Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 01 35 20 - LEED Sustainable Requirements

.2 Section 01 74 19 – Waste Management and Disposal

1.2 REFERENCES

.1 Definitions:

.1 HVAC System: complete air duct system from outside air intake louvers to furthest air supply terminal unit and including:

.1 Rigid supply and return ductwork;

.2 Flexible ductwork;

.3 Mixing plenum boxes;

.4 Return air plenums including ceiling plenums;

.5 Cooling and heating coils and compartments;

.6 Condensate drain pans, eliminator blades and humidifiers;

.7 Fans, fan blades and fan housing;

.8 Filter housing and frames;

.9 Acoustically insulated duct linings;

.10 Diffusers, registers and terminal units;

.11 Dampers and controls;

.2 Reference Standards:

.1 National Air Duct Cleaners Association (NADCA)

.1 ACR Standard: Assessment, Cleaning and Restoration of HVAC Systems.

.2 North American Insulation Manufacturers Association (NAIMA)

.1 NAIMA, Cleaning Fibrous Glass Insulated Duct Systems - Recommended Practices.

1.3 ADMINISTRATIVE REQUIREMENTS

.1 Site Evaluation: conduct Site visit 2 weeks before start of Work to establish scope of Work and schedule.

.2 Scheduling: Hours of Operation: complete Work during regular business hours.

.3 Project Co-ordination: assign Project Co-ordinator to oversee air duct cleaning processes.

.4 Damaged or broken equipment and components found during initial testing and inspection will be repaired or replaced by Contractor.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's printed product literature and data sheets for antimicrobial agents and include product characteristics, performance criteria and limitations.

.2 Provide two copies of WHMIS MSDS in accordance with Section 01 35 29 - Health and Safety Requirements and 01 35 43 - Environmental Procedures for antimicrobial agents or coatings.

1.5 CLOSEOUT SUBMITTALS

.1 Provide submittals in accordance with Section 01 78 00 - Closeout Submittals.

.2 Post Cleaning Inspection Report: submit 4 copies of Final Inspection Report, including data collected, observations and recommendations as well as following information:

.1 Name and address of facility;

.2 Name and address of HVAC cleaning contractor;

.3 Description of HVAC systems with drawings identifying systems cleaned;

.4 Identification scheme for location points in systems that were inspected with accompanying notes describing methods of inspection or tests used;

.5 Identify systems tested, observations, actions taken and recommendations for future maintenance.

.3 Record post cleaning video survey: submit 2 copies of video survey DVD media, and include on video survey following:

.1 Areas of special interest and location;

.2 Special internal features;

.3 Problems such as broken or damaged controls or components;

.4 Ensure system tested, locations, observations, actions taken and recommendations are clearly identified in English on video using text or voice over.

1.6 EXTRA MATERIALS

.1 Extra Stock Materials:

.1 Supply 3 spare sets of filters for each HVAC System cleaned.

.2 Ensure filters are correct match, size, type and configuration of existing HVAC Systems.

1.7 QUALITY ASSURANCE

.1 Contractor: verification of 5 years minimum experience in work similar to or exceeding work of this Section.

.2 Contract Administrator: verification of 5 years minimum experience in work similar to or exceeding Work of this Section.

Part 2 Products

2.1 ACCESS PANELS

.1 Ductwork Access Panels: construct access doors from 1.27 mm minimum galvanized sheet steel sealed with duct sealant.

.1 Ensure access door is 25 mm greater in every dimension than access opening.

.2 Secure access doors with sheet metal screws on 75 mm centres minimum. Ensure 3 screws per side minimum.

2.2 ANTIMICROBIAL AGENT

.1 Use antimicrobial agents registered with US EPA-40 CFR.

2.3 SYSTEM FILTERS

.1 Supply and install new filters for each HVAC System cleaned.

2.4 AIR DUCT CLEANING EQUIPMENT

.1 Manually propelled full contact brushes:

.1 Ensure brushes are specifically manufactured and shaped to fit individual ducts, equipment and components of HVAC system.

.1 Ensure brushes are sized to fit various duct sizes in HVAC system.

.2 Ensure brushes make scrubbing motion and full contact with HVAC system interior surfaces to be cleaned.

.2 Brushes: manually propelled with integrally-mounted motor or drive and non-metallic material bristles.

.1 Ensure motor has capacity to continue to push brush after bristles are distorted.

.2 Replace worn and ineffective brushes when required.

2.5 MULTI-FUNCTIONAL ROBOTIC CLEANING SYSTEM

.1 Self-propelled remote controlled, track drive equipped with camera and lights.

.1 Ensure brushes are specifically manufactured and shaped to fit applicable ductwork, equipment and components of HVAC system.

.2 Ensure brushes make scrubbing motion and full contact with HVAC system interior surfaces.

.3 Replace worn and ineffective brushes when required.

.2 Camera: remote control focus and dustproof with 480 lines of resolution, capable of storing 4 hours of recorded media.

.1 Camera Light: 2 x 20 watt Halogen with dimmer

2.6 HEPA FILTER EVACUATION FAN

.1 Evacuation Fan: includes fan, HEPA filter, flexible hose and motor capable of maintaining debris and particulates airborne in airstream until they reach evacuation fan and maintaining system under negative pressure.

.1 Ensure HEPA filters are clean and maintain evacuation fan and HEPA filter to run efficiently.

2.7 HEPA VACUUM UNIT

.1 Vacuum Unit: includes vacuum fan, integral HEPA filter, suction hose and vacuum head, capable of maintaining HVAC System debris and particulates airborne in air stream until they reach vacuum unit and maintaining system under negative pressure.

.1 Ensure HEPA filters are clean and maintain vacuum unit and HEPA filter to run efficiently.

Part 3 Execution

3.1 PREPARATION

.1 Close down HVAC system.

.2 Locate and identify externally visible HVAC system features which may affect cleaning process including:

- .1 Control devices;
- .2 Fire and smoke control dampers;
- .3 Balancing dampers: HVAC system to be balanced prior to air balancing;
- .4 Air volume control boxes;
- .5 Fire alarm devices;
- .6 Monitoring devices and controls;

.3 Cut openings in equipment panels and ductwork for access to system interior.

- .1 Square or rectangular opening sizes: 200 mm minimum each side.
- .2 Circular opening sizes: 200 mm minimum diameter.

.4 When acoustically lined duct is cut for access, repair cut edges of acoustic lining using self-adhesive fibre glass tape and water based duct sealer.

- .1 Adhere new acoustic lining to match existing to inside of access panel or door to ensure continuity of acoustic properties of system.

.5 Remove and reinstall ceiling tiles to gain access to HVAC system as required.

- .1 Replace ceiling tiles damaged or soiled by air duct cleaning procedures.

3.2 EXAMINATION / PRE-CLEANING INSPECTION

.1 Verification of Conditions:

- .1 Make visual inspection of interior of HVAC system using remote controlled robotic camera.
- .2 Insert camera at pre-established strategic locations to evaluate condition and cleanliness of HVAC systems and components.

.2 Evaluation and Assessment:

- .1 Identify location and type of internal components.
- .2 Identify extent of potential problems.
- .3 If toxic or hazardous materials or deposits are suspected after initial inspection immediately stop work and inform Contract Administrator.
  - .1 Do not proceed further with inspection operations until written approval from Contract Administrator.

3.3 DUCT CLEANING

.1 Do duct cleaning in accordance with NADCA ACR Standard.

.2 Isolate and clean sections in zones to ensure that dirt deposits and debris from zone being cleaned does not pass through another zones which has already been cleaned.

- .1 Isolate zone of duct using air inflated zone bag before cleaning.

.3 Ensure vacuum units and evacuation fans are securely in place before starting cleaning operation of isolated section of HVAC air duct system.

.4 Install HEPA filter evacuation fan at one end of zone section and insert full contact brushes at other end.

.5 Clean HVAC supply air duct system and components.

.6 Clean exhaust, return, transfer ductwork and plenums, equipment and components.

.7 Energize brushes to travel from insertion point to HEPA filter evacuation fan.

.1 Pass brushes through sections as often as necessary to achieve required cleanliness.

.2 Change brush sizes as required to ensure positive contact with duct and component interiors.

.3 Clean corners and pockets where dirt and debris can accumulate.

.8 Clean equipment, components and other features in isolated zone before moving to next zone of HVAC air duct system.

.9 Clean diffusers, registers, louvers, and other terminal units.

.10 Remove perforated supply diffusers from suspended tee-bar ceiling.

.1 Dismantle and clean perforated plates and supply diffuser duct collars.

.2 Re-assemble perforated plate diffusers and reconnect to HVAC system using supply diffuser duct collar after cleaning.

.11 Advise Contract Administrator 72 hours minimum before deactivation of fire alarm and smoke detectors duct cleaning operations.

3.4 ACOUSTICALLY LINED DUCTWORK CLEANING

.1 Clean glass fibre acoustically insulated ducts to NAIMA recommended practices.

.1 Use specifically designed robotic apparatus that has been demonstrated not to damage acoustic glass fibre lining.

.2 Monitor cleaning process progress by onboard camera.

3.5 COMPONENTS AND EQUIPMENT CLEANING

.1 Brush and vacuum coils, humidifiers, air handling unit enclosures, and heat exchanger surfaces to achieve required cleanliness.

.2 When cleaning equipment and components by brushing and vacuuming is inappropriate or insufficient, dismantle and remove equipment or component.

.1 Pressure wash with water and cleaning solution until required cleanliness is achieved.

.2 Clean equipment and components in place only if there is no hazard to adjacent materials.

.3 Compressed air and manual cleaning is acceptable only for cleaning individual components and small areas as follows and only after written approval from Contract Administrator:

.1 Fan blades;

.2 Dampers;

.3 Turning vanes;

.4 Controls;

.5 Sensor bulbs;

.6 Fire alarms;

.7 Smoke detectors;

3.6 FIELD QUALITY CONTROL/FINAL INSPECTIONS

.1 Post Cleaning Inspection: carry out final inspection using robotic camera and other visual inspection methods after final cleaning has been completed.

.1 Carry out video survey as directed by Contract Administrator.

.2 Identify on HVAC system record drawings access points used for inspection and cleaning.

.3 Re-collect and analyze particulates collected at same locations where original samples were collected before cleaning.

.4 Reset components including dampers and sensors, which have been disturbed during cleaning operations.

3.7 SYSTEM STARTUP

.1 Install new system filters after cleaning operations are completed.

.2 Cover each inspection opening with access panel and secure in place after inspection and cleaning are completed.

.3 Restart each HVAC system.

3.8 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.2 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal and 01 35 20 - LEED Sustainable Requirements.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 01 35 20 - LEED Sustainable Requirements

.2 Section 01 74 19 – Waste Management and Disposal

1.2 REFERENCES

.1 Canadian General Standards Board (CGSB)

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

.2 Canada Green Building Council (CaGBC)

.1 LEED Canada- LEED 2009 New Construction, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For New Construction and Major Renovations (including Addenda).

.3 Green Seal Environmental Standards (GSES)

.1 Standard GS-11, Environmental Standard for Paints and Coatings.

.4 National Fire Code of Canada

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.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.

.3 Sustainable Design Submittals:

.1 LEED Submittals: in accordance with Section 01 35 20 - LEED Sustainable Requirements.

1.4 QUALITY ASSURANCE

.1 Sustainability Standards Certification:

.1 Low-Emitting Materials: provide listing of sealants and coatings used in building, comply with VOC and chemical component limits or restriction requirements.

1.5 DELIVERY, STORAGE AND HANDLING

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

.2 Delivery and Acceptance Requirements:

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

.3 Packaging Waste Management: remove for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

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 Primer: maximum VOC limit to LEED Standards.

.3 Paints: maximum VOC limit to LEED Standards.

.2 Sealants: in accordance with Section 07 92 00 - Joint Sealants.

.1 Sealants: maximum VOC limit to LEED Standards.

.3 Adhesives: maximum VOC limit to LEED Standards.

.4 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 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 as shown on drawings and according to related codes

.2 Threaded 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.

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

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

.3 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 in accordance with requirements of Section 01 74 11 - Cleaning supplemented 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 or codes.

.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 Administator.

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

.7 Insulate or conceal Work only after approval and certification of tests by Contract Administator.

3.13 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal and 01 35 20 - LEED Submittal Requirements.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 01 35 20 - LEED Sustainable Requirements

.2 Section 01 74 19 – Waste Management and Disposal

1.2 REFERENCES

.1 ASTM International

.1 ASTM A125, Standard Specification for Steel Springs, Helical, Heat-Treated.

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

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

.2 Canada Green Building Council (CaGBC)

.1 LEED Canada-LEED 2009 New Construction, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For New Construction and Major Renovations (including Addenda).

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

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

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

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

.4 Underwriter's Laboratories of Canada (ULC)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit shop drawings for:

.1 Bases, hangers and supports.

.2 Connections to equipment and structure.

.3 Structural assemblies.

.4 Certificates:

.1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Manufacturers' Instructions:

.1 Provide manufacturer's installation instructions.

.6 Sustainable Design Submittals:

.1 LEED Canada- Submittals: in accordance with Section 01 35 20 - LEED Sustainable Requirements.

1.4 CLOSEOUT SUBMITTALS

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

1.5 DELIVERY, STORAGE AND HANDLING

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

.2 Delivery and Acceptance Requirements:

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

.3 Packaging Waste Management: remove for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

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 SUSTAINABLE REQUIREMENTS

.1 Materials and products in accordance with Section 01 35 20 – LEED Sustainable Requirements.

2.3 GENERAL

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

2.4 PIPE HANGERS

.1 Finishes:

.1 Pipe hangers and supports: galvanized.

.2 Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.

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

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

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

.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 all insulated piping.

.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: black.

.2 Finishes for copper, pipework: black, epoxy coated or galvanized.

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

2.5 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.

2.6 INSULATION PROTECTION SHIELDS

.1 Insulated cold piping:

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

.2 Insulated hot piping:

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

2.7 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.

2.8 EQUIPMENT SUPPORTS

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

2.9 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.10 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.

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

2.11 OTHER EQUIPMENT SUPPORTS

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

.2 Submit structural calculations with shop drawings.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Install in accordance with:

.1 Manufacturer's instructions and recommendations.

.2 Vibration Control Devices:

.1 Install on piping systems at pumps, 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.

3.3 HANGER SPACING

.1 Plumbing piping: to Canadian Plumbing Code.

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

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

.4 Flexible joint roll groove pipe: in accordance with table below 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.

.5 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	

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

3.4 HANGER INSTALLATION

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

.2 Adjust hangers to equalize load.

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

3.5 HORIZONTAL MOVEMENT

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

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

3.6 FINAL ADJUSTMENT

.1 Adjust hangers and supports:

.1 Ensure that rod is vertical under operating conditions.

.2 Equalize loads.

.2 Adjustable clevis:

.1 Tighten hanger load nut securely to ensure proper hanger performance.

.2 Tighten upper nut after adjustment.

.3 C-clamps:

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

.4 Beam clamps:

.1 Hammer jaw firmly against underside of beam.

3.7 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 - ACTION AND INFORMATIONAL 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 Schedule Site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

.2 Verification requirements in accordance with Section 01 35 20 – LEED Sustainable Requirements. Include:

.1 Materials and resources.

.2 Storage and collection of recyclables.

.3 Construction waste management.

.4 Resource reuse.

.5 Recycled content.

.6 Local/regional materials.

.7 Certified wood.

.8 Low-emitting materials.

3.8 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal and 01 35 20 - LEED Sustainable Requirements.

END OF SECTION

Part 1 General

1.1 SCOPE OF WORK

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

1.2 RELATED REQUIREMENTS

.1 Section 01 35 20 - LEED Sustainable Requirements

.2 Section 01 74 19 – Waste Management and Disposal

1.3 REFERENCES

.1 Canadian General Standards Board (CGSB)

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

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

.2 National Fire Protection Association (NFPA)

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

1.4 SUBMITTALS

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

.2 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 Provide nameplates for all equipment designated by Tags as indicated in the drawings. e.g. PU-1, EF-2.

.2 Colours:

.1 Hazardous: red letters, white background.

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

.3 Construction:

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

.4 Sizes:

.1 Conform to following table:

Type	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.

.5 Locations:

.1 Terminal cabinets, control panels: use Type 5.

.2 Equipment in Mechanical Rooms: use Type 8.

.3 Equipment elsewhere: sizes as appropriate.

2.3 IDENTIFICATION OF PIPING SYSTEMS

.1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows in accordance with 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 Colours for legends, arrows: to following table:

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

.2 Background colour marking and legends for piping systems:

Contents	Background colour marking:	Legend
Domestic water	Green – None	DCW
Domestic hot water supply	Blue – None	DHW
Dom. HWS recirculation	Blue – White	DRW
Storm Sewer	Grey – Black	--
Combine Sewer	Grey – None	--
Hot water supply	Pink – None	HWS
Hot water return	Pink – Black	HWR
Plumbing vent	Green	SAN. VENT
Refrigeration suction	Black	REF. SUCTION
Refrigeration liquid	Black	REF. LIQUID
Refrigeration hot gas	Black	REF. HOT GAS
Natural gas	Yellow (According to Codes)	

Acceptable Material: W.H. Brady, Seton Name Plate Corporation, Setmark Pipe Markers.

2.6 VALVES, CONTROLLERS

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

2.7 CONTROLS COMPONENTS IDENTIFICATION

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

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

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 TIMING

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

3.3 INSTALLATION

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

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

.3 Perform pipe identification as piping is installed and insulated. All identification must be performed before the installation of T-bar ceiling.

3.4 NAMEPLATES

.1 Locations:

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

.2 Standoffs:

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

.3 Protection:

.1 Do not paint, insulate or cover.

3.5 LOCATION OF IDENTIFICATION ON PIPING SYSTEMS

.1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 10 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 At least once in each small room through which piping or ductwork passes.

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

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

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

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

.7 Identify branch, equipment, or building served after each valve.

.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.

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

3.6 VALVES, CONTROLLERS

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

.2 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.

1.2 RELATED SECTIONS

.1 Section 23 08 00 - Commissioning of HVAC

.2 Section 01 35 20 - LEED Sustainable Requirements

.3 Section 01 74 19 – Waste Management and Disposal

1.3 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.

.2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-[1998].

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing.

.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.

1.4 PURPOSE OF TAB

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

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

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

1.5 EXCEPTIONS

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

1.6 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.

1.7 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.

1.8 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.

1.9 OPERATION OF SYSTEMS DURING TAB

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

1.10 START OF TAB

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

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

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

.2 Application of weatherstripping, sealing, and caulking.

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

.4 Provisions for TAB installed and operational.

.3 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.

1.11 APPLICATION TOLERANCES

.1 Do TAB to following tolerances of design values:
.1 HVAC systems: plus or minus 5 %.

1.12 ACCURACY TOLERANCES

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

1.13 INSTRUMENTS

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

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

1.14 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit, prior to commencement of TAB:

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

1.15 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.

1.16 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 3 copies of TAB Report to Contract Administrator for verification and approval, in English in D-ring binders, complete with index tabs.

1.17 VERIFICATION

.1 Reported results subject to verification by Contract Administrator.

.2 Provide personnel and instrumentation to verify up to 100 % of reported results.

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

1.18 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.

1.19 COMPLETION OF TAB

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

1.20 AIR SYSTEMS

.1 Standard: TAB to most stringent of this section.

.2 Do TAB of following systems, equipment, components, controls:

.1 AHU-1, AHU-2.

.2 ERV-1a, ERV-1b, ERV-2.

.3 EF-1, EF-2, EF-3, EF-4

.4 All grilles, registers, diffusers, and associated balance dampers.

.5 Fire dampers.

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

.4 Quality assurance: perform TAB under direction of supervisor qualified to standards of 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).

1.21 POST-OCCUPANCY TAB

.1 Participate in systems checks twice during Warranty Period - #1 approximately 3 months after acceptance and #2 within 1 month of termination of Warranty Period.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 01 35 20 - LEED Sustainable Requirements

.2 Section 01 74 19 – Waste Management and Disposal

1.2 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, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 ASTM International Inc.

.1 ASTM C335, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.

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

.3 ASTM C547, Standard Specification for Mineral Fiber Pipe Insulation.

.4 ASTM C 518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

.5 ASTM C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.6 ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

.7 ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB)

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

.4 Canada Green Building Council (CaGBC)

.1 LEED Canada-NC Version 1.0-[2004], LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For New Construction and Major Renovations (and Addenda).

.5 Green Seal Environmental Standards (GSES)

.1 Standard GS-36, Commercial Adhesives.

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

.7 Underwriters Laboratories of Canada (ULC)

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

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

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.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, special handling criteria, installation sequence, and cleaning procedures.

.4 Sustainable Design Submittals:

.1 LEED Submittals: in accordance with Section 01 35 20 - LEED Sustainable Requirements.

1.4 QUALITY ASSURANCE

.1 Qualifications:

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

1.5 DELIVERY, STORAGE AND HANDLING

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

.2 Deliver materials to Site in original factory packaging, labelled with manufacturer's name.

.3 Packaging Waste Management: remove for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

.1 Materials and products in accordance with Section 01 35 20 – LEED Sustainable Requirements.

2.2 FIRE AND SMOKE RATING

.1 To CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.3 INSULATION

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

.1 Recycled content: in accordance with Section 01 35 20 - LEED Sustainable Requirements.

.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.

2.4 JACKETS

.1 Canvas:

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

.2 Lagging adhesive: compatible with insulation.

.1 Maximum VOC limit 50 g/L to GSES GS-36.

2.5 ACCESSORIES

.1 Vapour retarder lap adhesive:

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

.1 Maximum VOC limit 50 g/L to GSES GS-36.

.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 Tape: self-adhesive, aluminum, plain, 75 mm wide minimum.

.6 Contact adhesive: quick-setting

.1 Maximum VOC limit 50 g/L to SCAQMD Rule 1168 or GSES GS-36.

.7 Canvas adhesive: washable.

.1 Maximum VOC limit 50 g/L to SCAQMD Rule 1168 or GSES GS-36.

.8 Tie wire: 1.5 mm stainless steel.

.9 Banding: 19 mm wide, 0.5 mm thick stainless steel.

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

.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, free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards.

.2 Apply materials in accordance with manufacturers 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)
Rectangular cold and dual temperature supply air ducts	C-1	yes	50
Round cold and dual temperatire supply air ducts	C-2	yes	50
Rectangular warm air ducts	C-1	no	25
Round warm air ducts	C-2	no	25
Supply, return and exhaust ducts exposed in space being served	none		
Mixing plenums	C-1	yes	25
Exhaust duct between	C-1	no	25

dampers and louvres			
Acoustically lined ducts	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:

Indoor, concealed	All Service Jacket
Indoor, exposed within mechanical room	Canvas Jacket
Indoor, exposed elsewhere	Canvas Jacket

3.5 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal and 01 35 20 - LEED Submittal Requirements.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

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

1.1 RELATED REQUIREMENTS

.1 Section 01 35 20 - LEED Sustainable Requirements

.2 Section 01 74 19 – Waste Management and Disposal

1.2 REFERENCES

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

.1 ASHRAE Standard 90.1, 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 C335, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.

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

.3 ASTM C533, Calcium Silicate Block and Pipe Thermal Insulation.

.4 ASTM C547, Mineral Fiber Pipe Insulation.

.5 ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB)

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

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

.4 Department of Justice Canada (Jus)

.1 Canadian Environmental Assessment Act (CEAA)

.2 Canadian Environmental Protection Act (CEPA)

.3 Transportation of Dangerous Goods Act (TDGA)

.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.

.7 Underwriters' Laboratories of Canada (ULC)

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

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

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

.4 CAN/ULC-S702.2, 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:

.1 CRF: Code Rectangular Finish.

.2 CPF: Code Piping Finish.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

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

.1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

.3 Shop Drawings:

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

.4 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

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

.2 Instructions: submit manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

.1 Qualifications:

.2 Installer: specialist in performing Work of this Section, and have at least 5 years successful experience in this size and type of project, qualified to standards and a member of TIAC.

.3 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Packing, shipping, handling and unloading:

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

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

.2 Storage and Protection:

.1 Protect from weather, construction traffic.

.2 Protect against damage.

.3 Store at temperatures and conditions required by manufacturer.

.3 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

.2 Place excess or unused insulation and insulation accessory materials in designated containers.

.3 Divert unused metal materials from landfill to metal recycling facility.

.4 Dispose of unused adhesive material at official hazardous material collections site.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

.1 Materials and products in accordance with Section 01 35 20 – LEED Sustainable Requirements.

2.2 FIRE AND SMOKE RATING

.1 In accordance with CAN/ULC-S102.

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.3 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-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S702 and ASTM C547.

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

.3 Maximum "k" factor: to CAN/ULC-S702 and ASTM C547.

.4 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 and ASTM C547.

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

.3 Maximum "k" factor: to CAN/ULC-S702 and ASTM C547.

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

.1 Insulation: with vapour retarder jacket.

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

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

2.4 INSULATION SECUREMENT

.1 Tape: self-adhesive, aluminum, plain, 75 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.

2.5 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 JACKETS

.1 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.

.7 PVC jacket to be installed on all exposed piping. Jacket to be painted to match adjacent surfaces.

.2 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 manufacturers 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 valves, primary flow measuring elements, and unions at equipment.

.2 Design: 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 manufacturers 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 TIAC Code: A-3.

.1 Securements: Tape at 300 mm on centre.

.2 Seals: VR lap seal adhesive, VR lagging adhesive.

.3 Installation: TIAC Code.

.3 TIAC Code: A-6.

.1 Seals: lap seal adhesive, lagging adhesive.

.2 Installation: TIAC Code.

.4 TIAC Code: C-2 with vapour retarder jacket.

.1 Seals: lap seal adhesive, lagging adhesive.

.2 Installation: TIAC Code.

.5 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)					
			to 1	1 1/4 to 2	2 1/2 to 4	5 to 6	8	up to 175
Domestic HWS		[A-3]	25	25	25	38	38	38
Domestic CWS with vapour retarder		[C-2]	25	25	25	25	25	25
Refrigerant [suction]	4 - 13	[A-6]	25	25	25	25	25	25
RWL and RWP		[C-2]	25	25	25	25	25	25
Cooling Coil cond. drain		[C-2]	25	25	25	25	25	25

.6 Finishes:

.1 Exposed indoors: PVC 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 Finish attachments: SS bands, at 150 mm on centre. Seals: closed.

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

3.7 FIELD QUALITY CONTROL

.1 Verification requirements in accordance with Section 01 35 20 – LEED Sustainable Requirements. Include:

.1 Materials and resources.

.2 Storage and collection of recyclables.

.3 Construction waste management.

.4 Resource reuse.

.5 Recycled content.

.6 Local/regional materials.

.7 Certified wood.

.8 Low-emitting materials.

3.8 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 General requirements for Commissioning of HVAC equipment and systems.

.2 Related Sections:

.1 Section 01 35 20 LEED Sustainable Requirements
.2 Section 01 74 19 Waste Management and Disposal
.3 Section 01 91 13 General Commissioning Requirements
.4 Section 23 05 93 Testing, Adjusting and Balancing for HVAC
.5 Section 22 08 00 Commissioning of Plumbing
.6 Section 25 08 00 Commissioning of Digital Design Controls
.7 Section 26 08 00 Commissioning of Electrical Systems

.3 Acronyms:

.1 Cx - Commissioning.
.2 CxA - Commissioning Agent

1.2 INTENT

.1 Provide commissioning of HVAC equipment and systems in accordance with this, Section 01 91 13 General Commissioning Requirements and related sections.

.2 All items noted in this document are the responsibility of the contractor supplying and installing the equipment, unless noted otherwise.

1.3 MANUFACTURER'S SERVICE ON SITE

.1 Arrange and pay for qualified Manufacturer's representatives to supervise starting and testing of the following mechanical equipment and systems (if applicable):

.1 Air Handling Units
.2 Condensing units
.3 Fans
.4 Heat Recovery Ventilators
.5 Unit Heaters/Force Flow Units
.6 Variable Frequency Drives
.7 Baseboard heaters
.8 Electric duct heaters
.9 Variable air volume boxes

.2 Use manufacturers factory trained personnel where required to maintain manufacturer's warranty.

.3 Maintain documentation of all equipment start-up and commissioning and provide to Commissioning Agent.

1.4 **AIR SYSTEM TESTING, ADJUSTING & BALANCING**

.1 The Contractor will hire a Certified Balancing Agent for completion of the testing, adjusting and balancing of all air handling systems as per Section 23 05 93 Testing, Adjusting & Balancing for HVAC.

Part 2 Products

2.1 Not Used

Part 3 Execution

3.1 **GENERAL**

.1 Commission all equipment and systems installed as part of this contract. Typical required information or actions are listed below for each equipment or system.

.2 Provide check sheets for equipment not listed in this section.

.3 Document the commissioning process by completing the Component Verification Forms, System (functional) Tests and Integrated System Tests.

.4 The following procedures noted below outline generally accepted good practices for HVAC equipment and systems. If these systems do not apply to this building project, then they are not applicable to commissioning.

3.2 **AHU COOLING COILS**

.1 Check that installation is in accordance with drawings, specifications and Manufacturer's recommendations.

.2 Complete Manufacturer's installation and start-up check sheets and include the following items:

.1 Pipe connections have been correctly made for counter current heat exchange between air and fluid.

.2 Clearances have been provided and piping is flanged for easy removal and servicing.

.3 Coil air vent, drain valve and deadleg drain valves have been provided.

.4 Coil is sloped to ensure complete drain down.

.5 Pressure and temperature tappings, Pete's plugs, have been provided.

.6 Fins inspected and combed straight as required.

.7 Cooling coil drain pan and trapped drain line installed correctly.

.8 Labels are clearly visible

.9 Control valve piping is connected for correct flow through valve body and for required fail safe action of valve.

.10 Check operation of cooling coil condensate drain with supply fan at maximum air flow. Ensure that condensate will drain away against maximum suction pressure of supply fan. Check for and eliminate condensate carry-over at maximum air velocity.

.3 Provide performance testing to ensure that coils perform as per specifications.

.4 Provide maintenance services.

.1 Drain coils if they are in danger of freezing.

.2 Clean coils prior to takeover by The City.

.3 Ensure that all equipment is installed so as to provide easy access for maintenance and removal.

3.3 AIR HANDLING EQUIPMENT AND SYSTEMS - AIR HANDLING UNITS

.1 Check that installation is in accordance with drawings, specifications and Manufacturer's recommendations.

.2 Complete Manufacturer's installation and start-up check sheets and include the following:

.1 Air blender and mixing baffles.

.2 Fresh, exhaust and recirculation air motorized dampers, operation and size.

.3 Filters.

.4 Check that fan base vibration isolation and flexible connections to ductwork are properly installed.

.5 Special features, access doors, liners, inlet vanes and labels.

.6 Ensure silencers are installed.

.7 Lubricate bearings on fans as recommended by Manufacturer. Ensure fan wheels rotate in correct direction without binding. Adjust belts to proper alignment and tension.

.8 Vacuum clean air systems.

.9 Ensure temporary filters are installed. NEVER operate system without filters installed.

.10 Ensure all balancing and fire dampers are open and ductwork is complete.

.11 Ensure all coils are in operation. If outside air temperature is less than 2°C, ensure coils are dry or filled with glycol.

.12 On parallel fan systems ensure backdraft dampers are installed.

.13 Ensure electrical connections are complete and system disconnects are within sight of unit.

.14 Ensure controls are operational.

.15 Ensure inlet and discharge duct geometry is correct.

.16 Ensure hose bibs have been installed for washing coils.

.3 Start the system in accordance with the Manufacturer's recommendations.

.1 Check for correct static deflection of unit vibration isolators and that start-up and shut down deflection is within resilience limits.

.2 Run for one day and check filters, coils, and humidifier for bypass. Seal as required.

.4 Provide performance testing to ensure equipment meets specifications.

.1 Verify operation of the Heat Recovery Unit (if present).

.2 Confirm that unit is performing as per specifications.

.3 Check controls operation and tune operating parameters to optimize air handling unit performance.

.4 Tune system for energy efficient operation

.5 Provide maintenance services.

.1 Check that bearings are not overheating.

.2 Replace temporary filters with permanent filters.

.3 Wash heating, cooling and steam injected humidifier coils.

.4 Lubricate bearings.

.5 Check belts for tension and wear.

.6 Ensure that coils can be drained and that the drainage system is functioning properly.

.7 Ensure that all equipment is serviced prior to takeover by The City.

.8 Ensure that all equipment is installed so as to provide easy access for maintenance and removal.

3.4 AIR HANDLING EQUIPMENT AND SYSTEMS – FANS

.1 Check that installation is in accordance with drawings, specifications and Manufacturer's recommendations.

.2 Complete Manufacturer's installation and start-up check sheets and include the following:

.1 Backdraft dampers.

.2 Accessories.

.3 Special features.

.4 Check that fan base vibration isolation and flexible connections to ductwork are properly installed.

.5 Lubricate bearings on fans as recommended by Manufacturer.

.6 Ensure fan wheels rotate in correct direction without binding.

.7 Adjust belts to proper alignment and tension.

.8 Ensure ductwork and fan casing is free of dirt or foreign material.

.9 Ensure electrical connections are complete and disconnect is within sight of fan.

.10 Ensure inlet and discharge duct geometry is correct.

.3 Follow Manufacturer's recommendations for starting

.1 Check for correct static deflection of unit vibration isolators, and that start-up and shut down deflection is within resilience limits.

.4 Provide performance testing to ensure fan performance meets or exceeds performance outlined in the specifications.

.5 Provide maintenance services.

.1 Check that bearings are not over heating.

.2 Lubricate bearings.

.3 Check belts for tension and wear.

.4 Confirm that all equipment is easily accessible for maintenance purposes.

3.5 **AIR HANDLING EQUIPMENT AND SYSTEMS - FORCE FLOW/UNIT HEATERS**

.1 Check that installation is in accordance with drawings, specifications and Manufacturer's recommendations.

.2 Complete Manufacturer's installation and start-up check sheets and include the following:

.1 Piping connections are properly installed.
.2 Vibration isolation and flexible connections on pipes are properly installed.
.3 Ducting connections are properly installed.
.4 Disconnect switches are functional.
.5 Unit is clean and free from debris.
.6 No physical damage to unit has occurred.
.7 All bolts, screws are tight.
.8 All fins have been combed and are not bent.
.9 Takeoffs for future installations are provided.
.10 Provisions for draining system in the event of leakage or additions to the system.
.11 Controls and valves are installed in a neat and tidy manner.
.12 All equipment is installed so as to provide access for maintenance and removal.
.13 Controls points list and flowcharts are completed.
.14 Equipment is labelled.

.3 Provide maintenance services.

.1 Adjust thermostat to final setting
.2 Clean unit
.3 Confirm that all equipment is accessible for maintenance and operations

.4 Confirm that unit heaters are performing as intended.

3.6 **AIR HANDLING EQUIPMENT AND SYSTEMS – DISTRIBUTION**

.1 Check that installation is in accordance with drawings, specifications and Manufacturer's recommendations.

.2 Complete Manufacturer's installation and start-up check sheets.

.3 Inspect air systems including ductwork layout, support, and vibration isolation before pressure testing any section of ductwork.

.4 Power vacuum all ducts.

.5 Pressure test sections of ductwork prior to application of insulation or concealment. Include pressure testing of ductwork on commissioning schedule and notify the Contract Administrator prior to any system pressure tests.

.6 Check that insulation is installed as per specifications and is neat and tidy.

.7 Check that insulation has not been damaged during construction and note any sections that require repair.

.8 Check that all distribution ductwork is labelled.

.9 Provide Testing, Adjusting and Balancing for all Air Handling Equipment and Systems by a Certified Independent Agent.

.10 Provide performance testing to ensure that air handling equipment and systems perform as per specifications.

.11 Provide maintenance services.

.1 Ensure all equipment is serviced prior to take-over.

.2 Ensure all equipment is installed so as to provide easy access for maintenance and removal.

3.7 MECHANICAL EQUIPMENT AND SYSTEMS TESTING, ADJUSTING AND BALANCING

.1 Provide Testing, Adjusting and Balancing in accordance with Section 23 05 93 Testing, Adjusting & Balancing for HVAC..

3.8 MECHANICAL EQUIPMENT AND SYSTEMS DEMONSTRATION AND INSTRUCTION

.1 Provide demonstrations and instruction in accordance with Section 01 91 13 General Commissioning Requirements.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 01 35 20 - LEED Sustainable Requirements

.2 Section 01 74 19 – Waste Management and Disposal

1.1 GENERAL

.1 All drawings and all sections of the specifications shall apply to and form an integral part of this section. Refer to sections on AHU's, HRV's, etc to obtain information on their own packaged controls.

.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, 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 contractor shall have minimum 5 years experience in related Work.

.4 Technical assessment of proposed system will be made as part of our selection criteria.

.5 Controls contractor provides actuators for all motorized dampers in accordance with this section.

.6 **Facility will controlled by a web-based DDC system.**

.7 All controls provided under this section shall be compatible with the current protocol for the City's web-based DDC system.

1.2 SCOPE OF SERVICE

.3 The contractor is to have the expertise to install a new DDC system for the new equipment.

.4 Provide a fully commissioned DDC system and documentation.

.5 The contractor shall provide the necessary engineering, installation, supervision, equipment, commissioning and programming for a complete and fully operational system including but not limited to:

.1 Provide control shop drawings.

.2 Provide a network of Direct Digital Control (DDC) panels.

.3 Provide all wells, sensors, interface devices, automatic control valves, VAV controllers, control dampers, transducers, relays, dampers, damper actuators, wiring, conduit raceways and piping.

.4 Provide graphics software, system software, and any third party software required to meet the intent of these specifications.

.5 Provide labelling of the DDC controls system.

.6 Provide labour and supervision for installation, calibration, checkouts and commissioning of systems.

.7 Provide all application, database and graphic programming.

.8 Provide shop drawings, training manuals and as-built drawings.

.9 Provide operator training. 8 hrs of training required (or 2 x 4 hr sessions).

.10 Provide a one-year warranty on all components.

.11 Provide one year of maintenance.

.12 Provide all the necessary software and interface devices for DDC based control of the points listed in the points list and the systems described in the sequences of operation.

1.3 SCOPE OF WORK

.1 Includes the design, supply, installation, commissioning, and training for a complete DDC control system for control and/or monitoring of the following equipment.

1. Air handing unit AHU-1 and associated gas heating system, DX cooling, motorized dampers and variable frequency drives (VFD). *
2. ERV-1a, ERV-1b and associated motorized dampers. *
3. Air handing unit AHU-2 and associated gas heating system, DX cooling and motorized dampers. *
4. ERV-2 and associated motorized dampers. *
5. Exhaust fans EF-1 to EF-4. Refer to sequence of operations to determine if DDC control is required.
6. Service/Zamboni room ventilation system.
7. CO_2 sensors for ventilation system.
8. Sump pumps and control panels, c/w high level alarm to DDC.

2. All motorized dampers, actuators, control valves and devices required by this Section.

3. VFD's supplied by controls contractor. Refer to electrical specifications for VFD requirements.

4. The controls contractor shall be responsible for mounting and wiring all remote-mounted sensors and controls supplied with vendor-supplied equipment including the AHU.

* Graphic required for this system – see Control Schematics.

1.4 SUBMITTALS

.6 Product Data:

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

Part 2 Products

2.1 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 in writing. Spare parts shall be available for at least five years after completion of this Contract.

2.2 COMMUNICATION

.1 All control products provided for this project shall comprise a BACnet network. Communication involving control components (i.e., all types of controllers and operator interfaces) shall conform to *ANSI/ASHRAE Standard 135-2010, BACnet*.

.2 Each BACnet device shall operate on the BACnet or Data Link/Physical layer protocol specified for that device as defined in this section.

.3 The contractor shall provide all communication media, connectors, repeaters, hubs, and routers necessary for the network.

.4 All controllers shall have a communication port for connections with the operator interfaces using the BACnet Data Link/Physical layer protocol.

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

.1 Connection of an operator interface device to any one controller on the network 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 network.

.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 network. 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 network value passing.

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

.4 The network 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 OPERATOR INTERFACE

.1 Contractor shall supply an LCD touchscreen interface. LCD screen shall be mounted in the mechanical mezzanine. Confirm final location with Contract Administrator. This screen shall be able to access all information in the system through the web-based DDC system.

.2 Workstation information access shall use the BACnet protocol. Communication shall use the ISO 8802-3 (Ethernet) Data Link/Physical layer protocol.

.3 System Software

.1 System Graphics. Provide graphics for all systems noted under Section 1.2 of this specification. Graphics shall be similar to existing graphics.

.4 System Applications. Each workstation shall provide operator interface and off-line storage of system information. Provide the following applications at each workstation:

.1 Automatic System Database Save and Restore. Each workstation shall store on the hard disk a copy of the current database of each Building Controller. This database shall be updated whenever a change is made in any system panel. The storage of these data shall be automatic and not require operator intervention. In the event of a database loss in a building management panel, the first workstation to detect the loss shall automatically restore the database for that panel. This capability may be disabled by the operator.

.2 Manual Database Save and Restore. A system operator with the proper password clearance shall be able to save the database from any system panel. The operator also shall be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.

.3 System Configuration. The workstation software shall provide a method of configuring the system. This shall allow for future system changes or additions by users under proper password protection.

.4 On-Line Help. Provide a context-sensitive, online help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.

.5 Security. Each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system supervisor shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the functions accessible to viewing and/or changing each system application, editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto logoff time period shall be user-adjustable. All system security data shall be stored in an encrypted format.

.6 System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.

.7 Alarm Processing. Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, alarm limit differentials, states, and reactions for each object in the system.

.8 Alarm Messages. Alarm messages shall use the English language descriptor for the object in alarm in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying upon acronyms or other mnemonics.

.9 Alarm Reactions. The operator shall be able to determine (by object) what, if any, actions are to be taken during an alarm. Actions shall include logging, printing, starting programs, displaying messages, dialing out to remote stations, paging, providing audible annunciation, or displaying specific system graphics. Each of these actions shall be configurable by workstation and time of day.

.10 Trend Logs. The operator shall be able to define a custom trend log for any data object in the system. This definition shall include interval, start time, and stop time. Trend data shall be sampled and stored on the building controller panel, be archivable on the hard disk, and be retrievable for use in spreadsheets and standard database programs.

.11 Alarm and Event Log. The operator shall be able to view all system alarms and change of states from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and clear alarms. All that have not been cleared by the operator shall be archived to the hard disk on the workstation.

.12 Object and Property Status and Control. Provide a method for the operator to view, and edit if applicable, the status of any object and property in the system. The status shall be available by menu, on graphics, or through custom programs.

.13 Clock Synchronization. The system shall be able to automatically synchronize all system real-time clocks daily from any operator-designated device in the system. The system shall automatically adjust for daylight savings and standard time, if applicable.

.14 Reports and Logs. Provide a reporting package that allows the operator to select, modify, or create reports. Each report shall be definable as to data content, format, interval, and date. Report data shall be archivable on the hard disk for historical reporting. Provide the ability for the operator to obtain real-time logs of all objects by type or status (e.g., alarm, lockout, normal). Reports and logs shall be stored on the PC hard disk in a format that is readily accessible by other standard software applications, including spreadsheets and word processing. Reports and logs shall be readily printed to the system printer and shall be set to be printed either on operator command or at a specific time each day.

.15 Standard Reports. The following standard system reports shall be provided for this project. Provide ability for The City to readily customize these reports for this project.

.1 All Objects: All system (or subsystem) objects and their current values.

.2 Alarm Summary: All current alarms (except those in alarm lockout).

.3 Disabled Objects: All objects that are disabled.

.4 Alarm Lockout Objects: All objects in alarm lockout (whether manual or automatic).

.5 Alarm Lockout Objects in Alarm: All objects in alarm lockout that are currently in alarm.

.6 Logs:

.1 Alarm History
.2 System Messages
.3 System Events
.4 Trends

.16 Custom Reports. Provide the capability for the operator to easily define any system data into a daily, weekly, monthly, or annual report. These reports shall be time and date stamped and shall contain a report title and the name of the facility.

.5 Workstation Applications Editors. Each PC workstation shall support editing of all system applications. Provide editors for each application at the PC workstation. The applications shall be downloaded and executed at one or more of the controller panels.

.1 Controller. Provide a full-screen editor for each type of application that shall allow the operator to view and change the configuration, name, control parameters, and set points for all controllers.

.2 Scheduling. An editor for the scheduling application shall be provided at each workstation. Provide a method of selecting the desired schedule and month. This shall consist of a monthly calendar for each schedule. Exception schedules and holidays shall be shown clearly on the calendar. Provide a method for allowing several related objects to follow a schedule. The start and stop times for each object shall be adjustable from this master schedule. Schedules shall be easy to copy to other objects and/or dates.

.3 Custom Application Programming. Provide the tools to create, modify, and debug custom application programming. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The system shall be fully operable while custom routines are edited, compiled, and downloaded. The programming language shall have the following features:

.4 The language shall be English language oriented, be based on the syntax of BASIC, FORTRAN, C, or PASCAL, and allow for free-form programming (i.e., not column-oriented or “fill in the blanks”). Alternatively, the programming language can be graphically based using function blocks as long as blocks are available that directly provide the functions listed below and that custom or compound function blocks can be created.

.5 A full-screen character editor/programming environment shall be provided. The editor shall be cursor/mouse-driven and allow the user to insert, add, modify, and delete custom programming code. It also shall incorporate word processing features such as cut/paste and find/replace.

.6 The programming language shall allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.

.7 The editor/programming environment shall have a debugging/simulation capability that allows the user to step through the program and observe any intermediate values and/or results. The debugger also shall provide error messages for syntax and execution errors.

.8 The programming language shall support conditional statements (IF/THEN/ELSE/ELSE-IF) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

.9 The programming language shall support floating-point arithmetic.

.10 The programming language shall have predefined variables that represent time of day, day of the week, month of the year, and the date. Other predefined variables shall provide elapsed time in seconds, minutes, hours, and days. These elapsed time variables shall be able to be reset by the language so that interval-timing functions can be stopped and started within a program. Values from all of the above variables shall be readable by the language so that they can be used in a program for such purposes as IF/THEN comparisons, calculations, etc.

.11 The language shall be able to read the values of the variables and use them in programming statement logic, comparisons, and calculations.

.12 The programming language shall have predefined variables representing the status and results of the System Software and shall be able to enable, disable, and change the set points of the System Software described below.

2.4 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 or 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.

2.5 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

.1 Assume a predetermined failure mode,

.2 Generate an alarm notification.

.7 The Building Controller shall communicate with other BACnet devices on the network 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).

.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. If the manufacturer does not provide this keypad and display, provide a portable operator terminal.

.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 building 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 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.

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

.2 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.

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

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

.1 Assume a predetermined failure mode and

.2 Generate an alarm notification.

.5 The custom application controller shall communicate with other BACnet devices on the network 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 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 custom application 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).

2.7 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 network 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).

.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 application specific controller shall use non-volatile memory and maintain all BIOS and programming information in the event of a power loss.

.6 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).

.7 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.

2.8 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.

2.9 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.

2.10 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 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 on exhaust and air intake applications shall have insulated blades and may be parallel or opposed blade type with blade and side seals. See control drawings for locations of these dampers and damper specifications for details.

.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 Motorized dampers shall be installed next to duct access doors for ease in maintenance.

.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 Control valves.

.1 Control valves shall be two-way or three-way type for two-position or modulating service as shown. Perimeter radiators shall have pneumatic (non-DDC) two-position

valves, AHU coils shall have modulating electric (DDC) valves and reheat coil valves shall be two-position electric (DDC) valves.

.2 Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:

.1 Water Valves:

.1 Two-way: 150% of total system (pump) head.

.2 Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.

.3 Water Valves:

.1 Body and trim style and materials shall be in accordance with manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.

.2 Sizing Criteria:

.1 Two-position service: Line size.

.1 Two-way modulating service: Pressure drop shall be equal to 50% of the pressure difference between supply and return mains, or 5 psi, maximum.

.2 Three-way modulating service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 35 kPa (5 psi) maximum.

.3 Valves ½ in. through 2 in. shall be bronze body or cast brass ANSI Class 250, spring-loaded, PTFE packing, quick opening for two-position service. Two-way valves to have replaceable composition disc or stainless steel ball.

.4 Valves 2½ in. and larger shall be cast iron ANSI Class 125 with guided plug and PTFE packing.

.3 Water valves shall fail normally open or closed, as scheduled on plans, or as follows:

.1 Water zone valves—normally open preferred.

.2 Heating coils in air handlers—normally open.

.3 Other applications—as scheduled or as required by sequences of operation.

.4 Binary Temperature Devices

.1 Low-voltage space 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.

.5 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.

.6 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.

.7 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.

.3 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.

2.11 WIRING AND RACEWAYS

.1 General: Provide copper wiring, plenum cable, and raceways as specified in the applicable sections of Division 16.

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

2.12 SPACE MOUNTED CO_2 SENSORS

.1 Units shall be certified to UL and CSA standards.

.2 The Gas Monitor will be powered by an external power supply rated at 20-28 Vac/dc.

.3 The unit will perform the detection of carbon dioxide. Carbon dioxide will be detected non-dispersive infrared diffusion sampling. The monitor will have resolution levels of 1 ppm with a minimum range of 0-2000 ppm (0-5% accuracy). Temperature and relative humidity variations will have no effect on the unit's accuracy. Infrared monitor life will be no less than 10 years.

.4 The units will require very low levels of maintenance, including only one verification per year where required.

.5 The unit must also be capable of providing a local display of the concentration of CO2 and provide a 4 -20 ma output for connection to a DDC system.

.6 The monitor will be capable of operating within relative humidity ranges of 0-95% and temperature ranges of 0°C to 50°C (32°F to 122°F).

.7 The unit shall have a footprint of 119 mm (4.7") high X 84 mm (3.3 in) wide X 29 mm (1.15") deep. The unit must be designed for in space applications.

.8 The unit must be manufactured within an ISO 9001-2000 production environment and shall be warranted by the manufacturer for a period of five years.

.9 Provide protective cover for installation in gymnasium.

.10 Acceptable product: "Greystone", in-space application CO2 stand-alone sensor or approved equal in accordance with B7.

2.13 MOTORIZED CONTROL DAMPERS (M)

.1 Parallel blade, insulated for intakes / exhaust purpose (M), extruded aluminum, 102 mm depth, 2mm blade thickness, flange mount frame, thermally broken with high density polyurethane injected foam insulation, santoprene blade and jamb seals, linkage concealed in frame, Belimo actuators provided by controls contractor. Size as shown on drawings.

.2 Fail open.

.3 Acceptable Product: "Tamco" series 9000, Alumavent Model 3965 FM

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 General

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

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

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

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

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

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

.7 All electrical work shall be installed by experienced personnel and conform to CEC and all local codes. Where requirements of Division 16 differ from those contained herein, Division 16 section shall take precedence.

3.3 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.

3.4 WIRING

.1 All control and interlock wiring shall comply with the CEC and local electrical codes and Electrical section of this specification. Where the requirements of this section differ from those in the Electrical section, 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 16 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 contractor 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 contractor, 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 16 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 contractor 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.

3.5 COMMUNICATION WIRING

.1 The contractor 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 contractor 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 labelled to indicate origination and destination data.

3.6 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 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, 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.

3.7 FLOW SWITCH INSTALLATION

.1 Use correct paddle for pipe diameter.

.2 Adjust flow switch in accordance with manufacturer's instructions.

3.8 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.

3.9 WARNING LABELS

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

3.10 IDENTIFICATION OF HARDWARE AND WIRING

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

.2 All pneumatic tubing shall be labelled at each end within 5 cm (2 in.) of termination with a descriptive identifier.

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

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

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

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

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

.8 Identifiers shall match record documents.

3.11 CONTROLLERS

.1 Provide a separate controller for each AHU or other HVAC system. A DDC controller may control more than one system provided that all points associated with the system are assigned to the same DDC 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.

3.12 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 contractor. 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.

.4 Operator Interface

.1 Standard graphics—Provide graphics for all mechanical systems identified. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as set points.

.2 Show terminal equipment information on a “graphic” summary table. Provide dynamic information for each point shown.

.3 The contractor shall provide all the labour necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third party software installation and integration required for successful operation of the operator interface.

3.13 CONTROL SYSTEM CHECKOUT AND TESTING

.1 Start-up Testing: All testing listed in this article shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the Contract Administrator is notified of the system demonstration.

.1 The contractor shall furnish all labour 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 contractor shall check all control valves and automatic dampers to ensure proper action and closure. The contractor 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 DDC loops and optimum start/stop routines.

.7 Alarms and Interlocks:

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

.2 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.

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

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

3.14 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

.1 Refer to Section 21 05 01 – Common Work Results For Mechanical for commissioning details and requirements.

3.15 CLEANING

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

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

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

3.16 TRAINING

.1 Provide training sessions for the City's personnel.

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

.1 Day-to-day Operators:

.1 Proficiently operate the system

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

.3 Operate the workstation and peripherals

.4 Log on and off the system

.5 Access graphics, point reports, and logs

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

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

.8 Understand system drawings and Operation and Maintenance manual

.9 Understand the job layout and location of control components

.10 Access data from DDC controllers and ASCs

.3 Provide course outline and materials. The instructor(s) shall provide one copy of training material per student.

.4 The instructor(s) shall be factory-trained instructors experienced in presenting this material.

.5 One 8 hour training session or 2 x 4 hour training sessions are required.

.6 Provide a follow up training sessions 6 months after the first training session as described above.

3.17 DDC CONTROLS SEQUENCE OF OPERATION (REFER TO MECHANICAL DRAWINGS)

.1 General:

.1 Controls contractor shall enter the base schedule of the community center's occupied times into the DDC control system and shall train designated community center personnel with the new DDC software.

.2 DDC software to have capability for trained personnel to change scheduled occupancy times as required and to schedule special events mode into the DDC control system.

.2 Air Handling Units and Heat Recovery Ventilators: (Refer to Sections 23 73 11 - Air Handling Units – Packaged and 23 72 00 Air-to-Air Energy Recovery Equipment).

HRV dampers and actuators by controls contractor.

DDC system shall control air handling system to achieve occupied/unoccupied modes, discharge air control, space temperature control and setup/setback functions.

.3 Air Handling Unit AHU-1 / Condensing Unit CU-1, Energy Recovery Ventilators ERV-1a/1b (Gymnasium)

.1 Air Handling Unit (AHU-1) shall operate on a programmable occupied / unoccupied schedule as follows:

.2 Occupied Mode:

.1 AHU supply fan to operate continuously.

.2 Outdoor air damper closed, return air damper open. Remote relief damper closed.

.3 AHU to maintain space temperature at set point. Provide automatic changeover between heating, cooling, and economizer modes based on outdoor air temperature (operator adjustable).

.1 Heating Mode: Gas heating controls to be provided by the air handler supplier. DDC to tie into control system via BACnet. Supply air temperature shall be controlled by an outdoor air reset schedule in the DDC. DDC to provide set point to air handler controls. Supply air temperature override on call for space heating.

.2 Cooling Mode: Control remotely mounted condensing unit (CU-1) to maintain space temperature at set point.

.3 Economizer Mode: Where outdoor temperatures permit, economizer shall be staged to maintain room set point. Remote relief damper fully open. Lockout free cooling when outdoor air enthalpy is greater than indoor air enthalpy. Three stages of economizer shall be available:

1. Stage 1: ERV-1a in economizer mode.
2. Stage 2: ERV-1b in economizer mode.
3. Stage 3: Modulate AHU dampers.

When air handling system is in economizer mode, ERV-1a & ERV-1b shall operate in economizer (non-heat recovery) mode.

.4 Supply air low limit to close fresh air damper (if open) based on low discharge air temperature, turn ERV's off, and after time delay, shut down unit and alarm.

.5 One energy recovery ventilators (ERV-1a or ERV-1b) to operate continuously while the other remains standby. Upon detection of high CO2 levels operate both ERV's.

.3 Un-Occupied Mode:

.1 AHU supply fan to operate as required.

.2 Outdoor air damper closed, return air damper open. Remote relief damper closed.

.3 AHU to maintain space temperature at set back/up point. Provide automatic changeover between heating, cooling, and economizer modes based on outdoor air temperature (operator adjustable).

.1 Heating Mode: Gas heating controls to be provided by the air handler supplier. DDC to tie into control system via BACnet. Supply air temperature shall be controlled by an outdoor air reset schedule in the DDC. DDC to provide set point to air handler controls.

.2 Cooling Mode: Control remotely mounted condensing unit (CU-1) to maintain space temperature at set point.

.3 Economizer Mode: Where outdoor temperatures permit, economizer shall be staged to maintain room set point. Remote relief damper fully open. Lockout free cooling when outdoor air enthalpy is greater than indoor air enthalpy. Three stages of economizer shall be available:

1. Stage 1: ERV-1a in economizer mode.
2. Stage 2: ERV-1b in economizer mode.
3. Stage 3: Modulate AHU dampers.

When air handling system is in economizer mode, ERV-1a & ERV-1b shall operate in economizer (non-heat recovery) mode.

.4 Supply air low limit to close fresh air damper (if open) based on low discharge air temperature, turn ERV's off, and after time delay, shut down unit and alarm.

.5 Energy recovery ventilators ERV-1a and ERV-1b turned OFF. Upon detection of high CO2 levels, operate both ERV's and operate AHU-1 and CU-1 per occupied mode operating sequence for a give period of time (2 hours, operator adjustable).

.4 DDC system shall monitor:

.1 AHU-1

.1 Supply fan status

.2 Space temperature

.3 Supply air temperature

.4 Return air temperature

.5 Outdoor air temperature and enthalpy.

.6 Damper Status and Positions

.7 Pressure drop across the filters

.2 Space CO_2 levels

.3 Condensing Unit Status

.4 ERV's (ERV-1a and ERV-1b)

.1 ERV Status

.2 Air Temperature of supply and exhaust air streams before and after each ERV.

.3 Supply and exhaust air flow rates.

.5 DDC system shall alarm:

.1 AHU-1

.1 Supply fan failure

.2 Damper failure

.3 Heating system failure (freeze stat)

.4 Pressure clogged filters

.5 Supply duct high pressure (Critical – Shut down AHU fans and generate alarm)

.6 Return duct low pressure (Critical– Shut down AHU fans and generate alarm)

.7 Low supply air temperature from AHU-1 (non-critical)

.2 High CO_2 levels

.3 Condensing Unit Failure

.4 Low space temperature – for each zone (non-critical)

.5 ERV's

.1 ERV Failure

.4 Air Handling Unit AHU-2 / Condensing Unit CU-2, Energy Recovery Ventilators ERV-2

.1 Air Handling Unit (AHU-2) and Condensing Unit (CU-2) shall operate on a programmable occupied / unoccupied schedule as follows:

.1 Occupied Mode:

.1 AHU supply fan to operate continuously.

.2 Outdoor air damper and relief damper closed, return air damper open.

.3 Provide automatic changeover between heating, cooling, and economizer modes based on outdoor air temperature (operator adjustable).

.1 Heating Mode: Gas heating controls to be provided by the air handler supplier. DDC to tie into control system via BACnet. Supply air temperature shall be controlled by

an outdoor air reset schedule in the DDC. DDC to provide set point to air handler controls.

.2 Cooling Mode: Control remotely mounted condensing unit (CU-1) to maintain space temperature at set point. (On call for cooling from a given zone thermostat.)

.3 Economizer Mode: Where outdoor temperatures permit, economizer shall be staged to maintain room set point. Remote relief damper fully open. Lockout free cooling when outdoor air enthalpy is greater than indoor air enthalpy. (On call for cooling from a given zone thermostat). Two stages of economizer shall be available:

.1 Stage 1: ERV-2 in economizer mode.

.2 Stage 2: Modulate AHU dampers.

When air handling system is in economizer mode, ERV-2 shall operate in economizer (non-heat recovery) mode.

.4 Supply air low limit to close fresh air damper (if open) based on low discharge air temperature, turn ERV off, and after time delay, shut down unit and alarm.

.5 Upon detection of high CO2 levels, outdoor air / relief air damper to modulate open (up to 25%). ERV to remain ON.

.2 Un-Occupied Mode:

.1 AHU supply fan to operate as required. (On call for heating/cooling from any given zone thermostat.)

.2 Outdoor air / relief air dampers closed, return air damper open.

.3 Provide automatic changeover between heating, cooling, and economizer modes based on outdoor air temperature (operator adjustable).

.1 Heating Mode: Gas heating controls to be provided by the air handler supplier. DDC to tie into control system via BACnet. Supply air temperature shall be controlled by an outdoor air reset schedule in the DDC. DDC to provide set point to air handler controls.

.2 Cooling Mode: Control remotely mounted condensing unit (CU-1) to maintain space temperature at set point.

.4 Economizer Mode: Where outdoor temperatures permit, economizer shall be staged to maintain room set point. Remote relief damper fully open. Lockout free cooling when outdoor air enthalpy is greater than indoor air enthalpy. Two stages of economizer shall be available:

.1 Stage 1: ERV-2 in economizer mode.

.2 Stage 2: Modulate AHU dampers.

When air handling system is in economizer mode, ERV-2 shall operate in economizer (non-heat recovery) mode.

.4 Supply air low limit to close fresh air damper (if open) based on low discharge air temperature, turn ERV's off, and after time delay, shut down unit and alarm.

.5 Energy recovery ventilator ERV-2 turned OFF. Upon detection of high CO2 levels during unoccupied mode, operate ERV-2, AHU-2 and CU-2 per occupied mode operating sequence for a give period of time (operator adjustable).

.3 DDC system shall monitor:

.1 AHU-1

.1 Supply fan status

.2 Space temperature

.3 Supply air temperature

.4 Return air temperature

.5 Outdoor air temperature and enthalpy.

.6 Damper Status and Positions

.7 Pressure drop across the filters

.2 Space CO_2 levels

.3 Condensing Unit Status

.4 ERV (ERV-2)

.5 ERV Status

.6 Air Temperature of supply and exhaust air streams before and after each ERV.

.7 Supply and exhaust air flow rates.

.6 DDC system shall alarm:

.1 AHU-1

.1 Supply fan failure

.2 Damper failure

.3 Heating system failure (freeze stat)

.4 Pressure clogged filters

.5 Supply duct high pressure (Critical – Shut down AHU fans and generate alarm)

.6 Return duct low pressure (Critical– Shut down AHU fans and generate alarm)

.7 Low supply air temperature from AHU-1 (non-critical)

.2 High CO_2 levels

.3 Condensing Unit Failure

.5 Low space temperature – for each zone (non-critical)

.4 ERV's

.1 ERV Failure

.5 Special Events Override

.1 Special Events Override Button: Provide a Special Events Override Button to put the gymnasium air handling systems (Both AHU-1 and AHU-2 and associated systems) into "Occupied Mode" for a given period of time (Operator adjustable). Locate button in the office and identify with signage.

.6 Variable Air Volume (VAV) Boxes

.1 VAV shall be controlled by a remote wall DDC thermostat. VAV damper shall modulate to provide cooling air to the space and maintain space set point. VAV

box flow rates shall modulate between flow rates described in the schedule on the drawing.

.2 VAV box shall follow unoccupied modes described in air handler sequence of operations and to maintain space set back or setup temperatures.

.7 Kitchen Exhaust Hood RH-1

.1 Kitchen exhaust hood to be controlled by a manual 2-way (on/off) switch located near the exhaust hood. DDC control is not required.

.8 Electrical Room Cooling Fan, EF-1

.1 Exhaust fan to be controlled by a space thermostat. When thermostat calls for cooling, motorized dampers on supply and exhaust ducts shall open and EF-1 shall start. When thermostat is satisfied, EF-1 shall turn off and motorized dampers shall close.

.9 Zamboni Room Exhaust Fan, EF-2

.1 Exhaust fan to be controlled by gas detection system. Controls contractor to design, supply, install and commission detection system and provide a fully functional exhaust system.

.2 If gases are detected, controller shall open motorized damper for inlet air and exhaust air and energize EF-2. EF-2 shall continue to run until gas concentrations are below set point. Once set point is reached, EF-2 shall turn off and motorized dampers shall close.

.3 Tie gas detection system into DDC for monitoring. DDC should display current gas concentrations, gas concentration set points and status of EF-2.

.10 Storage Room Exhaust Fan EF-3

.1 Storage room exhaust fan shall operate based on an occupancy sensor. Tie fan into DDC controls.

.11 Bathroom Exhaust Fans EF-4

.1 Bathroom exhaust fan shall operate based on an occupancy sensor. Tie fan into DDC controls.

.12 Vestibule Heaters, FC-1 & FC-2

.1 Vestibule heaters shall operate based on a space temperature sensor located in the vestibule. When temperature sensor calls for heating, FC-1 shall turn on. Integral electric heater shall be controlled by an SCR controller. When temperature sensor is satisfied, FC-1 shall turn off.

.13 Motorized Dampers

.1 Dampers and damper actuators provided for all operating dampers by this Section. Dampers that are located in air handling units are supplied with air handling units with actuators provided by this section. All other remote dampers and actuators provided by this Section.

3.18 ALARMS AND MONITORING

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

.1 Freeze stat on AHU fans (critical)

.2 Fan failure AHU, HRV's, SF, RF's, EF's (critical)

3.19 THERMOSTATS AND TEMPERATURE SENSORS

.1 Provide wall-mounted thermostats and/or space temperature sensors suitable for specified operation. Provide vandal proof protective covers for all units.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and installation for piping, valves and fittings for gas fired equipment.

.2 Sustainable requirements for construction and verification:

.2 Related Requirements

.1 Section 01 35 20 - LEED Sustainable Requirements

.2 Section 01 74 19 – Waste Management and Disposal

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B16.5, Pipe Flanges and Flanged Fittings.

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

.1 ASTM A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.

.2 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.

.3 Canadian Standards Association (CSA International)

.1 CSA W47.1, Certification of Companies for Fusion Welding of Steel.

.4 Canadian Standards Association (CSA)/Canadian Gas Association (CGA)

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

.5 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 Section 01 33 00 - Submittal Procedures.

.2 Co-ordinate submittal requirements and provide submittals required by Section 01 35 20 – LEED Sustainable Requirements.

.3 Product Data:

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

.2 Submit WHMIS MSDS in accordance with Section 01 35 20 – LEED Sustainable Requirements. Indicate VOC's for adhesive and solvents during application and curing.

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

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

.6 Instructions: submit manufacturer's installation instructions.

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

1.4 QUALITY ASSURANCE

.1 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

.2 Construction requirements: in accordance with Section 01 35 20 – LEED Sustainable Requirements.

.3 Verification: Contractor's verification in accordance with Section 01 35 20 – LEED Sustainable Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Waste Management and Disposal:

.1 Separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

.2 Remove from Site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).

.4 Separate for reuse or recycling and place in designated containers in accordance with Waste Management Plan (WMP).

.5 Divert unused materials from landfill to recycling facility.

Part 2 Products

2.1 MATERIALS

.1 Materials and products in accordance with Section 01 35 20 – LEED Sustainable Requirements.

2.2 PIPE

.1 Steel pipe: to ASTM A53/A53M, Schedule 40, seamless as follows:

.1 NPS 1/2 to 2, threaded.

.2 NPS2 1/2 and over, plain end.

2.3 JOINTING MATERIAL

.1 threaded fittings: pulverized lead paste.

.2 Welded fittings: to CSA W47.1.

.3 Flange gaskets: nonmetallic flat.

2.4 FITTINGS

.1 Steel pipe fittings, screwed, flanged or welded:

.1 Malleable iron: threaded, banded, Class 150.

.2 Steel pipe flanges and flanged fittings: to ASME B16.5.

.3 Welding: butt-welding fittings.

.4 Unions: malleable iron, brass to iron, ground seat, to ASTM A47/A47M.

.5 Bolts and nuts: to ASME B18.2.1.

.6 Nipples: schedule 40, to ASTM A53/A53M.

2.5 VALVES

.1 Provincial Code approved, lubricated plug type.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PIPING

.1 Install in accordance with Section 23 05 05 - Installation of Pipework, and applicable codes/standards, supplemented as specified.

.2 Install drip points:

.1 At low points in piping system.

.2 At connections to equipment.

3.3 VALVES

.1 Install valves with stems upright or horizontal.

.2 Install valves at branch take-offs to isolate pieces of equipment, and as indicated.

3.4 FIELD QUALITY CONTROL

.1 Site Tests/Inspection:

.1 Test system in accordance with CAN/CSA B149.1 and requirements of authorities having jurisdiction.

.2 Manufacturer's Field Services:

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

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

.3 Schedule Site visits to review Work at stages listed:

.1 Upon completion of Work, after cleaning is carried out.

.3 Obtain reports within 3 days of review and submit immediately to Contract Administrator.

.4 Verification requirements in accordance with Section 01 35 20 – LEED Sustainable Requirements. Include:

.1 Materials and resources.

.2 Storage and collection of recyclables.

.3 Construction waste management.

.4 Resource reuse.

.5 Recycled content.

.6 Local/regional materials.

.7 Certified wood.

.8 Low-emitting materials.

.5 PV procedures:

.1 Test performance of components.

3.5 ADJUSTING

.1 Purging: purge after pressure test in accordance with CAN/CSA B149.1.

.2 Pre-Start-Up Inspections:

.1 Check vents from regulators, control valves, terminate outside building in approved location, protected against blockage, damage.

.2 Check gas trains, entire installation is approved by authority having jurisdiction.

3.6 CLEANING

.1 Cleaning: in accordance with CAN/CSA B149.1, supplemented as specified.

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

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and installation for copper tubing and fittings for refrigerant.

.2 Sustainable requirements for construction and verification:

.2 Related Requirements

.1 Section 01 35 20 - LEED Sustainable Requirements

.2 Section 01 74 19 – Waste Management and Dipsosal

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME)

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

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

.3 ASME B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.

.4 ASME B31.5, Refrigeration Piping and Heat Transfer Components.

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

.1 ASTM B280, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

.3 Canadian Standards Association (CSA International)

.1 CSA B52, Mechanical Refrigeration Code.

.4 Environment Canada (EC)

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

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

.1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Co-ordinate submittal requirements and provide submittals required by Section 01 35 20 – LEED Sustainable Requirements.

.3 Product Data:

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

.2 Submit WHMIS MSDS in accordance with Section 01 35 20 – LEED Sustainable Requirements. Indicate VOC's for adhesive and solvents during application and curing.

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

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

.6 Instructions: submit manufacturer's installation instructions.

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

1.4 QUALITY ASSURANCE

.1 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

.2 Construction requirements: in accordance with Section 01 35 20 – LEED Sustainable Requirements.

.3 Verification: Contractor's verification in accordance with Section 01 35 20 – LEED Sustainable Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Waste Management and Disposal:

.1 Separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

.2 Remove from Site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).

.4 Separate for reuse or recycling and place in designated containers in accordance with Waste Management Plan (WMP).

.5 Divert unused materials from landfill to recycling facility as approved by Contract Administrator.

Part 2 Products

2.1 MATERIALS

.1 Materials and resources in accordance with Section 01 35 20 – LEED Sustainable Requirements.

2.2 TUBING

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

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

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

2.3 FITTINGS

.1 Service: design pressure 2070 kPa and temperature 121 degrees C.

.2 Brazed:

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

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

.3 Flanged:

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

.2 Gaskets: suitable for service.

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

.4 Flared:

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

2.4 PIPE SLEEVES

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

2.5 VALVES

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

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

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 GENERAL

.1 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5 Section 23 05 05 - Installation of Pipework.

3.3 BRAZING PROCEDURES

.1 Bleed inert gas into pipe during brazing.

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

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

3.4 PIPING INSTALLATION

.1 General:

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

.2 Hot gas lines:

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

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

.3 Provide inverted deep trap at top of risers.

.4 Provide double risers for compressors having capacity modulation.

.1 Large riser: install traps as specified.

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

3.5 PRESSURE AND LEAK TESTING

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

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

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

3.6 FIELD QUALITY CONTROL

.1 Site Tests/Inspection:

.1 Close service valves on factory charged equipment.

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

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

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

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

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

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

.2 Break vacuum with refrigerant to 14 kPa.

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

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

.7 Charging:

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

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

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

.8 Checks:

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

.9 Manufacturer's Field Services:

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

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

.3 Schedule Site visits, to review Work, at stages listed:

.1 Upon completion of the Work, after cleaning is carried out.

.4 Obtain reports, within 3 days of review, and submit, immediately, to Contract Administrator.

.10 Verification requirements in accordance with Section 01 35 20 – LEED Sustainable Requirements. Include:

.1 Materials and resources.

.2 Storage and collection of recyclables.

.3 Construction waste management.

.4 Resource reuse.

.5 Recycled content.

.6 Local/regional materials.

.7 Certified Wood.

.8 Low-emitting materials.

3.7 DEMONSTRATION

.1 Instructions:

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

3.8 CLEANING

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

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

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

.2 Related Sections:

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 35 20 - LEED Sustainable Requirements

.3 Section 01 74 19 – Waste Management and Disposal

1.2 REFERENCES

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

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

.2 National Fire Protection Association (NFPA).

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

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

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

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

.2 SMACNA HVAC Air Duct Leakage Test Manual.

1.3 SUBMITTALS

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

Part 2 Products

2.1 SEAL CLASSIFICATION

.1 Classification as follows:

Maximum Pressure: 500 Pa

.2 Transverse joints and connections made air tight with duct sealant. Longitudinal seams sealed. Seal all joints.

2.2 SEALANT

.1 Sealant: water based duct sealant. Temperature range of application: minus 5 degrees Celsius to plus 30 degrees Celsius.

.1 Acceptable Material: Duro Dyne DWN.

2.3 FITTINGS

.1 Fabrication: to SMACNA.

.2 Radiused elbows.

.1 Rectangular: standard radius or short radius without turning vanes. Centreline radius: 1.5 times width of duct.

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

.3 Mitred elbows, rectangular:

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

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

.4 Branches:

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

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

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

.4 Main duct branches: with splitter damper.

.5 Transitions:

.1 Diverging: 20 degrees maximum included angle.

.2 Converging: 30 degrees maximum included angle.

.6 Offsets:

.1 Full radiused elbows.

2.4 GALVANIZED STEEL

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

.2 Thickness, fabrication and reinforcement: to SMACNA.

.3 Joints: to SMACNA.

2.5 HANGERS AND SUPPORTS

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

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

.2 Hanger configuration: to SMACNA.

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

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10

.1 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.

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

.1 Insulate strap hangers 100 mm beyond insulated duct.

.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.

.6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

3.2 HANGERS

.1 Strap hangers: install in accordance with SMACNA.

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

.3 Hanger spacing: in accordance with SMACNA as follows:

Duct Size (mm)	Spacing (mm)
to 1500	3000

3.3 WATERTIGHT DUCT

.1 Provide watertight duct for:

.1 Fresh air intake.

.2 Exhaust discharges.

Slope ducts to drain back outside.

.2 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.

.3 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.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

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

.2 Related Requirements:

.1 Section 01 35 20 - LEED Sustainable Requirements

.2 Section 01 74 19 – Waste Management and Disposal

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.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Co-ordinate submittal requirements and provide submittals required by Section 01 35 20 – LEED Sustainable Requirements.

.3 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.

.2 Submit WHMIS MSDS in accordance with Section 01 35 20 – LEED Sustainable Requirements. Indicate VOC's for adhesive and solvents during application and curing.

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

.1 Certification of ratings: catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

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

.6 Instructions: submit manufacturer's installation instructions.

.7 Manufacturer's Field Reports: manufacturer's field reports specified.

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

1.4 QUALITY ASSURANCE

.1 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

.2 Construction requirements: in accordance with Section 01 35 20 – LEED Sustainable Requirements.

.3 Verification: Contractor's verification in accordance with Section 01 35 20 – LEED Sustainable Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Waste Management and Disposal:

.1 Separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

.2 Remove from Site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).

.4 Separate for reuse and recycling and place in designated containers in accordance with Waste Management Plan (WMP).

.5 Divert unused materials from landfill to recycling facility.

Part 2 Products

2.1 MATERIALS

.1 Materials and resources in accordance with Section 01 35 20 – LEED Sustainable Requirements.

2.2 GENERAL

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

2.3 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.

2.4 ACCESS DOORS IN DUCTS

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

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

.3 Gaskets: neoprene.

.4 Hardware:

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

.2 301 to 450 mm: four sash locks.

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

.4 Hold open devices.

2.5 TURNING VANES

.1 Factory or shop fabricated double thickness with trailing edge, to recommendations of SMACNA and as indicated.

2.6 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.

2.7 SPIN-IN COLLARS

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

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

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Flexible Connections:

.1 Install in following locations:

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

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

.3 As indicated.

.2 Length of connection: 100 mm.

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

.4 Install in accordance with recommendations of SMACNA.

.5 When fan is running:

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

.2 Ensure slack material in flexible connection.

.2 Access Doors and Viewing Panels:

.1 Size:

.1 As indicated.

.2 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 And as indicated.

.4 Turning vanes:

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

3.3 FIELD QUALITY CONTROL

.1 Verification requirements in accordance with Section 01 35 20 – LEED Sustainable Requirements. Include:

.1 Materials and resources.
.2 Storage and collection of recyclables.
.3 Construction waste management.
.4 Resource reuse.
.5 Recycled content.
.6 Local/regional materials.
.7 Certified Wood.
.8 Low-emitting materials.

3.4 CLEANING

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

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

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

.2 Related Requirements:

.1 Section 01 35 20 - LEED Sustainable Requirements

.2 Section 01 74 19 – Waste Management and Disposal

1.2 REFERENCES

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

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

1.3 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 Quality assurance submittals: submit in accordance with Section 01 33 00 - Submittal Procedures.

1.4 QUALITY ASSURANCE

.1 Health and Safety Requirements:

.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

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

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

.1 Materials and products in accordance with Section 01 35 20 – LEED Sustainable Requirements.

2.2 GENERAL

.1 Manufacture to SMACNA standards.

2.3 SPLITTER DAMPERS

.1 Fabricate from same material as duct but one sheet metal thickness heavier, with appropriate stiffening.

.2 Double thickness construction.

.3 Control rod with locking device and position indicator.

.4 Rod configuration to prevent end from entering duct.

.5 Pivot: piano hinge.

.6 Folded leading edge.

2.4 SINGLE BLADE DAMPERS

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

.2 Size and configuration to recommendations of SMACNA, except maximum height 100 mm.

.3 Locking quadrant with shaft extension to accommodate insulation thickness.

.4 Inside and outside nylon end bearings.

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

2.5 MULTI-BLADED DAMPERS

.1 Factory manufactured of material compatible with duct.

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

.3 Maximum blade height: 100 mm.

.4 Bearings: pin in bronze bushings.

.5 Linkage: shaft extension with locking quadrant.

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

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Install where indicated.

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

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

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

.5 Dampers: vibration free.

.6 Ensure damper operators are observable and accessible.

3.3 FIELD QUALITY CONTROL

.1 Verification requirements in accordance with Section 01 35 20 – LEED Sustainable Requirements. Include:

.1 Materials and resources.

.2 Storage and collection of recyclables.

.3 Construction waste management.

.4 Resource reuse.

.5 Recycled content.

.6 Local/regional materials.

.7 Low-emitting materials.

3.4 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Fire dampers.

.2 Sustainable requirements for construction and verification.

.1 Related Requirements:

.1 Section 01 35 20 - LEED Sustainable Requirements

.2 Section 01 74 19 – Waste Management and Disposal

1.2 REFERENCES

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

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

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

.1 Material Safety Data Sheets (MSDS).

.3 Underwriters Laboratories of Canada (ULC)

.1 CAN4-S112, Fire Test of Fire Damper Assemblies.

.2 ULC-S505, Fusible Links for Fire Protection Service.

1.3 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.

.1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

.2 Indicate the following:

.1 Fire dampers.

.2 Operators.

.3 Fusible links.

.4 Design details of break-away joints.

.2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

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

.2 Instructions: submit manufacturer's installation instructions.

.3 Closeout Submittals:

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

1.4 QUALITY ASSURANCE

.1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

.2 Certificates:

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

1.5 MAINTENANCE

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

1.6 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

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

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

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

.1 Materials and products in accordance with Section 01 35 20 – LEED Sustainable Requirements.

2.2 FIRE DAMPERS

.1 Fire dampers: meet requirements of authorities having jurisdiction. Fire damper assemblies fire tested in accordance with CAN4-S112.

.2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.

.1 Fire dampers: fire rated as indicated on drawings.

.2 Fire dampers: automatic operating type and have dynamic rating suitable for maximum air velocity and pressure differential to which it will be subjected.

.3 Top hinged: curtain type; sized to maintain full duct cross section.

.4 Fusible link actuated, spring closure and lock in closed position when released.

.5 Install retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.

.6 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.

.7 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition of floor slab depth or thickness.

.8 Dynamic fire dampers that will close in the event of a fire and where airflow continues.

.9 Use only Type B or C dampers, except for locations where fire damper is directly behind a grille. Where fire dampers are located directly behind a grille, use Type A dampers.

.10 Acceptable Product: "Naylor", "Greenheck" or approved equal 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 Install in accordance with ANSI/NFPA 90A and in accordance with conditions of ULC listing.

.2 Maintain integrity of fire separation.

.3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.

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

.5 Co-ordinate with installer of firestopping.

.6 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.

.7 Install break-away joints of approved design on each side of fire separation.

3.3 FIELD QUALITY CONTROL

.1 Verification requirements in accordance with Section 01 35 20 – LEED Sustainable Requirements. Include:

.1 Materials and resources.
.2 Storage and collection of recyclables.
.3 Construction waste management.
.4 Resource reuse.
.5 Recycled content.
.6 Local/regional materials.
.7 Low-emitting materials.

3.4 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and installation of flexible ductwork, joints and accessories.

.2 Sustainable requirements for construction and verification.

.3 Related Requirements:

.1 Section 01 35 20 - LEED Sustainable Requirements

.2 Section 01 74 19 – Waste Management and Disposal

1.2 REFERENCES

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

.2 Department of Justice Canada (Jus).

.1 Canadian Environmental Protection Act (CEPA).

.2 Transportation of Dangerous Goods Act.

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

.1 Material Safety Data Sheets (MSDS).

.4 National Fire Protection Association (NFPA).

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

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

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

.1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, (Including Addenda).

.2 SMACNA IAQ Guideline for Occupied Buildings under Construction.

.6 Underwriters' Laboratories Inc. (UL).

.1 UL 181, Standard for Factory-Made Air Ducts and Air Connectors.

.7 Underwriters' Laboratories of Canada (ULC).

.1 CAN/ULC-S110, Fire Tests for Air Ducts.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Co-ordinate submittal requirements and provide submittals required by Section 01 35 20 – LEED Sustainable Requirements.

.3 Submit Indoor Air Quality (IAR) Management Plan in accordance with Section 01 35 20 – LEED Sustainable Requirements.

.4 Product Data: submit WHMIS MSDS in accordance with Section 01 35 20 – LEED Sustainable Requirements for the following:

.1 Thermal properties.

.2 Friction loss.

.3 Acoustical loss.

.4 Leakage.

.5 Fire rating.

1.4 QUALITY ASSURANCE

.1 Certification of Ratings:

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

.2 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

.3 Sustainable Requirements:

.1 Construction requirements: in accordance with Section 01 35 20 – LEED Sustainable Requirements.

.2 Verification: Contractor's verification in accordance with Section 01 35 20 – LEED Sustainable Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Protect on Site stored or installed absorptive material from moisture damage.

.2 Store and manage hazardous materials in accordance with Section 01 35 20 – LEED Sustainable Requirements.

.3 Waste Management and Disposal:

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

.2 Remove from Site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Place materials defined as hazardous or toxic in designated containers.

.5 Handle and dispose of hazardous materials in accordance with applicable regulations.

.6 Ensure emptied containers are sealed and stored safely.

.7 Fold up metal and plastic banding, flatten and place in designated area for recycling.

1.6 INDOOR AIR QUALITY (IAQ) MANAGEMENT PLAN

.1 Develop and implement an Indoor Air Quality (IAQ) Management Plan in accordance with Section 01 35 20 – LEED Sustainable Requirements: Construction for construction and preoccupancy phases of building.

.2 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

.1 Materials and products in accordance with Section 01 35 20 – LEED Sustainable Requirements: Construction.

2.2 GENERAL

.1 Factory fabricated to CAN/ULC-S110.

.2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.

.3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

2.3 NON-METALLIC - UNINSULATED

.1 Non-collapsible, coated aluminum foil mylar type, mechanically bonded to, and helically supported by, external steel wire.

.2 Performance:

.1 Factory tested to 2.5 kPa without leakage.

.2 Maximum relative pressure drop coefficient: 3.

.3 Maximum length allowed at diffuser is 1.5 meters.

Part 3 Execution

3.1 DUCT INSTALLATION

.1 Install in accordance with applicable standards.

3.2 FIELD QUALITY CONTROL

.1 Verification requirements in accordance with Section 01 35 20 – LEED Sustainable Requirements. Include:

.1 Materials and resources.

.2 Storage and collection of recyclables.

.3 Construction waste management.

.4 Resource reuse.

.5 Recycled content.

.6 Local/regional materials.

.7 Low-emitting materials.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

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

.2 Sustainable requirements for construction and verification.

.1 Related Requirements:

.1 Section 01 35 20 - LEED Sustainable Requirements

.2 Section 01 74 19 – Waste Management and Disposal

1.2 REFERENCES

.1 Air Conditioning and Mechanical Contractors (AMCA)

.1 AMCA Publication 99, Standards Handbook.

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

.3 AMCA 301, 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, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.

.3 Canadian General Standards Board (CGSB)

.1 CAN/CGSB 1.181, 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, external 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.

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 and product data in accordance with Section 01 33 00 - Submittal Procedures.

.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.

.2 Minimum performance achievable as appropriate.

.5 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

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

.2 Instructions: submit manufacturer's installation instructions.

.6 Closeout Submittals:

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

1.5 QUALITY ASSURANCE

.1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.6 MAINTENANCE

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

.1 Spare parts to include:

.1 Matched sets of belts.

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

.1 Bearings and seals.

.2 Addresses of suppliers.

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

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

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

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

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

.1 Materials and products in accordance with Section 01 35 20 – LEED Sustainable Requirements.

2.2 RANGE HOOD, RH-1:

.1 Performance: 283 L/s (600 cfm), 120V/1ph, 5.5 Amps, sound to be 9.5 Sonnes

.2 Stainless steel construction, 100 cm (39") width, seamless corners, three speed control, four 20-watt halogen bulbs, telescoping flue fits 2.4 to 2.7 meter (8' to 9') ceilings, easily removable and dishwasher-safe stainless steel grease filter.

.3 Acceptable Product: "Broan" model 637004 or approved equal in accordance with B7.

2.3 EXHAUST FAN, EF-1:

.1 Performance: 200 cfm, 0.4" w.g., 1673 Fan RPM, 0.04 BHP, 1/6 motor HP, TENV motor enclosure, 1725 motor RPM, 115V/1ph with an FLA of 3.4 Amps. Sound to be 5.7 Sonnes.

.2 Direct drive centrifugal inline fan, galvanized steel construction, backward inclined aluminum wheel, two bolted access panels, integral duct connection flanges, corrosion resistant fasteners.

.3 Acceptable Product: "Greenheck" model SQ-70-VG or approved equal in accordance with B7.

2.4 EXHAUST FAN, EF-2:

.1 Performance: 260 L/s (550 cfm), 100 Pa (0.6" w.g.), 1518 Fan RPM, 67 W (0.09 BHP), 124 W (1/6 HP) motor, TEFC motor enclosure, 1725 motor RPM, 115V/1ph with an FLA of 3.1 Amps. Sound to be 7.8 Sonnes.

.2 Direct drive centrifugal inline fan, galvanized steel construction, backward inclined aluminum wheel, two bolted access panels, integral duct connection flanges, corrosion resistant fasteners.

.3 Acceptable Product: "Greenheck" model SQ-95-VG or approved equal in accordance with B7.

2.5 EXHAUST FAN, EF-3:

.1 Performance: 35 L/s (75 cfm), 62 Pa (0.25" w.g.), 700 Fan RPM, 50 Watts, 50 Watt motor, ODP motor enclosure, 115V/1ph, 0.65 Amps, Sound to be 2.3 Sonnes.

.2 Ceiling fan, corrosion resistant galvanized steel scroll and housing, white non-yellowing grille, round outlet duct collar with integral backdraft damper, single inlet forward curved wheel, plug type disconnect, adjustable mounting brackets.

.3 Options & Accessories

- .1 UL/cUL 507 Listed – Electric Fans
- .2 Solid State Speed Control, Shipped Loose
- .3 Round Duct Connection
- .4 Polypropylene Wheel Material

.4 Acceptable Product: "Greenheck" model SP-B90 or approved equal in accordance with B7.

2.6 EXHAUST FAN, EF-4

.1 Performance: 47 L/s (100 cfm), 62 Pa (0.25" w.g.) 706 Fan RPM, 129 Watts, 129 Watt motor, ODP motor enclosure, 115V/1ph, 1.7 Amps, Sound to be 0.6 Sones.

.2 Ceiling fan, corrosion resistant galvanized steel scroll and housing, white non-yellowing grille, round outlet duct collar with integral backdraft damper, single inlet forward curved wheel, plug type disconnect, adjustable mounting brackets

.3 Options & Accessories

.1 UL/cUL 507 Listed – Electric Fans

.2 Solid State Speed Control, Shipped Loose

.3 Round Duct Connection

.4 Polypropylene Wheel Material

.4 Acceptable Product: "Greenheck" model SP-B150 or approved equal 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.

3.3 ANCHOR BOLTS AND TEMPLATES

.1 Size anchor bolts to withstand seismic acceleration and velocity forces.

3.4 FIELD QUALITY CONTROL

.1 Verification requirements in accordance with Section 01 35 20 – LEED Sustainable Requirements. Include:

.1 Materials and resources.

.2 Storage and collection of recyclables.

.3 Construction waste management.

.4 Resource reuse.

.5 Recycled content.

.6 Local/regional materials.

.7 Low-emitting materials.

3.5 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Variable volume boxes.

.2 Sustainable requirements for construction and verification.

.1 Related Requirements:

.1 Section 01 35 20 - LEED Sustainable Requirements

.2 Section 01 74 19 – Waste Management and Disposal

1.2 REFERENCES

.1 American National Standards Institute (ANSI)

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

.2 ANSI/NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.

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

.1 Material Safety Data Sheets (MSDS).

.3 International Organization of Standardization (ISO)

.1 ISO 3741, Acoustics-Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Methods for Reverberation Rooms.

.4 Underwriter's Laboratories (UL)

.1 UL 181, Factory-Made Air Ducts and Air Connectors.

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 certified ADC (Air Diffusion Council) 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 Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.2 Test data: to ANSI/AMCA 210.

.1 Submit published test data on DIN (Direct Internal Noise), in accordance with ISO 3741 made by independent testing agency for 0, 2.5 and 6 m/s branch velocity or inlet velocity.

.2 Sound power level with minimum inlet pressure of 0.25 kPa in accordance with ISO 3741 for 2nd through 7th octave band.

.3 Pressure loss through silencer shall not exceed 60% of inlet velocity pressure maximum.

.2 Shop Drawings:

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

.2 Indicate the following:

.1 Capacity.

.2 Pressure drop.

.3 Noise rating.

.4 Leakage.

.3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

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

.2 Instructions: submit manufacturer's installation instructions.

.4 Closeout Submittals:

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

1.5 QUALITY ASSURANCE

.1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

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

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

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

1.7 MAINTENANCE

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

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

.1 Bearings and seals.

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

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

.1 Materials and products in accordance with Section 01 35 20 – LEED Sustainable Requirements.

2.2 MANUFACTURED UNITS

.1 Terminal units of the same type to be product of one manufacturer.

2.3 SINGLE DUCT, VARIABLE AIR VOLUME TERMINAL, VAV-1 TO VAV-7:

.1 Performance: Refer to schedule on drawings.

.2 The primary air assemblies shall be pressure independent and shall reset to any air flow between zero and the maximum catalogued air volume.

.3 Sound ratings of air distribution assemblies shall not exceed 18 NC at 2 Pa (0.01") static pressure drop across the unit, and the downstream static pressure of 125 Pa (0.5" W.C.)

.4 The airflow sensor shall be of a cross configuration located at the inlet of the assembly. The sensor shall have twelve total pressure sensing ports and a centre averaging chamber designed to accurately average the flow across the inlet of the assembly. Sensor shall provide accuracy within 5% with a 90° sheet metal elbow directly at the inlet of the assembly. The airflow sensor shall amplify the sensed airflow signal.

.5 The assembly casing shall be constructed of zinc coated steel, internally lined with 13 mm (1/2") thick, dual density fibreglass insulation which complies with UL-181 and NFPA-90A. Any cut edges of fibreglass exposed to the air stream shall be coated with NFPA-90A approved sealant.

.6 Gauge of the assembly casing shall be as follows:
1. Casing width less than 36" - minimum 22 gauge.
2. Casing width 36" or greater - minimum 20 gauge.

.7 The primary air valve damper shall be heavy gauge metal, with peripheral gasket, and soild steel shaft, pivoted in self-lubricating bearings. In the full closed position, air leakage past the closed damper shall not exceed 2% of the nominal catalogue rating at 747 Pa (3" w.g.) inlet static pressure, when tested in accordance with ASHRAE 130.

.8 Units shall incorporate a single point electrical and control connection for the entire unit. All electrical components shall be enclosed in a single control box with an access panel mounted on the side of the assembly. All controls shall be sealed from primary air flow. Units shall be ETL listed to meet UL1995 and CSA No. 236 and ARI certified.

.9 Manufacturer shall provide controls to control the VAV box and associated electric reheat coil. Space (DDC) thermostat to be tied into controller. VAV controller shall tie into DDC control system by controls contractor.

.10 Units to include an integral 900 mm attenuator on the discharge of the VAV box.

.11 Acceptable product: "E.H. Price" model SDV8000 or approved equal in accordance with B7. Refer to drawings for VAV schedule

2.4 FANC COILS, FC-1 & FC-2:

.1 Horizontal blow-thru ducted, electric heat fan coil unit for ducted installations, c/w water coils, fans, motors, drain pan, all required wiring, piping,18-gage galvanized steel plenum section, 1" throwaway filter, lined with 1/2" thick fibreglass insulation, removable panel to provide access to fan/motor assembly, 3-speed 4-position fan switch for field mounting.

ETL approved, CSA approved, insulation and adhesive meet NFPA 90A requirements, wiring complies with NEC requirements.

.2 Sound Power Data: Casing radiated 56 dBA, Discharge 54 dBA,

.3 Electrical Heater: 208 V, single phase, 4kW, 19.2 Amps FLA.

.4 Fan motor: Voltage 120V/1ph, 980 Fan RPM, 165 Watts, 0.72 Amps, 1/10 nominal HP

.5 Fans: Direct driven, double-width fan wheel shall have forward-curved blades, scrolls and fans constructed of galvanized steel.

.6 Acceptable product: “Carrier” model 42DCA06BLCY6YYYY or approved equal 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 Install in accordance with manufacturers recommendations.

.2 Support independently of ductwork.

.3 Locate controls, dampers and access panels for easy access.

3.3 FIELD QUALITY CONTROL

.1 Verification requirements in accordance with Section 01 35 20 – LEED Sustainable Requirements. Include:

.1 Materials and resources.
.2 Storage and collection of recyclables.
.3 Construction waste management.
.4 Resource reuse.
.5 Recycled content.
.6 Local/regional materials.
.7 Low-emitting materials.

3.4 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

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

.1 Related Requirements:

.1 Section 01 35 20 - LEED Sustainable Requirements

.2 Section 01 74 19 – Waste Management and Disposal

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 Section 01 33 00 - Submittal Procedures. 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.

.2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

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

.2 Instructions: submit manufacturer's installation instructions.

1.4 QUALITY ASSURANCE

.1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

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

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

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

1.6 MAINTENANCE

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

.2 Include:

.1 Keys for volume control adjustment.

.2 Keys for air flow pattern adjustment.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

.1 Materials and products in accordance with Section 01 35 20 – LEED Sustainable Requirements.

2.2 GENERAL

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

.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, where specified.

.4 Colour: as directed by Contract Administrator.

2.3 MANUFACTURED UNITS

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

2.4 GRILLE SCHEDULE

.1 As indicated on drawings. **Confirm all colours and/or finishes with Contract Administrator prior to ordering materials.**

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.

.3 Bolt grilles, registers and diffusers, in place, in gymnasium and similar game rooms.

.4 Provide concealed safety chain on each grille, register and diffuser in gymnasium and similar game rooms.

3.3 FIELD QUALITY CONTROL

.1 Verification requirements in accordance with Section 01 35 20 – LEED Sustainable Requirements. Include:

.1 Materials and resources.

.2 Storage and collection of recyclables.

.3 Construction waste management.

.4 Resource reuse.

.5 Recycled content.

.6 Local/regional materials.

.7 Low-emitting materials.

3.4 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

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

.2 Related Requirements:

.1 Section 01 35 20 - LEED Sustainable Requirements

.2 Section 01 74 19 – Waste Management and Disposal

1.2 REFERENCES

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

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

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

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

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

1.3 SYSTEM DESCRIPTION

.1 Performance Requirements:

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

1.4 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 Indicate following:

.1 Pressure drop.

.2 Face area.

.3 Free area.

.2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

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

.2 Instructions: submit manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

.1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

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

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

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

.1 Materials and products in accordance with Section 01 35 20 – LEED Sustainable Requirements.

2.2 FIXED LOUVRES - ALUMINUM

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

.2 Performance rated in accordance with AMCA certification.

.3 Material: extruded aluminum, 39° blade angle.

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

.5 Drainable blade with 125 mm (5”) blade spacing.

.6 Frame, head, sill and jamb: 152 mm deep one piece extruded aluminum, minimum 2 mm thick with approved caulking slot, integral to unit.

.7 Design wind load: 161 kph (100 mph).

.8 Screen: standard bird screen, ½” x ½”, re-galvanized, 19 gauge.

.9 Free area velocity at beginning point of water penetration is to be at least 1233 fpm as defined by AMCA Standard 511. Pressure drop at beginning of water penetration to be 57 Pa (0.23” w.c.) or less.

.10 Finish: factory finished, color to be coordinated with Contract Administrator.

.11 Acceptable Material: “E.H. Price” or “Ventex”, sizes as per Louvers Schedule. See Architectural for Louver mounting detail.

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.

3.3 FIELD QUALITY CONTROL

.1 Verification requirements in accordance with Section 01 35 20 – LEED Sustainable Requirements. Include:

.1 Materials and resources.

.2 Storage and collection of recyclables.

.3 Construction waste management.

.4 Resource reuse.

.5 Recycled content.

.6 Local/regional materials.

.7 Low-emitting materials.

3.4 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials, components, framing, installation and testing for an evaporative condenser closed circuit cooling tower.

.1 Related Requirements:

.1 Section 01 35 20 - LEED Sustainable Requirements

.2 Section 01 74 19 – Waste Management and Disposal

1.2 REFERENCES

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

.1 ASTM A48/A48M, Standard Specification for Gray Iron Castings.

.2 ASTM A123/A/123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

.3 ASTM A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

.4 ASTM C67, Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.

.5 ASTM D520, Standard Specification for Zinc Dust Pigment.

.2 Canadian Standards Association (CSA International)

.1 CSA B52, Mechanical Refrigeration Code.

.3 Cooling Technology Institute (CTI)

.1 CTI-ATC-105, Acceptance Test Code.

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

.1 Material Safety Data Sheets (MSDS).

.5 Underwriters Laboratories' of Canada (ULC)

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

.6 National Electrical Manufacturers Association (NEMA)

.1 NEMA MG 1, Motors and Generators.

1.3 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 Section 01 33 00 - Submittal Procedures.

.2 Indicate:

.1 Connections, piping, fittings, valves, strainers, control assemblies and ancillaries, identifying factory and field assembled.

.2 Wiring as assembled and schematically.

.3 Dimensions, construction details, recommended installation and support, mounting bolt hole sizes and locations and point loads.

.4 Vibration and seismic control measures.

.5 Manufacturers recommended clearances.

.3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.1 Instructions: submit manufacturer's installation instructions.

.2 Manufacturer's Field Reports: manufacturer's field reports specified.

.4 Closeout Submittals:

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

.2 Include:

.1 Description of equipment giving manufacturers name, type, model year, capacity.

.2 Start-up and commissioning procedures.

.3 Details of operation, servicing and maintenance.

.4 Recommended spare parts list.

1.4 QUALITY ASSURANCE

.1 Qualifications:

.1 Installer: company or person specializing in air-cooled condenser installations with minimum 5 years experience.

.2 Regulatory Requirements: Work to be performed in compliance with applicable Provincial regulations.

.3 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

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

.2 Storage and Protection:

.1 Store and protect materials from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

.3 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

1.6 MAINTENANCE

.1 Extra Materials:

.1 Include with data complete list of parts and supplies.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

.1 Materials and products in accordance with Section 01 35 20 – LEED Sustainable Requirements.

2.2 SPLIT SYSTEM AIR COOLED CONDENSERS, CU-1,2:

.1 Units shall be cETL approved. Condensing units shall be designed for a minimum of 8℃ liquid subcooling. Condensing units shall oerpate down to 10℃ as standard. Multiple compressor/condenser circuits shall be separate from each other. Suction and liquid lines shallbe extended to the outside of the cabinet. Service ports fiited with Schraeder fittings shall be connected to the suction and discharge lines for chargin or pressure gauge readings.

.2 Controls for hermetic compressor units shall include compressor and condenser fan motor contactors, control circuit transformer, cooling realys, non-recylcing pump-down relays, ambient compressor lockout, manual reset high pressure controls and automatic reset low pressure controls. Head pressure actuated fan cycling controls hsall be provided on all multiple condenser fan units.

.3 Provide a minimum of three individually circuited compressors for redundancy and capacity control.

.4 Provide five minute anti-cycle timers.

.5 Provide interstage timed delay timers.

.6 Provide hot gas bypass connection on the lead compressor.

.7 Refrigeration specialties such as solenoid valves, TX valves, etc. including R410A refrigerant, to be supplied and installed by refrigeration contractor.

.8 Design to account for piping lengths and condenser location relative to the DX coil as indicated on the drawings.

.9 Disconnect supplied and installed by the Electrical Subcontractor.

.10 Acceptable Product: “Engineered Air”. See schedule at end of section for model numbers.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 GENERAL

.1 Mount on structural supports and vibration isolators and to manufacturer's recommendations.

.2 Ensure clearance for servicing and maintenance as recommended by manufacturer.

.3 Manufacturers field service representative to approve installation, to perform start up and to instruct operators.

3.3 FIELD QUALITY CONTROL

.1 Site Tests:

.1 Test under actual operating conditions in accordance with CTI-ATC-105 to verify specified performance.

.2 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 Schedule Site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

.3 Verification requirements in accordance with Section 01 35 20 – LEED Sustainable Requirements. Include:

.1 Materials and resources.

.2 Storage and collection of recyclables.

.3 Construction waste management.

.4 Resource reuse.

.5 Recycled content.

.6 Local/regional materials.

.7 Low-emitting materials.

3.4 ADJUSTING

.1 Lubricate bearings with oil or grease as recommended by manufacturer.

.2 Tighten belts to manufacturer's specified tension.

3.5 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 Wipe equipment clean, and remove traces of oil, dust, dirt, or paint spots.

.3 Maintain system in clean condition until final acceptance.

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

END OF SECTION

TAG		CU-1	CU-2
SERVICE		AHU-1	AHU-2
ACCEPTABLE PRODUCT: MANUFACTURER		Engineered Air	Engineered Air
ACCEPTABLE PRODUCT: MODEL			
	Nominal Tonnage	18	18
	Minimum No. of Compressors	3	3
	Suction Temp (°F)	52	48.9
	Refrigerant	R410A	R410A
COMMENTS	All refrigeration specialties are by others.		

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials, components and installation for heat reclaim devices.

.2 Related Requirements:

.1 Section 01 35 20 - LEED Sustainable Requirements

.2 Section 01 74 19 – Waste Management and Disposal

1.2 REFERENCES

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

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

1.3 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 Section 01 33 00 - Submittal Procedures.

.1 Indicate following: all performance data, unit dimensions, motor drive, accessories provided, dampers, control panel design, wiring diagram, and sequence of operation. Provide service access as shown on the drawings.

.3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.1 Instructions: submit manufacturer's installation instructions.

.4 Closeout Submittals:

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

1.4 QUALITY ASSURANCE

.1 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

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

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

1.6 MAINTENANCE

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

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

.1 Bearings and seals.

.2 Addresses of suppliers.

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

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

.1 Materials and products in accordance with Section 01 35 20 – LEED Sustainable Requirements.

2.2 GENERAL

.1 Comply with ASHRAE 84.

2.3 DUAL CORE HEAT RECOVERY VENTILATOR, ERV-1a, ERV-1b & ERV-2:

.1 Performance:

.1 ERV-1a,1b: 484 L/s (1,025 cfm), 560 W (3/4 HP) blower motors, 125 Pa (0.5” w.g.) E.S.P., 495 kg (1089 lbs).

.2 ERV-2: 330 L/s (700 cfm), 373 W (1/2 HP) blower motors, 125 Pa (0.5” w.g.) E.S.P., 350 kg (770 lbs).

.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.

.1 Panels and access doors shall be constructed as a 1-inch (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 48x48 panel under 30” W.C pressure. Units that cannot demonstrate this deflection are unacceptable. Outer casing shall be finished with a powder coated industrial paint.

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

.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 Voltage: 208/3/60 single point power connection. FLA: 9 amps

.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 Provide and mount a damper controls for standalone operation of the ERV.

.5 CONTROLS

.1 The unit shall be capable of being turned on/off via remote signal from a BacNet direct digital control (DDC) based building management system.

.2 The unit shall be capable of operating on low speed and high speed(1600 / 800 CFM). The DDC system shall provide low speed / high speed signals to the unit.

.3 Once turned on, the unit shall operate under its own controls. Provide dry contacts for unit status (On/Off) fan failure and damper failure signals (to be wired to the DDC by section 230933).

.6 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 2", 50mm pleated MERV 8 panel filters.

.7 ENERGY RECOVERY

.1 Dual Core Energy Recovery

.1 Unit shall be equipped with Dual Core energy recovery technology. The unit shall be 90% efficient (sensible +-5%) at equal airflow in winter and up to 80% sensible in summer. It shall also provide up to 70% latent recovery 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 Cross leakage rate shall be less than 3%.

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

.8 Acceptable Product: "Tempeff" models:

.1 ERV-1a, ERV-1b: RGSP 1800 or approved equal in accordance with B7.

.2 ERV-2: RGSP 1200 or approved equal 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 Install in accordance with manufacturers recommendations.

.2 Support independently of adjacent ductwork and provide flexible connections.

3.3 FIELD QUALITY CONTROL

.1 Tests:

.1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Verification requirements in accordance with Section 01 35 20 – LEED Sustainable Requirements. Include:

.1 Materials and resources.
.2 Storage and collection of recyclables.
.3 Construction waste management.
.4 Resource reuse.
.5 Recycled content.
.6 Local/regional materials.
.7 Low-emitting materials.

3.4 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

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

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 01 35 20 - LEED Sustainable Requirements

.2 Section 01 74 19 – Waste Management and Disposal

1.2 REFERENCES

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

.1 ANSI/ARI 430, Central-Station Air-Handling Units.

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

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

.2 ANSI/ASHRAE 52.2, 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, Ready-Mixed Organic Zinc-Rich Coating.

.4 Canada Green Building Council (CaGBC)

.1 LEED Canada-LEED 2009 New Construction, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For New Construction and Major Renovations (including Addendum [2007]).

.5 Green Seal Environmental Standards (GSES)

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

.6 Master Painters Institute (MPI)

.1 MPI-INT 5.3, Galvanized Metal.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.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.

.3 Shop Drawings:

.1 Indicate following: fan, fan curves showing point of operation, motor drive, bearings, filters, mixing box, dampers, coil; include performance data.

.4 Sustainable Design Submittals:

.1 LEED Submittals: in accordance with Section 01 35 20 – LEED Submittal Requirements.

1.4 CLOSEOUT SUBMITTALS

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

.2 Include following: fan, bearings, motor, damper, air volume, total cooling, sensible cooling, EDB, EWB, OAT.

1.5 MAINTENANCE MATERIAL SUBMITTALS

.1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

.2 Provide one spare set of filters.

.3 Provide list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

.4 Spare filters: in addition to filters installed immediately prior to acceptance by Contract Administrator, supply 1 complete set of filters for each filter unit or filter bank.

1.6 DELIVERY, STORAGE AND HANDLING

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

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

.3 Packaging Waste Management: remove for reuse or return of packaging materials in accordance with Section 01 74 19 -Waste Management and Disposal.

Part 2 Products

2.1 AIR HANDLING UNIT, AHU-1:

.1 Performance: See schedule at end of specification

.2 Unit shall be an indoor type, with pillow block bearings, hinged access doors with lever lock handles, filter section with 50 mm Merv 13 pleated filters in metal frames, mix section complete with modulating operators with TAMCO 9000 outside air dampers and TAMCO 1000 on return. Forward curved blowers with ODP motors with isolation, 2” 1-1/2 lb/ft^3 insulation throughout, 18 gauge casing construction with grey enamel finish coat. DX coil shall be c/w alternate row circuiting. Refer to drawings for unit configuration. Disconnects by Electrical Subcontractor.

.3 Heating units shall be indirect natural gas fired approved for both sea level and high altitude areas. The entire package including dampers controls, fan controls, and all other miscellaneous controls and accessories shall be approved by an independent testing authority and carry the approval label of that authority as a complete operating package.

.4 Provide high efficiency heat exchangers tested and certified to ANSI/CSA standards to provide a minimum of 90% efficiency throughout the entire operating range as required by Ashrae 90.1. The manufacturer shall be routinely engaged in the manufacture of this type of high efficiency equipment.

.5 All units must exceed the Ashrae 90.1 requirement of steady state efficiency at low fire. Heat exchanger shall be a primary drum and multi-tube secondary assembly constructed of titanium stainless steel with multi-plane metal turbulators and shall be of a floating stress relieved design. Heat exchanger shall be provided with condensate drain connections. Condensate drains and neutralizing tank shall be supplied by the manufacturer for field installation by the Contractor. Using duct type furnaces and closed coupled blowers are not acceptable. The heat exchanger/burner assembly shall be a

blow through positive pressure type and shall have an interrupted pilot ignition system to provide increased safety. Units using continuous or intermittent pilots are not acceptable.

.6 Indoor units required installation and condensing vent provisions to be in accordance with CAN/CSA Standard B149.1, ANSI.1-NFPA 54 and local authorities having jurisdiction. Type "BH" category II venting certified to UL 1738/ULCS636 with AL 29-4C SS or equivalent. Venting supplied and installed by Contractor.

.7 Combustion efficiency of high efficiency heat exchangers shall increase by up to 4-5% from high fire to low fire while turning down on units incorporating 15:1 turndown. The high turn down heat exchanger/burner assembly minimum input shall be capable of controlling 6.7% of its rated input, excluding the pilot assembly, without on/off cycling and include built electronic linearization of fuel and combustion air.

.8 Provide electronic control module complete with proportional/integral control and discharge air sensor to maintain set point temperature. Combustion air motor speed varies proportionally in response to the modulation of gas flow to provide optimum fuel/air mixture and efficiency at all conditions. Two speed or step speed combustion blowers are not acceptable.

.9 The control module shall include the following standard features:

.1 Service analyzer with diagnostic lights for ease of set-up and service

.2 -40℃ minimum operating ambient temperature

.3 Non-recycling auto by-pass low limit with alarm contacts and built-in sensor checking

.4 Separate gas and air actuators independently controlled to give the correct air to fuel ration throughout the entire firing rang.

Unit controls heating, economizer and mechanical cooling with DDC reset.

.10 Motor to be inverter duty type. VFD supplied and installed by controls contractor.

.11 Acceptable Product: "Engineered Air". Refer to data sheet at end of section for model number.

2.2 AIR HANDLING UNIT, AHU-2:

.1 Performance: See schedule at end of specification

.2 Unit shall be an indoor type, with pillow block bearings, hinged access doors with lever lock handles, filter section with 50 mm MERV 13 pleated filters in metal frames, mix section complete with modulating operators with TAMCO 9000 outside and exhaust air dampers and TAMCO 1000 on return. Forward curved blowers with 208/3/60 ODP motors with isolation, 2" 1-1/2 lb/ft^3 insulation throughout, 18 gauge casing construction with grey enamel finish coat. DX coil shall be c/w alternate row circuiting. Refer to drawings for unit configuration. Disconnects by Electrical Subcontractor.

.3 Heating units shall be indirect natural gas fired approved for both sea level and high altitude areas. The entire package including dampers controls, fan controls, and all other miscellaneous controls and accessories shall be approved by an independent testing authority and carry the approval label of that authority as a complete operating package.

.4 Provide high efficiency heat exchangers tested and certified to ANSI/CSA standards to provide a minimum of 90% efficiency throughout the entire operating range as required by Ashrae 90.1. The manufacturer shall be routinely engaged in the manufacture of this type of high efficiency equipment.

.5 All units must exceed the Ashrae 90.1 requirement of steady state efficiency at low fire. Heat exchanger shall be a primary drum and multi-tube secondary assembly constructed

of titanium stainless steel with multi-plane metal turbulators and shall be of a floating stress relieved design. Heat exchanger shall be provided with condensate drain connections. Condensate drains and neutralizing tank shall be supplied by the manufacturer for field installation by the Contractor. Using duct type furnaces and closed coupled blowers are not acceptable. The heat exchanger/burner assembly shall be a blow through positive pressure type and shall have an interrupted pilot ignition system to provide increased safety. Units using continuous or intermittent pilots are not acceptable.

.6 Indoor units required installation and condensing vent provisions to be in accordance with CAN/CSA Standard B149.1, ANSI.1-NFPA 54 and local authorities having jurisdiction. Type “BH” category II venting certified to UL 1738/ULCS636 with AL 29-4C SS or equivalent. Venting supplied and installed by Contractor.

.7 Combustion efficiency of high efficiency heat exchangers shall increase by up to 4-5% from high fire to low fire while turning down on units incorporating 15:1 turndown. The high turn down heat exchanger/burner assembly minimum input shall be capable of controlling 6.7% of its rated input, excluding the pilot assembly, without on/off cycling and include built electronic linearization of fuel and combustion air.

.8 Provide electronic control module complete with proportional/integral control and discharge air sensor to maintain set point temperature. Combustion air motor speed varies proportionally in response to the modulation of gas flow to provide optimum fuel/air mixture and efficiency at all conditions. Two speed or step speed combustion blowers are not acceptable.

.9 The control module shall include the following standard features:

.1 Service analyzer with diagnostic lights for ease of set-up and service

.2 -40℃ minimum operating ambient temperature

.3 Non-recycling auto by-pass low limit with alarm contacts and built-in sensor checking

.4 Separate gas and air actuators independently controlled to give the correct air to fuel ration throughout the entire firing rang.

Unit controls heating, economizer and mechanical cooling with DDC reset.

.10 Motors to be inverter duty type. VFD supplied and installed by controls contractor.

.11 Acceptable Product: “Engineered Air”. Refer to data sheet at end of section for model number.

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.

3.3 FANS

.1 Install fan sheaves required for final air balance.

.2 Install flexible connections at fan inlet and fan outlets.

.3 Install vibration isolators.

3.4 DRIP PANS

.1 Install deep seal P-traps on drip lines.

.1 Depth of water seal to be 1.5 times static pressure at this point.

3.5 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.2 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal and 01 35 20 – LEED Submittal Requirements.

TAG		AHU-1	AHU-2
SERVICE		Gymnasium	Community Center
ACCEPTABLE PRODUCT: MANUFACTURER		Engineered Air	Engineered Air
ACCEPTABLE PRODUCT: MODEL		DJX100/C	DJX60/C
SUPPLY	CFM:	8,000	8,000
	ESP (“WC):	1.5	1.2
	BHP (HP):		
	MOTOR (HP):	7.5	7.5
	MOTOR RPM:		
	BLOWER:	20/18 FC	20/18 FC
	BLOWER RPM:		
Return	CFM:	-	8,000
	ESP (“WC):	-	0.4
	BHP (HP):	-	
	MOTOR (HP):	-	7.5
	MOTOR RPM:	-	
	BLOWER:	-	18/18 FC
	BLOWER RPM:	-	
DX COOLING (Ref: R410A)	Coil Size H x L Rows/FPI (mm)		
	EAT (DB/WB) (°F):	80.0/67.0	76.3/63.5
	LAT (DB/WB) (°F):	59.8/58.4	54.3/53.9
	Capacity (Btu/hr):	241.7	230.1
	Capacity (tons):		
	Suction (°F)	52	48.9
GAS HEATING	Input (Btu/hr):	750,000	450,000
	Output (Btu/hr):	675,000	405,000
	Temp Rise (°F)	78.1	46.8
ELECTRICAL	VOLTAGE	208	208
	PHASE	3	3
	HERTZ	60	60
OVERALL DIMENSIONS	H x W x L, mm (in)		
COMMENTS	AHU-1 has remote relief. Variable Volume.		
	Variable Volume.		

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 01 35 20 - LEED Sustainable Requirements

.2 Section 01 74 19 – Waste Management and Disposal

1.2 REFERENCES

.1 ASTM International

.1 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

.2 ASTM C916, Standard Specification for Adhesives for Duct Thermal Insulation.

.3 ASTM C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

.2 Canada Green Building Council (CaGBC)

.1 LEED Canada-LEED 2009 New Construction, LEED (Leadership in Energy and Environmental Design): Green Building Rating System for New Construction and Major Renovations (including Addenda).

.3 National Fire Protection Association (NFPA)

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

.2 NFPA 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems (ANSI).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.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 supports, sizes and location of mounting bolt holes.

.5 Sustainable Design Submittals:

.1 LEED Canada submittals: in accordance with Section 01 35 20 – LEED Submittal Requirements.

.2 Construction Waste Management:

.1 Submit project Waste Management Plan or Waste Reduction Workplan highlighting recycling and salvage requirements.

.2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating of construction wastes that were recycled or salvaged.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for unit heaters for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and 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 in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect unit heaters from damage.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse or return of packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal and Section 01 35 20 – LEED Submittal Requirements.

Part 2 Products

2.1 UNIT HEATERS, UH-1

.1 Performance Data: 63 kW (215,000 Btu/hr) input, 59 kW (199,950 Btu/hr) output, 1,824 L/s (3,865 CFM) entering airflow, 3.55 m/s (699 FPM) outlet velocity, 28℃ (48℉) air temperature rise, 5.2 m (17 ft.) maximum mounting height,18.3 m (60 ft.) heat throw at maximum mounting height, PSC motor type, 373 W (1/2 HP) motor, 1075 motor RPM, 115V, 1 Phase, 7.0 motor amps, 9.3 total amps.

.2 Condensing furnace, indirect-fired heat exchanger, 93% minimum efficiency, 20 gauge aluminized steel unit casing, 7-mil thickness polyester powder paint, adjustable horizontal air deflectors, 18 gauge aluminized steel tubes and headers in primary heat exchanger, crimped heat exchanger tubes, AL29-4C stainless steel collector box and secondary heat exchanger, in-shot type burners, 1080 x 795 x 560 mm overall dimensions, direct spark igniter, single-stage gas controls, all electrical components UL, ETL, or CSA listed.

.3 Acceptable Product: “Modine”, model PTC215AS0111 as specified or approved equal in accordance with B7.

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 unit 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.

3.2 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 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.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

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

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.3 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 74 19 - Waste Management and Disposal and Section 01 35 20 – LEED Submittal Requirements.

.1 Remove recycling containers and bins from Site and dispose of materials at appropriate facility.

3.4 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