cm (1 in.) or larger.

.17 Use coded conductors throughout with conductors of different colors.

.18 Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.

.19 Conceal all raceways, except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 15 cm (6 in.) from high-temperature equipment (e.g., steam pipes or flues).

.20 Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.

.21 Adhere to this specification's Division 26 requirements where raceway crosses building expansion joints.

.22 Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.

.23 The Control Subcontractor shall terminate all control and/or interlock wiring and shall maintain updated (asbuilt) wiring diagrams with terminations identified at the job site.

.24 Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Flexible metal raceway less than ½ in. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.

.25 Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.4 COMMUNICATION WIRING

.1 The Control Subcontractor shall adhere to the items listed in the "Wiring" article in Part 3 of the specification.

.2 All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.

.3 Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.

.4 Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.

.5 Control Subcontractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.

.6 When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lighting arrestor shall be installed according to the manufacturer's instructions.

.7 All runs of communication wiring shall be un-spliced length when that length is commercially available.

.8 All communication wiring shall be labeled to indicate origination and destination data.

3.5 INSTALLATION OF SENSORS

.1 Install sensors in accordance with the manufacturer's recommendations.

.2 Mount sensors rigidly and adequately for the environment within which the sensor operates.

.3 Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.

.4 All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

.5 Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.

.6 Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 3 m of sensing element for each 1 m^2 (1 ft of sensing element for each 1 ft^2) of coil area.

.7 All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.

.8 Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.

.9 Differential air static pressure.

.1 Supply Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.

.2 Return Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor.

.3 Building Static Pressure: Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.

.4 The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.

.5 All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.

.6 All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.

3.6 ACTUATORS

.1 Mount and link control damper actuators according to manufacturer's instructions.

.1 To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.

.2 Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

.3 Provide all mounting hardware and linkages for actuator installation.

.2 Electric/Electronic

.1 Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° available for tightening the damper seals. Actuators shall be mounted following manufacturer's recommendations.

.2 Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.7 WARNING LABELS

.1 Permanent warning labels shall be affixed to all equipment that can be automatically started by the Control system.

.1 Labels shall use white lettering (12-point type or larger) on a red background.

.2 Warning labels shall read as follows:

C A U T I O N
This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.

.2 Permanent warning labels shall be affixed to all motor starters and all control panels that are connected to multiple power sources utilizing separate disconnects.

.1 Labels shall use white lettering (12-point type or larger) on a red background.

.2 Warning labels shall read as follows:

C A U T I O N
This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing. Identification Of Hardware And Wiring

.3 All wiring and cabling, including that within factory fabricated panels, shall be labeled at each end within 5 cm (2 in.) of termination with the termination number.

.4 Permanently label or code each point of field terminal strips to show the instrument or item served.

.5 Identify control panels with minimum 1 cm (½ in.) letters on laminated plastic nameplates.

.6 Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.

.7 Identify room sensors relating to terminal box or valves with nameplates.

.8 Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.

.9 Identifiers shall match record documents.

3.8 CONTROLLERS

.1 Provide a separate controller for each AHU or other HVAC system. A controller may control more than one system provided that all points associated with the system are assigned to the same controller. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.

.2 Building Controllers and Custom Application Controllers shall be selected to provide a minimum of 15% spare I/O point capacity for each point type found at each location. If input points are not universal, 15% of each type is required. If outputs are not universal, 15% of each type is required. A minimum of one spare is required for each type of point used.

.3 Future use of spare capacity shall require providing the field device, field wiring, point database definition, and custom software. No additional controller boards or point modules shall be required to implement use of these spare points.

3.9 PROGRAMMING

.1 Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25% of available memory free for future use.

.2 Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index.

.3 Software Programming:

.1 Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the system, but not specified in this document, also shall be provided by the Control Subcontractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation.

3.10 CONTROL SYSTEM CHECKOUT AND TESTING

.1 Start-up Testing: All testing listed in this article, as well as functional tests shall be performed by the Control Subcontractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the Contract Administrator's representative is notified of the system demonstration.

.1 The Control Subcontractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.

.2 Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.

.3 Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturers' recommendations.

.4 Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.

.5 Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The Control Subcontractor shall check all control valves and automatic dampers to ensure proper action and closure. The Control Subcontractor shall make any necessary adjustments to valve stem and damper blade travel.

.6 Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all loops and optimum start/stop routines.

.7 Alarms and Interlocks:

Check each alarm separately by including an appropriate signal at a value that will trip the alarm.

Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.

Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

.8 Testing and balancing shall also be performed according to the Testing and Balancing section.

3.11 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

.1 Demonstration

.1 Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Control Subcontractor has completed the installation, started up the system, and performed his/her own tests.

.2 The tests described in this section are to be performed in addition to the tests that the Control Subcontractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" article in Part 3 of this specification. The Contract Administrator will be present to observe and review these tests. The Contract Administrator shall be notified at least 10 days in advance of the start of the testing procedures.

.3 The demonstration process shall follow that approved in Part 1, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.

.4 The Control Subcontractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the Control Subcontractor.

.5 As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.

.6 Demonstrate compliance with Part 1, "System Performance."

.7 Demonstrate compliance with sequences of operation through all modes of operation.

.8 Demonstrate complete operation of operator interface.

.9 Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The Control Subcontractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

.2 Acceptance:

.1 All tests described in this specification shall have been performed to the satisfaction of the Contract Administrator prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the Control Subcontractor may be exempt from the completion requirements if stated as such in writing by the Contract Administrator. Such tests shall then be performed as part of the warranty.

.2 The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1, "Submittals."

3.12 CLEANING

.1 The Control Subcontractor shall clean up all debris resulting from his/her activities daily. The Control Subcontractor 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 Control Subcontractor 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.

3.13 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, control and optimizing routines (algorithms)

.3 Adjust and change system set points, time schedules, and holiday schedules. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals. Understand system drawings and Operation and Maintenance manual

.4 Understand the job layout and location of control components

.5 Access data from controllers and ASCs

.2 Advanced Operators:

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

.2 Create, delete, and modify reports

.3 Add, remove, and modify system's physical points

.4 Create, modify, and delete programming

.5 Add panels when required

.6 Add operator interface stations

.7 Create, delete, and modify system displays, both graphical and others

.8 Perform controller unit operation and maintenance procedures

.9 Perform control system diagnostic procedures

.10 Configure hardware including PC boards, switches, communication, and I/O points

.11 Maintain, calibrate, troubleshoot, diagnose, and repair hardware

.12 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 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.

3.14 SEQUENCE OF OPERATION (REFER TO CONTROL SCHEMATICS)

.1 Baseboard Heaters (BH-):

.1 Heaters shall operate with line voltage thermostats. Refer to Section 23 82 39 for thermostat specification. (Supplied by mechanical, installed by electrical).

.2 Force Flow Heaters (FF-1):

.1 Heater shall operate with line voltage thermostat. Refer to Section 23 82 39 for thermostat specification. (Supplied by mechanical, installed by electrical).

.3 Force Flow Heaters (FF-2 to FF-5):

.1 Heaters shall operate with integral thermostats.

.4 Unit Heaters (UH-)

.1 Heater shall operate with low-voltage thermostats.

.5 Packaged Terminal Air Conditioners (PTAC-)

.1 Units shall operate with low-voltage thermostats.

.6 Energy Recovery Ventilator (ERV-1)

.1 Unit shall enter occupied mode when the position of the corridor light switch is in the on position.

.1 Occupied mode:

.1 ERV-1 shall turn on and associated motorized dampers (MD-5 & MD-6) shall open.

.2 ERV-1 shall enter free cooling mode on a call for cooling from the associated free cooling thermostat,

where outdoor air temperatures are lower than the free cooling thermostat setpoint.

.2 Unoccupied mode:

.1 ERV-1 shall turn off and associated motorized dampers (MD-5 & MD-6) shall close.

.7 Garage Ventilation System

.1 Control Subcontractor to design, supply, install, and commission gas detection system and provide a fully functional ventilation control system.

.2 Gas detection system shall continuously monitor CO and NO2 levels.

.1 When either CO or NO2 levels exceed allowable limit, supply fan (SF-2) and exhaust fan (EF-2) shall turn on, motorized dampers (MD-3 & MD-4) shall open, and Duct Heater (DH-2) shall be enabled. System shall continue to operate until gas concentrations are below set point.

.2 When enabled, Duct Heater (DH-2) shall operate to maintain constant supply air discharge temperature. (Setpoint shall be operator adjustable.)

.3 Once setpoint is reached, supply fan (SF-2) and exhaust fan (EF-2) shall turn off, motorized dampers (MD-3 & MD-4) shall close, and Duct Heater (DH-2) shall be disabled.

.8 Receiving/Sorting Ventilation System

.1 System shall enter occupied mode when the position of the any of the room light switches is in the on position.

.1 Occupied Mode:

.1 Supply fan (SF-1) and exhaust fan (EF-1) shall be on, associated motorized dampers (MD-1 & MD-2) shall be open, and Duct Heater (DH-1) shall be enabled.

.2 When enabled, Duct Heater (DH-1) shall operate to maintain constant supply air discharge temperature. (Setpoint shall be operator adjustable.)

.3 During normal occupied mode, supply fan (SF-1) and exhaust fan (EF-1) shall operate to provide 25% of design airflow capacity.

.4 Free Cooling: Where outdoor air temperatures permit, supply fan (SF-1) and exhaust fan (EF-1) shall modulate to maintain free cooling thermostat setpoint.

.1 Duct Heater (DH-1) shall be disabled in free cooling mode.

.2 Unoccupied Mode:

.1 Supply fan (SF-1) and exhaust fan (EF-1) shall be off, associated motorized dampers (MD-1 & MD-2) shall be closed, and Duct Heater (DH-1) shall be disabled.

.3 Flush Mode:

.1 The ventilation system shall enter flush mode based on a signal from a push button. The system shall operate in flush mode for 15 minutes from the time that the push button was operated.

.2 Supply fan (SF-1) and exhaust fan (EF-1) shall be on, associated motorized dampers (MD-1 & MD-2) shall be open, and Duct Heater (DH-1) shall be enabled.

.3 During flush mode, supply fan (SF-1) and exhaust fan (EF-1) shall operate to provide 100% of design airflow capacity.

3.15 THERMOSTATS AND TEMPERATURE SENSORS

.1 Provide space mounted thermostat/temperature sensors suitable for specified operation.

.2 Provide lockable cover for ones located in public access areas.

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.

.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.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit shop drawings and product data in accordance with E3 – Shop Drawings.

Part 2 Products

2.1 SEAL CLASSIFICATION

.1 Classification as follows:

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

.1 Class C: transverse joints and connections made air tight with gaskets, sealant, tape, 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.

.1 Acceptable Material: Duro Dyne DWN or approved equivalent in accordance with B7.

2.3 TAPE

.1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.

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 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.

.4 Transitions:

.1 Diverging: 20 degrees maximum included angle.

.2 Converging: 30 degrees maximum included angle.

.5 Offsets:

.1 Full radiused elbows.

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

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

.1 Maximum size duct supported by strap hanger: 500mm. Larger ducts to use trapeze hangers.

.2 Hanger configuration: to 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 or steel plate washer.

.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 as follows:

Duct Size (mm)	Spacing (mm)

to 1500	3000
1501 and over	2500

3.3 WATERTIGHT DUCT

.1 Provide watertight duct for:

.1 Fresh air intake.

.2 Exhaust air discharge.

.2 Slope horizontal branch ductwork down to outside.

.3 Form bottom of horizontal duct without longitudinal seams.

.1 Solder or weld joints of bottom and side sheets.

.2 Seal all other joints with duct sealer.

.4 Slope horizontal branch ductwork down towards louvers served.

.1 Slope header ducts down toward risers.

.2 Provide drain piping to floor.

3.4 SEALING AND TAPING

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

.2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturers recommendations.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and 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 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with E3 – Shop Drawings.

.2 Product Data:

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

.1 Flexible connections.

.2 Duct access doors.

.3 Turning vanes.

.4 Instrument test ports.

.3 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in E5 - Operation and Maintenance Manuals.

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/m².

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 complete with safety chain.

.2 301 to 450 mm: four sash locks complete with safety chain.

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

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

.5 Hold open devices.

2.4 TURNING VANES

.1 Factory or shop fabricated to recommendations of SMACNA and as indicated.

2.5 INSTRUMENT TEST

.1 1.6 mm thick steel zinc plated after manufacture.

.2 Cam lock handles with neoprene expansion plug and handle chain.

.3 28 mm minimum inside diameter. Length to suit insulation thickness.

.4 Neoprene mounting gasket.

2.6 SPIN-IN COLLARS

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

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

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Flexible Connections:

.1 Install in following locations:

.1 Inlets and outlets to supply air units and fans.

.2 Inlets and outlets of exhaust and return air fans.

.3 As indicated.

.2 Length of connection: 100 mm.

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

.4 Install in accordance with recommendations of SMACNA.

.5 When fan is running:

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

.2 Ensure slack material in flexible connection.

.2 Access Doors and Viewing Panels:

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

1.2 REFERENCES

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

.1 ASTM A653/A653M-04a, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.

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

.1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with E3 - Shop Drawings. Include product characteristics, performance criteria, and limitations.

.2 Indicate the following:

.1 Performance data.

.2 Closeout Submittals

.1 Provide maintenance data for incorporation into manual specified in E5 - Operations and Maintenance Manuals.

Part 2 Products

2.1 BACK DRAFT DAMPERS

.1 Automatic gravity operated, multi leaf, aluminum construction with nylon bearings, as indicated.

2.2 INSULATED MOTORIZED DAMPERS (MD-1TO MD-6)

.1 Dampers shall be parallel blade action.

.2 Operator: by Section 23 09 33 – Electric and Electronic Control for HVAC.

.3 Extruded aluminum (6063-T5) damper frame shall not be less than 2 mm in thickness. Damper frame shall be 100 mm deep x 25 mm, with duct mounting flanges on both sides of frame. Damper frame shall have a 50 mm mounting flange on the rear of the damper, when installed as Extended Rear Flange install type. Frame to be assembled using zinc-plated steel mounting fasteners.

.4 Blades shall be maximum 155 mm deep extruded aluminum (6063-T5) air-foil profiles with a minimum wall thickness of 1.5 mm. Blades shall be internally insulated with expanded polyurethane foam and shall be thermally broken. Complete blade shall have an insulating factor of R-2.29 and a temperature index of 55.

.5 Blade seals shall be extruded EPDM, secured in an integral slot within the aluminum blade extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Adhesive or clip-on type blade seals will not be approved.

.6 Frame seals shall be extruded silicone, secured in an integral slot within the aluminum frame extrusions and shall be mechanically fastened to prevent shrinkage and movement over the life of the damper. Metallic compression type jamb seals will not be approved.

.7 Bearings shall be a dual bearing system composed of a Celcon inner bearing (fixed around a 11 mm aluminum hexagon blade pivot pin), rotating within a polycarbonate outer bearing inserted in the frame. Single axle bearing, rotating in an extruded or punched hole shall not be acceptable.

.8 Hexagonal control shaft shall be 11 mm. It shall have an adjustable length and shall be an integral part of the blade axle. A field-applied control shaft shall not be acceptable. All parts shall be zinc-plated steel.

.9 Linkage hardware shall be aluminum and corrosion-resistant zinc-plated steel, installed in the frame side, out of the airstream, and accessible after installation. Linkage hardware shall be complete with cup-point trunnion screws to prevent linkage slippage. Linkage that consists of metal rubbing metal will not be approved.

.10 Dampers shall be designed for operation in temperatures ranging from -40°C to 100°C.

.11 Dampers shall be AMCA rated for Leakage Class 1A at 250 Pa static pressure differential. Standard air leakage data to be certified under the AMCA Certified Ratings Program.

.12 Dampers shall be custom made to required size, with blade stops not exceeding 32 mm in height.

.13 Dampers mounting type: Flanged to Duct.

.14 Installation of dampers must be in accordance with manufacturers current installation guidelines, provided with each damper shipment.

.15 Intermediate or tubular steel structural support is required to resist applied pressure loads for dampers that consist of two or more sections in both height and width.

.16 Acceptable Product: “Tamco” Series 9000 Thermally Insulated Damper or approved equivalent in accordance with B7. Sizes as indicated 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 Install where indicated.

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

.3 Seal multiple damper modules with silicon sealant.

.4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.

.5 Ensure dampers are observable and accessible.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Fans, motors, accessories and hardware for commercial use.

1.2 REFERENCES

.1 Air Conditioning and Mechanical Contractors (AMCA)

.1 AMCA Publication 99-2003, Standards Handbook.

.2 AMCA 300-1996, Reverberant Room Method for Sound Testing of Fans.

.3 AMCA 301-1990, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

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

.1 ANSI/AMCA 210-1999, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.

.3 Canadian General Standards Board (CGSB)

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

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

.1 Material Safety Data Sheets (MSDS).

1.3 SYSTEM DESCRIPTION

.1 Performance Requirements:

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

.2 Capacity: flow rate, static pressure, bhp, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.

.3 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.

.4 Sound ratings: comply with AMCA 301, tested to AMCA 300. Supply unit with AMCA certified sound rating seal.

.5 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210. Supply unit with AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

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

.2 Shop Drawings:

.1 Submit shop drawings and product data in accordance with E3 - Shop Drawings.

.3 Provide :

.1 Fan performance curves showing point of operation, BHP and efficiency.

.2 Sound rating data at point of operation.

.4 Indicate:

.1 Motors, sheaves, bearings, shaft details.

.5 Closeout Submittals:

.1 Provide operation and maintenance data for incorporation into manual specified in E5 - Operations and Maintenance Manuals.

1.5 MAINTENANCE

.1 Extra Materials:

.1 Provide the following maintenance materials:

.1 Spare parts to include:

.1 Matched sets of belts.

Part 2 Products

2.1 FANS GENERAL

.1 Motors:

.1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.

.2 Sizes as specified.

.2 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, coupling guards fan inlet and outlet safety screens as indicated and as specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment.

.3 Factory primed before assembly in colour standard to manufacturer.

.4 Scroll casing drains: as indicated.

.5 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.

.6 Vibration isolation: as per manufacturer’s requirements.

.7 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

2.2 SUPPLY FAN (SF-1)

.1 Performance: 1060 L/s @ 125 Pa (2250 CFM @ 0.5” w.g.), 1085 Fan RPM, 0.417 BHP.

.2 Motor: 115V/1ph/60hz, 1/2 HP, 1725 RPM, open enclosure, permanently lubricated. EC motor c/w controller to vary motor speed with 0-10Vdc signal.

.3 Direct drive centrifugal square inline fan, aluminum wheel, galvanized steel housing, three removable access doors, closed cell neoprene gasketing, inlet and outlet discharge duct collars.

.4 Dimensions(HxWxL): 560 x 560 x 686mm. Weight: 60 kg.

.5 Sound rating not to exceed 12.8 Sones at inlet, and 10.6 at outlet.

.6 Acceptable Product: “Cook” model SQN-D VF 165SQN17D (VF) or approved equivalent in accordance with B7.

2.3 SUPPLY FAN (SF-2)

.1 Performance: 377 L/s @ 125 Pa (800 CFM @ 0.5” w.g.), 1859 Fan RPM, 0.230 BHP.

.2 Motor: 115V/1ph/60hz, 1/4 HP, 1725 RPM, open enclosure. Permanently lubricated, ball bearing motor.

.3 Belt drive centrifugal square inline fan, aluminum wheel, galvanized steel housing, three removable access doors, closed cell neoprene gasketing, inlet and outlet discharge duct collars, Motor cover, spring ceiling vibration isolator.

.4 Dimensions(HxWxL): 673 x 350 x 550 mm. Weight: 25 kg.

.5 Sound rating not to exceed 8.5 Sones at inlet, and 11.1 Sones at outlet.

.6 Acceptable Product: “Cook” model SQN-B 100SQN-B or approved equivalent in accordance with B7.

2.4 EXHAUST FAN (EF-1)

.1 Performance: 1060 L/s @ 125 Pa (2250 CFM @ 0.5” w.g.), 1085 Fan RPM, 0.417 BHP.

.2 Motor: 115V/1ph/60hz, 1/2 HP, 1725 RPM, open enclosure, permanently lubricated. EC motor c/w controller to vary motor speed with 0-10Vdc signal.

.3 Direct drive centrifugal square inline fan, aluminum wheel, galvanized steel housing, three removable access doors, closed cell neoprene gasketing, inlet and outlet discharge duct collars.

.4 Dimensions(HxWxL): 560 x 560 x 686mm. Weight: 60 kg.

.5 Sound rating not to exceed 12.8 Sones at inlet, and 10.6 at outlet.

.6 Acceptable Product: “Cook” model SQN-D VF 165SQN17D (VF) or approved equivalent in accordance with B7.

2.5 EXHAUST FAN (EF-2)

.1 Performance: 377 L/s @ 63 Pa (800 CFM @ 0.25” w.g.), 1647 Fan RPM, 104 Watts power consumption.

.2 Motor: 115V/1ph/60hz, 1/4 HP, 1725 RPM, open enclosure, permanently lubricated, electronically commutated motor.

.3 Direct drive centrifugal wall mounted exhaust ventilator, aluminum wheel, all aluminum housing, two piece top cap with stainless steel quick release latches, mounting flange with keyslots and templates, birdscreen. Fan mounted speed control.

.4 Dimensions(Depth x Diameter): 575 mm x 638 mm. Weight: 9 kg.

.5 Sound rating not to exceed 10.6 Sones at inlet.

.6 Acceptable Product: “Cook” model ACWD-EC 101W17DEC or approved equivalent in accordance with B7.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 FAN INSTALLATION

.1 Install fans as indicated, complete with resilient mountings, flexible electrical leads and flexible connections in accordance with Section 23 33 00 - Air Duct Accessories.

.2 Provide sheaves and belts required for final air balance.

.3 Bearings and extension tubes to be easily accessible.

.4 Access doors and access panels to be easily accessible.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Supply, return and exhaust grilles and registers, diffusers and linear grilles, for commercial and residential use.

1.2 SYSTEM DESCRIPTION

.1 Performance Requirements:

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

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with E3 - Shop Drawings. Include product characteristics, performance criteria, and limitations.

.2 Indicate following:

.1 Capacity.

.2 Throw and terminal velocity.

.3 Noise criteria.

.4 Pressure drop.

.5 Neck velocity.

.6 Dimensions

Part 2 Products

2.1 GENERAL

.1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as indicated.

.2 Frames:

.1 Full perimeter gaskets.

.2 Plaster frames where set into plaster or gypsum board.

.3 Concealed fasteners.

.3 Concealed manual volume control damper operators.

2.2 MANUFACTURED UNITS

.1 Grilles, registers and diffusers of same generic type, products of one manufacturer.

2.3 GRILLES SCHEDULE

.1 As indicated 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 Install in accordance with manufacturer’s instructions.

.2 Install with stainless steel screws in countersunk holes where fastenings are visible.

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 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with E3 - Shop Drawings. 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: storm-proof 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: 12 mm exhaust, 19 mm intake mesh, 2 mm diameter wire aluminum birdscreen on inside face of louvres in formed U-frame.

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

.9 Acceptable Product: “E.H. Price” per louver schedule on drawings or approved equivalent in accordance with B7.

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 REFERENCES

.1 CSA Group

.1 CSA C22.2 No.46-M1988(R2011), Electric Air-Heaters.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with E3 - Shop Drawings.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for duct heaters and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit product data and include:

.1 Element support details.

.2 Heater: total kW rating, voltage, phase.

.3 Number of stages.

.4 Rating of stage: rating, voltage, phase.

.5 Heater element watt/density and maximum sheath temperature.

.6 Maximum discharge temperature.

.7 Unit support.

.8 Clearance from combustible materials.

.9 Internal components wiring diagrams.

.10 Minimum operating airflow.

.11 Pressure drop operating and minimum airflow.

1.3 DELIVERY, STORAGE AND HANDLING

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

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect duct heaters from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 DUCT HEATERS (DH-1 & DH-2)

.1 Construction

.1 Frame shall be corrosion-resistant and made of galvanized steel of suitable gauge as required by CSA.

.2 Coils shall be made of high grade Nickel-Chrome alloy and shall be insulated by floating ceramic bushings from the galvanized steel frame.

.3 Coil terminal pins shall be stainless steel, mechanically secured and insulated from the frame by means of non-rotating ceramic bushing.

.4 Coil support bushing shall be made of ceramic and shall be held in the frame by a lock which will keep it floating and stress free.

.2 Safety Controls

.1 Heaters shall be equipped with fail-safe automatic reset disc-type thermal cut-out(s) located in the top frame component above the heating elements.

.2 The sensing element of the cut-out shall be stream mounted, shall be shielded from mechanical damage and shall face the center portion of the heating section so as to make the heater non-sensitive to air flow direction.

.3 Cut-outs shall de-energize the heater in case of insufficient air flow.

.4 Load fuses shall be supplied as recommended by NEC (National Electrical Code).

.5 Airflow

.6 Duct heaters shall be non-sensitive to air flow direction and interchangeable for horizontal or vertical ducts without impairing safety.

.7 Heaters shall be CSA approved for zero clearance in horizontal ducts.

.3 Mounting

.1 Heaters shall be flanged-to-duct.

.2 Heaters shall be open coil flanged type, as shown on the plans or on the coil schedule.

.3 Flanged heaters shall be suitable for attaching to matching flanges on the duct.

.4 Mounting flanges shall be independent of the terminal box so as to allow installation without opening the box or drilling into it.

.4 Internal Wiring

.1 All internal wiring shall terminate on clearly identified terminal blocks.

.2 A wiring diagram shall be installed on the control box cover.

.3 Prior to shipping, heaters shall withstand tests as required by CSA.

.5 Controls

.1 All duct heaters shall be complete with the following built-in controls: High limit cut-outs, magnetic contactors as required, control transformer and air flow sensor as standard components.

.2 Unit shall include SCR Proportional controller.

.6 Acceptable Product: “Thermolec” model FC or approved equivalent in accordance with B7.

Tag	Heat Output (kW)	Airflow (L/s)	Face Dimensions (mm x mm)	Voltage V/Ph	Make/Model
DH-1	15	945	750 x 750	600/3	Thermolec/FC
DH-2	20	377	500 x 500	600/3	Thermolec/FC

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for duct heaters installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Contract Administrator.

.2 Inform Contract Administrator of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Contract Administrator.

3.2 INSTALLATION

.1 Make power and control connections to CSA C22.2 No.46.

3.3 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Perform tests in presence of Contract Administrator.

.1 Provide test report and include copy with Operations and Maintenance Manuals.

END OF SECTION

Part 1 General

1.1 REFERENCES

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

.1 ASHRAE 84-2013, Method of Testing Air-to-Air Heat/Energy Exchangers (ANSI approved).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with E3 - Shop Drawings.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for energy recovery equipment and include product characteristics, performance criteria, physical size, finish and limitations.

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

.4 Test Reports:

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

.2 Provide confirmation of testing.

1.3 MAINTENANCE MATERIAL SUBMITTALS

.1 Submit maintenance materials in accordance with E3 - Shop Drawings.

.2 Extra Materials:

.1 Furnish list of individual manufacturer's recommended spare parts for equipment include:

.1 Bearings and seals.

.2 Addresses of suppliers.

.2 List of specialized tools necessary for adjusting, repairing or replacing.

1.4 DELIVERY, STORAGE AND HANDLING

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

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location, and in accordance with manufacturer's recommendations.

.2 Store and protect energy recovery equipment from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 ENERGY RECOVERY VENTILATOR (ERV-1) (SUPPLIED BY THE CITY)

.1 Performance: 60 L/s @ 125 Pa ESP.

.2 Unit Construction:

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

.2 Panels and access doors shall be constructed as a 25-mm nominal thick; with injected polyurethane foam insulation. R value shall be 6.5 per inch of wall thickness. The outer panel shall be constructed of G90 galvanized steel. The inner liner shall be constructed of G90 galvanized steel. Manufacturer shall supply test data demonstrating less than L/240 deflection for an unsupported 1200mmx1200mm panel under 7440 Pa pressure. Units that cannot demonstrate this deflection are unacceptable. Outer casing shall be finished with a powder coated industrial paint.

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

.4 Unit Weight: 144 kg

.3 Supply / Return Fans

.1 Provide direct-drive plenum fan(s) with ECM motors. Fan assemblies including fan, motor and sheaves shall be dynamically balanced by the manufacturer on all three planes and at all bearing supports. Manufacturer must ensure maximum fan RPM is below the first critical speed.

.2 Fan and motor shall be mounted internally on a steel base. Provide access to motor, drive, and bearings through hinged access door. Fan and motor assembly shall be mounted on rubber-in-shear vibration type isolators inside cabinetry.

.4 Electrical

.1 120V/1Ph/60Hz, 5.5 FLA.

.2 All electrical components shall bear a UL and CSA safety listing.

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

.4 Air handler manufacturer shall provide and mount a damper controls for standalone operation of the ERV.

.5 Particulate Filters

.1 Filter section with filter racks and guides with hinged access doors for side loading and removal of filters

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

.3 Flat arrangement with 50mm pleated MERV 10 panel filters.

.6 Energy Recovery

.1 The unit shall be 90% efficient (sensible +-5%) at equal airflow in winter and up to 80% sensible in summer. It shall also provide up to 70% latent recovery in winter mode. Unit shall accomplish this recovery without a defrost cycle that will reduce the effectiveness of the device. Devices employing defrost cycles that bypass the energy recovery device, or reduce the effectiveness are not acceptable. Energy recovery device shall not require frost protection in applications down to -40 degrees. Cores shall be Generation 3, comprised of precisely corrugated high grade aluminum.

.2 Switchover damper section shall be comprised of low leakage dampers operated by fast acting electric actuators having damper switching times of 0.75 seconds. Dampers that do not switch within the specified times without objectionable noise are not acceptable.

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

.7 Product: “Temp Eff” model RGSP 300.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for energy recovery equipment installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Contract Administrator.

.2 Inform Contract Administrator of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Contract Administrator.

3.2 INSTALLATION

.1 Install in accordance with manufacturers recommendations.

.2 Support independently of adjacent ductwork with flexible connections.

.3 Install access doors in accordance with Section 23 33 00 - Air Duct Accessories for access to coils and dampers.

3.3 FIELD QUALITY CONTROL

.1 Tests:

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

3.4 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American National Standards Institute/Air-Conditioning and Refrigeration Institute (ANSI/ARI)

.1 ANSI/ARI 430-99(R2002), Central-Station Air-Handling Units.

.2 American Society of Heating, Refrigeration and Air Condition Engineers (ASHRAE)

.1 ANSI/ASHRAE 90.1-2007, (I-P) Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 ANSI/ASHRAE 52.2-2007, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

.3 Canadian General Standards Board (CGSB)

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

.4 Green Seal Environmental Standards (GSES)

.1 Standard GS-11-07, Environmental Standard for Paints.

.5 Master Painters Institute (MPI)

.1 MPI-INT 5.3-2007, Galvanized Metal.

.6 South Coast Air Quality Management District (SCAQMD), California State (SCAQMD)

.1 SCAQMD Rule 1113-04, Architectural Coatings.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with E3 - Shop Drawings.

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for insulation, filters, adhesives, and paints, and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Indicate following: fan, motor drive, voltage, total and sensible cooling, filters, mixing box, dampers, coil; include performance data.

1.3 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for incorporation into manual specified in E5 - Operation and Maintenance Manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

.1 Provide five spare sets of filters.

.2 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.

Part 2 Products

2.1 Air Conditioning Unit (AC-1) and Condensing Unit (CU-1)

.1 Performance: 3.8 kW (13,000 BTUH) Cooling Capacity, 15 SEER. 200L/s (424 CFM) airflow rate and 44 dBA sound pressure level at high fan speed (indoor unit).

.2 Construction: Ductless split system air conditioner, inverter driven swing compressor, mold-resistant washable air filter, wireless remote, R-410A Refrigerant.

.3 Electrical: 208-230/60/1 (V/Hz/Ph).

.4 Dimensions (HxWxD): 286 x 770 x 222 mm (11-1/4" x 30-5/16" x 8-3/4") indoor unit, 541x675x284 mm (21-5/8" x 26-9/16" x 11-3/16") condensing unit.

.5 Acceptable Products: "Daikin" model FTKN12NMVJU indoor unit and RKN12NMVJU condensing unit or approved equivalent in accordance with B7.

2.2 Rooftop Air Conditioning Unit (AC-2 & AC-3)

.1 Performance: 3.95 kW (13,500 BTU/H) Cooling capacity, 150L/s (320 CFM) airflow

.2 R-410A refrigerant, corrosion-resistant stainless steel screws to secure plastic shroud, plastic drain pan, sealed motor shaft.

.3 Electrical: 120V/60Hz/1Ph. 15.3 FLA.

.4 Weight: 36 kg (79.6 lb).

.5 Ceiling Assembly: Air diffuser grille, manual control dial, integral filter, 120V.

.6 Acceptable Products: "Coleman-Mach" model Mach 3 Plus c/w 9400 Series Ceiling Assembly or approved equivalent in accordance with B7.

2.3 Packaged Terminal Air Conditioning Unit (PTAC-1 & PTAC-2)

.1 General:

.1 Factory-assembled, single-piece heating and/or cooling unit. Contained within the unit enclosure shall be compressor, coils, fans and fan motor, heating means, controls, all wiring and piping, and a full refrigerant charge (R-410A).

.2 Chassis:

.1 The chassis shall be a factory-assembled, single piece heating and/or cooling unit that is simple to install and operate. Just slide the chassis into a wall sleeve, plug it into an outlet, and operate after installation. The chassis dimensions shall not exceed 1050 mm wide and 400 mm high with room cabinet in place. The chassis shall consist of the following functional sections and components:

.2 Operating Characteristics:

.1 Chassis shall be capable of starting and running at 46°C ambient outdoor temperature per maximum load criteria of ARI Standard 310/380.

.3 Electrical:

.1 Chassis shall be equipped with a 1450 mm long powercord. The chassis current draw shall be specified on the chassis nameplate and match electrical requirements specified on the Contract drawing schedule and

specifications. The power cord plug configuration shall conform to NEMA standards and the rating shall support the current draw of the electric resistance heater.

.2 Unit voltages shall be 208V/1Ph.

.3 Airflow System:

.1 The airflow system shall consist of one permanent split-capacitor, direct-drive permanently lubricated, two-speed fan motor for the indoor and outdoor fans. The outdoor fan shall be a dynamically balanced, corrosion resistant polymer multi-blade axial flow design, with integrated slinger ring. The indoor fan shall be a dynamically balanced, polymer, reverse curve blower wheel, to assure uniform air distribution. The Fan Motor shall be of an enclosed design to reduce the effects of moisture and corrosion.

.2 Units shall have 160 L/s airflow rate in cooling mode and 113 L/s airflow rate in heating mode.

.4 Compressor and Refrigerant:

.1 The rotary-type Compressor shall be fully hermetic with internal and external vibration isolation. The refrigeration system will be sealed and contain a full refrigerant charge (R-410a).

.5 Coils:

.1 Condenser and evaporator coils to be constructed of high-efficiency, lanced sine wave enhanced aluminum fins and seamless axial grooved copper tubing, necessary to achieve EER and COP rating, as specified on the chassis name plate.

.6 Factory-Installed Electric Heater:

.1 The factory-installed, open coil type, electric heater is standard in heat/cool and heat pump chassis. The electric heater shall contain both an automatic reset and a one-shot over temperature protection device.

.2 The heating capacity of the electric heater shall be as identified in the schedule below.

.7 Front Panel (supplied with chassis):

.1 Front panel shall be constructed of a polymer material to resist breakage and corrosion. It shall have a front louvered surface with integrated air filters. The air filters shall be easily accessible without removing the front panel from the chassis.

.8 Fresh Air Vent:

.1 The chassis shall have a manual adjustable fresh air vent with a concealed manual control. The vent control shall allow a maximum of 35 L/s of fresh air to be drawn into the room when the indoor fan is operating and the door is open.

.9 Condensate Removal System

.1 The chassis shall have a condensate removal system consisting of a condensate suction port, to draw and atomize condensate, and a slinger ring integrated in the outdoor fan, to disperse condensate onto the condenser coil to be evaporated.

.2 Condensation accumulated during reverse cycle heating must NOT be evaporated against the indoor coil so as to prevent contamination of the indoor air with pollutants and odors. Condensation must be disposed of using a (external) (internal) drain system as shown on plans.

.10 Controls

.1 Units shall have two stages of heating and two stages of cooling.

.2 All standard models shall be equipped with electromechanical controls to simplify the serviceability of the unit.

.3 Standard Controls

.1 The chassis shall have standard controls, accessible. The mode selection control shall provide OFF, FAN ONLY, HEAT or COOL operations.

.2 The temperature selection control shall be an adjustable thermostat with upper and lower limits.

.4 Continuous Fan

.1 All standard models shall have a continuous/ fan cycle selector switch located behind the front panel. It shall allow the selection of continuous fan operation for maximum comfort or cycle operation (fan only runs with cooling or heating operation) for maximum energy savings.

.5 Temperature Limiting

.1 All standard models shall have Temperature Limiting management built in to the system controls.

.2 The temperature limiting controls allow a room temperature set-point range to be established, to avoid extreme temperature settings, to maximize energy savings.

.6 Emergency Heat

.1 Emergency Heat Switch (Heat Pump Models Only), upon failure of the compressor, shall automatically disable the compressor in heating mode and only allow the use of electric strip heater during heating cycles. The Emergency Heat switch is active at all outdoor ambient temperatures.

.7 Thermostat

.1 Wall thermostat chassis shall come from the factory ready for wall thermostat installation, including a blank out plate in place of the digital control panel. Installation of harness and DIP switch required.

.8 Fan Speed Control

.1 Wall thermostat chassis (RC and RP models) shall have a user selectable fan speed control switch, on the control panel, to optimize fan speed for maximum comfort.

.9 Protection Circuits:

.1 Compressor shall have automatic reset, over temperature and over current protection. The fan motor shall have an inherent, automatic reset over temperature protection. The electric heater shall have two over temperature protectors.

.11 Refer to the following schedule for equipment performance and make and model:

Tag	Cooling Capacity (kW)	Heat Pump Capacity (kW) (8°C Ambient)	Electric Heat Coil Capacity (kW)	Make / Model [Note 1 & 2]
PTAC-1	2.11	2.05	2.05	Islandaire / EZ4207B
PTAC-2	2.11	2.05	2.95	Islandaire / EZ4207B

Note 1: Approved equivalents shall be in accordance with B7.

Note 2: Units shall be c/w optional wall thermostat and architectural extruded aluminum exterior grille.

Part 3 Execution

3.1 APPLICATION

.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 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.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASTM International

.1 ASTM E84-11a, Standard Test Method for Surface Burning Characteristics of Building Materials.

.2 ASTM C916-1985(R2007), Standard Specification for Adhesives for Duct Thermal Insulation.

.3 ASTM C1071-05e1, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

.2 National Fire Protection Association (NFPA)

.1 NFPA 90A-2012, Standard for the Installation of Air Conditioning and Ventilating Systems.

.2 NFPA 90B-2012, Standard for the Installation of Warm Air Heating and Air Conditioning Systems (ANSI).

.3 Underwriters' Laboratories (UL) Inc.

.1 UL 2021-1997, Fixed and Location-Dedicated Electric Room Heaters.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with E3 - Shop Drawings.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for unit heaters and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Manufacturer's Instructions: provide to indicate special handling criteria, installation sequence, and cleaning procedures.

.4 Shop Drawings:

.1 Indicate on drawings:

.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.

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with E5 - Operation and Maintenance Manuals.

.2 Operation and Maintenance Data: submit operation and maintenance data for unit heaters for incorporation into manual.

Part 2 Products

1.1 UNIT HEATERS, UH-1 TO UH-6

.1 Industrial suspended electrical unit heater.

.2 Casings shall be constructed of 18 gauge steel epoxy/polyester power paint. Adjustable louvres to direct airflow. High-limit temperature control with automatic reset. Stainless steel tubular heating elements. Factory-installed contactor. 58 dBA fan sound level. Fan delay to purge heater of residual heat.

.3 Motor: Totally enclosed and factory-lubricated ball bearing motor, thermally-protected. 1550 RPM.

.4 Controls: Thermostat and control wiring by Section 23 09 33.

.5 Electrical: 600V/3ph/60hz.

.6 Dimensions (HxWxL): 309x419x432mm.

.7 Approvals: CSA Approved.

.8 Refer to schedule below for model numbers or approved equivalent in accordance with B7:

Tag	Heating Output (kW)	Airflow (L/s)	Motor Power (kW)	Make/Model
UH-1	5	330	1/40	Ouellet/OAS05036
UH-2	5	330	1/40	Ouellet/OAS05036
UH-3	5	330	1/40	Ouellet/OAS05036
UH-4	5	330	1/40	Ouellet/OAS05036
UH-5	3	240	1/40	Ouellet/OAS03036
UH-6	3	240	1/40	Ouellet/OAS03036

1.2 FORCE FLOW HEATER, FF-1

.1 Architectural electrical wall mounted fan heater.

.2 Extruded aluminum front grille, 3mm thick. Epoxy/polyester powder paint. Bottom air outlet. High-temperature control with automatic reset. Tubular heating element with fins. 55 dBA fan sound level. Fan delay to purge heater of residual heat.

.3 Motor: Totally enclosed and factory-lubricated ball bearing motor.

.4 Controls: Line voltage thermostat, double pole, single throw, 5° - 25°C temperature range.

.5 Electrical: 208V/1ph/60hz.

.6 Dimensions (HxWxD): 578x408x149mm. 40mm exposed depth with recessed installation.

.7 Approvals: CSA Approved.

.8 Refer to schedule below for model numbers or approved equivalent in accordance with B7:

Tag	Heating Output (kW)	Airflow Rate (L/s)	Make/Model
FF-1	1.5	75	Ouellet/OAWH01502 with model OTL102C thermostat

1.3 FORCE FLOW HEATERS (FF-2 to FF-6)

.1 Commercial electrical wall mounted fan heater.

.2 4 kW heat output, 75 L/s airflow rate.

.3 18-gauge steel front cover. Epoxy/polyester powder paint. Bottom air outlet. High-temperature control with automatic reset. Tubular heating element with fins. 55 dBA fan sound level. Fan delay to purge heater of residual heat.

.4 Motor: Totally enclosed and factory-lubricated ball bearing motor.

.5 Controls: Built-in thermostat with control knob.

.6 Electrical: 208V/1ph/60hz.

.7 Dimensions (HxWxD): 561x410x137mm. 33mm exposed depth with recessed installation.

.8 Approvals: CSA Approved.

.9 Acceptable Product: “Ouellet” model OAC04008 or approved equivalent in accordance with B7.

1.4 BASEBOARD HEATERS (BH-1 TO BH-3)

.1 Electric resistance type baseboard heater.

.2 22-gauge steel body, 20-gauge steel front panel. Rounded upper corners. Epoxy/polyester powder paint. Bottom air outlet. High-temperature control with automatic reset. Stainless steel tubular heating element with aluminum fins. Floating heating element on high-temperature nylon bushings.

.3 Controls: Line voltage thermostat, double pole, single throw, 5° - 25°C temperature range.

.4 Electrical: 208V/1ph/60hz.

.5 Dimensions (HxD): 148x62mm.

.6 Approvals: CSA Approved.

.7 Refer to schedule below for model numbers or approved equivalent in accordance with B7:

Tag	Heating Output (kW)	Length (mm)	Make/Model
BH-1	1	1206	Ouellet/OFM1008
BH-2	1	1206	Ouellet/OFM1008
BH-3	1.5	1668	Ouellet/OFM1508
All baseboard heaters c/w model OTL102C thermostat.			

Part 3 Execution

3.1 INSTALLATION

.1 Install in accordance with manufacturer's instructions.

.2 Include 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 Clean finned tubes and comb straight.

.5 Provide supplementary suspension steel as required.

.6 Install thermostats in locations indicated.

.7 Before acceptance, set discharge patterns and fan speeds to suit requirements.

3.2 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by unit heaters installation.

END OF SECTION