

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings; submit drawings stamped and signed for approval by Department Representative.
- .3 Shop Drawings:
 - .1 Indicate on drawings:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
 - .2 Shop drawings and product data accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify current model production.
 - .5 Certification of compliance to applicable codes.
 - .3 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet".

1.2 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.
 - .1 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
 - .2 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for systems and component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
 - .3 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.

- .4 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .5 Approvals:
 - .1 Submit 2 copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.
 - .2 Make changes as required and re-submit as directed by Departmental Representative.
- .6 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .7 Site records:
 - .1 Department Representative will provide 1 set of digital mechanical drawings in pdf format. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 Transfer information weekly to reproducible, revising reproducible to show work as actually installed.
 - .3 Use different colour for each service.
 - .4 Make available for reference purposes and inspection.
- .8 As-built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
 - .3 Submit to Departmental Representative for approval and make corrections as directed.
 - .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
 - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .9 Submit copies of as-built drawings for inclusion in final TAB report.

1.3 MAINTENANCE MATERIAL SUBMITTALS

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

- .2 Furnish spare parts as follows:
 - .1 One set of packing for each pump.
 - .2 One casing joint gasket for each size pump.
 - .3 One head gasket set for each heat exchanger.
 - .4 One glass for each gauge glass.
 - .5 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
- .3 Provide one set of special tools required to service equipment as recommended by manufacturers.
- .4 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

- .1 All materials used on this project shall be new and CSA approved unless noted otherwise.

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 material installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

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

3.2 PAINTING REPAIRS AND RESTORATION

- .1 Do painting in accordance with Section 09 91 00 - Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.

3.3 SYSTEM CLEANING

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

3.4 FIELD QUALITY CONTROL

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - SUBMITTALS.
 - .1 Submit tests as specified in other sections of this specification.
- .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 - 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.

3.5 COORDINATION WITH THE ELECTRICAL CONTRACTOR

- .1 review all drawings and specified equipment requiring electrical hook-up with Electrical Contractor prior to ordering equipment. Ensure proper electrical characteristics are determined for all affected and related work.
- .2 Motors, electric heating, controls, distribution devices and equipment shall operate satisfactorily at 60 Hz within normal operating limits established.
- .3 Packaged mechanical equipment shall be supplied with one main power connection.
- .4 This Contractor shall arrange for controls associated power to be supplied and installed by Division 26. Otherwise all controls work, including wiring, shall be supplied and installed by Controls Contractor.
- .5 Provide wiring diagrams indicating all power and control wiring requirements for equipment supplied by Division 23, with accurate locations of electrical connection points and all necessary schematics and other drawings to facilitate electric work. These diagrams, schematics, and / or drawings shall be enclosed within the O&M Manuals.
- .6 Provide wiring of items supplied by equipment Manufacturers such as filter advance motors and control, high level alarms, low water cut-offs, anti vibration lock-outs, flow switches, remote and local thermostats for all equipment, sump pump alternators, level

controllers, water treatment equipment, and oil / grease interceptor alarms, and control wiring between starters and control panels (e.g. air cooled condensers, cooling towers and condensing units). Also provide wiring for communications interface panels, sensors, oil pumps, purge pumps and oil heaters supplied with water chillers.

3.6 COOPERATION WITH COMMISSIONING TEAM

- .1 The Mechanical Contractor to complete commissioning activities as per Section 01 91 13 - General Commissioning (Cx) Requirements. In addition, advise the Commissioning Authority of dates for the commissioning schedule when mechanical systems will be ready for commissioning reviews.
- .2 Cooperate with the Commissioning Team as follows:
 - .1 Inform Commissioning Team in advance of degreasing and flushing of heating system, hydrostatic and air tests.
 - .2 Allow Commissioning Team free access to the site during construction phase.
 - .3 Coordinate site visits during warranty period.
- .3 In-Contract Test:
 - .1 Include all formal tests required by the contract documents and carried out by the Mechanical Contractor or his testing agency. These tests are the responsibility of the Mechanical Contractor but are within the scope of the Commissioning Team. The Commissioning Team will witness selected in-contract tests. Provide documentation confirming of test and sign-off acceptance of each test by the Mechanical Contractor or his testing agency.
- .4 Allow for work necessary to assist Commissioning Team in completion of the commissioning process. The Mechanical Contractor shall fill a complete system of check sheets. Format of one checks sheet will be provided by the Commissioning Team.
- .5 Demonstrate all equipment and system operation and fail modes for all elements of mechanical work as defined by the project documents, and in accordance with the commissioning authorities' direction.

3.7 DEMONSTRATION

- .1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .4 Instruction duration time requirements as specified in appropriate sections.
- .5 Departmental Representative will record these demonstrations on video tape for future reference.

3.8 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.9

PROTECTION

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

END OF SECTION

Part 1 General

1.1 USE OF SYSTEMS

- .1 Use of existing and new permanent heating and/or ventilating systems for supplying temporary heat and/or ventilation is permitted only under following conditions:
 - .1 Upon request and approval of Department Representative.
 - .2 Entire system is complete, pressure tested, cleaned, flushed out.
 - .3 Specified water treatment system has been commissioned, water treatment is being continuously monitored.
 - .4 Building has been closed in, areas to be heated/ventilated are clean and will not thereafter be subjected to dust-producing processes.
 - .5 There is no possibility of damage from any cause.
 - .6 Supply ventilation systems are protected by 60% filters, inspected daily, changed every week or more frequently as required.
 - .7 Return systems have approved filters over openings, inlets, outlets.
 - .8 Systems will be:
 - .1 Operated as per manufacturer's recommendations and instructions.
 - .2 Operated by Contractor.
 - .3 Monitored continuously by Contractor.
 - .9 Warranties and guarantees are not relaxed and shall not begin until after final acceptance upon completion of Commissioning Functional Testing.
 - .10 Regular preventive and other manufacturers recommended maintenance routines are performed by Contractor at own expense and under supervision of Department Representative.
 - .11 Refurbish entire system before static completion; clean internally and externally, restore to "as- new" condition, replace filters in air systems.
- .2 Filters specified in this Section are over and above those specified in other Sections of this project.

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 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.

1.2 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.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition 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 250 g/L to Standard GS-11 and to SCAQMD Rule 1113.
 - .3 Paints: maximum VOC limit 150 g/L to Standard GS-11 and to SCAQMD Rule 1113.

- .2 Sealants: in accordance with Section 07 92 00 - Joint Sealants.
 - .1 Sealants: maximum VOC limit to SCAQMD Rule 1168 and to GSES GS-36.
- .3 Sealants: maximum VOC limit to SCAQMD Rule 1168 and to GSES GS-36.
- .4 Adhesives: maximum VOC limit to SCAQMD Rule 1168 and to GSES GS-36.

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.
 - .1 Unions are not required in installations using grooved mechanical couplings (the couplings shall serve as unions).
- .3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.
- .4 The flexible type grooved joint couplings may be used in lieu of a flexible connector at equipment connections for vibration attenuation and stress relief. Couplings shall be placed in close proximity to the source of the vibration, as per manufacturer's recommendations.

3.3 CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and National Fire Code.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated (whichever is greater) without interrupting operation of other system, equipment, components.

3.4 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: DN 20 (NPS ¾) gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.5 AIR VENTS

- .1 Install automatic air vents to at high points in piping systems.
- .2 Install isolating valve at each automatic air valve.
- .3 Install drain piping to approved location and terminate where discharge is visible.

3.6 DIELECTRIC WATERWAY FITTINGS AND COUPLINGS

- .1 General: compatible with system, to suit pressure rating of system.
- .2 Locations: where dissimilar metals are joined.
- .3 DN 50 (NPS 2) and under: isolating waterway fittings, unions or bronze valves.
 - .1 Waterway fittings shall be complete with thermoplastic liner.
- .4 Over DN 50 (NPS 2): isolating waterway fittings and flanges.
 - .1 Waterway fittings shall be complete with thermoplastic liner.

3.7 PIPEWORK INSTALLATION

- .1 Installation by certified journeyman.
- .2 Screwed fittings jointed with Teflon tape or pipe dope as recommended by manufacturer.
- .3 Grooved joint couplings and fittings shall be installed in accordance with the manufacturer's written installation instructions.
 - .1 Gaskets shall be verified as suitable for the intended service prior to installation. Gaskets shall be molded and produced by the coupling manufacturer.
 - .2 The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer's representative shall periodically visit the jobsite and review installation. Contractor shall remove and replace any joints deemed improperly installed.
- .4 Protect openings against entry of foreign material.
- .5 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .6 Assemble piping using fittings manufactured to ANSI standards.
- .7 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.
- .8 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.

- .9 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .10 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .11 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .12 Group piping wherever possible and as indicated.
- .13 Ream pipes, remove scale and other foreign material before assembly.
- .14 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .15 Provide for thermal expansion as indicated.
- .16 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.
 - .6 Use ball or butterfly valves at branch take-offs for isolating purposes except where specified.
 - .7 Install butterfly valves on chilled water and related condenser water systems only.
 - .8 Install butterfly valves between weld neck flanges to ensure full compression of liner.
 - .9 Install ball valves for glycol service.
 - .10 Use chain operators on valves DN 65 (NPS 2 ½) and larger where installed more than 2,400 mm above floor in Mechanical Rooms.
- .17 Check Valves:
 - .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.
 - .2 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

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 FIRESTOPPING

- .1 Install firestopping within annular space between pipes, ducts, insulation and adjacent fire separation in accordance with Section 07 84 00 - Firestopping.
- .2 Uninsulated unheated pipes not subject to movement: no special preparation.
- .3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe movement without damaging firestopping material or installation, or install per manufacturer's recommendation as specified within the associated approval.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

3.11 FLUSHING OUT OF PIPING SYSTEMS

- .1 Flush system in accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
- .2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11 - Cleaning supplemented as specified in relevant mechanical sections.
- .3 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 Department Representative 48 hours minimum prior to performance of pressure tests.
- .2 Pipework: test as specified in relevant sections or Divisions.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Conduct tests in presence of Department Representative.
- .6 Pay costs for repairs or replacement, retesting, and making good. Department Representative to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests Department Representative.

3.13 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).
- .2 Canadian Environmental Assessment Agency (CEAA)
- .3 Canadian Environmental Protection Act (CEPA)
- .4 Electrical Equipment Manufacturers' Association Council (EEMAC)
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .6 National Electrical Manufacturers Association (NEMA)
- .7 Natural Resources Canada (NRC)
 - .1 National Energy Code for Buildings (NECB).
- .8 Transportation of Dangerous Goods Act (TDGA)

1.2 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 (2) copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Quality Control: in accordance with Section 01 45 00 - Quality Control.
 - .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 Department Representative will make available one (1) copy of systems supplier's installation instructions.
- .4 Closeout Submittals
 - .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.3 QUALITY ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with CEPA, CEEA, TDGA, applicable Provincial regulations.
- .2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 GENERAL

- .1 Motors: premium efficiency, in accordance with local Electric/Hydro company standards and the requirements of NECB and ASHRAE 90.1, which ever is most stringent.

2.2 MOTORS

- .1 Provide motors for mechanical equipment as specified.
- .2 Motors under 560 W (3/4 HP): speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .3 Motors 560 W (3/4 HP) and larger: NEMA Class B, 1.15 service factor, squirrel cage induction, premium efficiency, speed as indicated, continuous duty, enclosure as indicated, ball bearing, maximum temperature rise 40°C, 3 phase, 600 V, unless otherwise indicated, suitable for inverted duty variable frequency drives (VFD).

- .4 Minimum certified motor efficiency shall be as outlined below:

MINIMUM EFFICIENCY (%) *				
HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1	75.5	82.5	80.0	74.0
1.5	82.5	84.0	85.5	77.0
2	84.0	84.0	86.5	82.5
3	85.5	87.5	87.5	84.0
5	87.5	87.5	87.5	85.5
7.5	88.5	89.5	89.5	85.5
10	89.5	89.5	89.5	88.5
15	90.2	91.0	90.2	88.5
20	90.2	91.0	90.2	89.5
25	90.5	91.7	91.3	89.6
30	90.8	91.9	91.4	90.7
40	91.4	92.5	92.3	90.6
50	91.9	92.7	92.3	91.3
60	92.4	93.2	92.9	91.6
75	92.5	93.5	93.1	92.8

(*) As defined in CSA C390 or IEEE 112B Nominal Standards

2.3 TEMPORARY MOTORS

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

2.4 BELT DRIVES

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise indicated.
- .3 For motors under 7.5 kW (10 HP): standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 For motors 7.5 kW (10 HP) and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.
- .5 Correct size of sheave determined during commissioning.
- .6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .7 Motor slide rail adjustment plates to allow for centre line adjustment.
- .8 Supply one set of spare belts for each set installed in accordance with Section 01 78 00 - Closeout Submittals.

2.5 DRIVE GUARDS

- .1 Provide guards for unprotected drives.
- .2 Guards for belt drives;
 - .1 Expanded metal screen welded to steel frame.
 - .2 Minimum 1.2 mm thick sheet metal tops and bottoms.
 - .3 38 mm diameter holes on both shaft centres for insertion of tachometer.
 - .4 Removable for servicing.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Install belt guards to allow movement of motors for adjusting belt tension.
- .5 Guard for flexible coupling:
 - .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
 - .2 Securely fasten in place.
 - .3 Removable for servicing.
- .6 Guard for unprotected fan inlets or outlets:
 - .1 Wire or expanded metal screen, galvanized, 19 mm mesh.
 - .2 Net free area of guard: not less than 80% of fan openings.
 - .3 Securely fasten in place.
 - .4 Removable for servicing.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Fasten securely in place.
- .2 Make removable for servicing, easily returned into, and positively in position.

3.3 FIELD QUALITY CONTROL

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - SUBMITTALS.
 - .1 As specified in other sections of this specification.
- .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.

3.4 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

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

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit product data and indicate for items as applicable:
 - .1 Manufacturer, model number, line contents, pressure and temperature rating.
 - .2 Movement handled, axial, lateral, angular and the amounts of each.
 - .3 Nominal size and dimensions including details of construction and assembly.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit maintenance data in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Data to include:
 - .1 Servicing requirements, including special requirements, stuffing box packing, lubrication and recommended procedures.

1.4 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 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .4 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .5 Collect, separate and place in designated containers for reuse and recycling, paper, plastic, polystyrene, corrugated cardboard packaging, steel, metal, in accordance with Waste Management Plan.
- .6 Unused sealant materials must not be disposed of into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.
- .7 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 BELLOWS TYPE EXPANSION JOINTS

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

- .2 Maximum operating pressure: same as pipe rating.
- .3 Maximum operating temperature: same as pipe rating.
- .4 Type A: controlled free flexing, factory tested to 1½ times maximum working pressure. Furnish test certificates.
- .5 Type B: externally pressurized, constant volume, pressure balanced, designed to eliminate pressure thrust, factory tested to 1 ½ times maximum working pressure. Furnish test certificates.
- .6 Bellows:
 - .1 Multiple bellows, hydraulically formed, single or two ply, austenitic stainless steel, monel, or inconel for specified fluid, pressure and temperature, water treatment and pipeline cleaning procedures.
- .7 Reinforcing or control rings:
 - .1 2-piece nickel iron.
- .8 Ends:
 - .1 Raised face, slip-on or weld neck flanges to match pipe.
- .9 Liner:
 - .1 Austenitic stainless steel in direction of flow.
- .10 Shroud:
 - .1 Carbon steel, painted.

2.2 GROOVED END EXPANSION JOINTS

- .1 Packless, Gasketed, Slip, Expansion Joints:
 - .1 2413 kPa maximum working pressure.
 - .2 Steel pipe fitting consisting of telescoping body and slip-pipe sections.
 - .3 PTFE modified polyphenylene sulfide coated slide section.
 - .4 Suitable for axial end movement to 75 mm.
- .2 Expansion joint consisting of series of grooved end pipe nipples joined in tandem with flexible couplings. Total joint movement dependent on number of couplings and nipples used.

2.3 FLEXIBLE CONNECTION

- .1 Application: to suit motion as indicated.
- .2 Minimum length in accordance with manufacturer's recommendations to suit offset.
- .3 Inner hose: bronze or stainless steel corrugated.
- .4 Braided wire mesh bronze or stainless steel outer jacket.
- .5 Diameter and type of end connection: threaded or flanged, same as pipe joint for the pipe size.
- .6 Operating conditions:
 - .1 Working pressure: 1034 kPa.

- .2 Working temperature: to match system requirements.
- .3 To match system requirements.
- .7 Three flexible grooved couplings placed in close proximity to vibration source for vibration attenuation and stress relief.

2.4 ANCHORS AND GUIDES

- .1 Anchors:
 - .1 Provide as indicated.
 - .2 Concrete: to Section 03 30 00 - Cast-in-Place Concrete.
 - .3 Reinforcement: to Section 03 20 00 - Concrete Reinforcing.
- .2 Alignment guides:
 - .1 Provide as indicated.
 - .2 To accommodate specified thickness of insulation.
 - .3 Vapour barriers, jackets to remain uninterrupted.

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 Install expansion joints with cold setting, as indicated. Make record of cold settings.
- .2 Install expansion joints and flexible connections in accordance with manufacturer's instructions.
- .3 Install pipe anchors and guides as indicated. Anchors to withstand 150% of axial thrust.
- .4 Do welding in accordance with section 23 05 17 - Pipe Welding.

3.3 PIPE CLEANING AND START-UP

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

3.4 PERFORMANCE VERIFICATION

- .1 In accordance with Section 23 08 01 - Performance Verification: Mechanical Piping Systems.

3.5 CLEANING

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

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1, Power Piping.
 - .2 ANSI/ASME B31.3, Process Piping.
 - .3 ANSI/ASME B31.5, Refrigeration Piping and Heat Transfer Components
 - .4 ANSI/ASME B31.9, Building Services
 - .5 ANSI/ASME Boiler and Pressure Vessel Code:
 - .1 Section I: Power Boilers.
 - .2 Section V: Non-destructive Examination.
 - .3 Section IX: Welding and Brazing Qualifications.
- .2 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C206, Field Welding of Steel Water Pipe.
- .3 American Welding Society (AWS)
 - .1 AWS B3.0, Welding Procedure and Performance Qualification
 - .2 AWS C1.1M/C1.1, Recommended Practices for Resistance Welding.
 - .3 AWS Z49.1, Safety in Welding, Cutting and Allied Process.
 - .4 AWS W1, Welding Inspection Handbook.
- .4 Canadian Standards Association (CSA International)
 - .1 CSA W47.2, Certification of Companies for Fusion Welding of Aluminum.
 - .2 CSA W48, Filler Metals and Allied Materials for Metal Arc Welding.
 - .3 CSA B51, Boiler, Pressure Vessel and Pressure Piping Code.
 - .4 CSA B52, Mechanical Refrigeration Code
 - .5 CSA-W117.2, Safety in Welding, Cutting and Allied Processes.
 - .6 CSA W178.1, Certification of Welding Inspection Organizations.
 - .7 CSA W178.2, Certification of Welding Inspectors.
- .5 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-48.2, Spot Radiography of Welded Butt Joints in Ferrous Materials.
- .6 Provincial Regulations: Boiler, Pressure Vessel and Compressed Gas Regulations.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Welders:
 - .1 Welding qualifications in accordance with CSA B51.
 - .2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.
 - .3 Submit welder's qualifications to Department Representative.
 - .4 Each welder to possess identification symbol issued by authority having jurisdiction.
 - .5 Certification of companies for fusion welding of aluminum in accordance with CSA W47.2.
 - .2 Inspectors:
 - .1 Inspectors qualified to CSA W178.2.
 - .3 Certifications:
 - .1 Registration of welding procedures in accordance with CSA B51, CSA B52 and provincial regulations.
 - .2 Copy of welding procedures available for inspection.
 - .3 Safety in welding, cutting and allied processes in accordance with CSA-W117.2.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 ELECTRODES

- .1 Electrodes: in accordance with CSA W48 Series.

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 QUALITY OF WORK

- .1 Welding: in accordance with ANSI/ASME B31.1, B31.3, B31.5, B31.9, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, and special procedures specified elsewhere in Mechanical Divisions and applicable requirements of provincial authority having jurisdiction.

3.3 INSTALLATION REQUIREMENTS

- .1 Identify each weld with welder's identification symbol.
- .2 Backing rings:
 - .1 Where used, fit to minimize gaps between ring and pipe bore.
 - .2 Do not install at orifice flanges.
- .3 Fittings:
 - .1 DN 50 (NPS 2) and smaller: install welding type sockets.
 - .2 Branch connections: install welding tees or forged branch outlet fittings.

3.4 INSPECTION AND TESTS - GENERAL REQUIREMENTS

- .1 Review weld quality requirements and defect limits of applicable codes and standards with Department Representative before work is started.
- .2 Formulate "Inspection and Test Plan" in co-operation with Department Representative.
- .3 Do not conceal welds until they have been inspected, tested and approved by inspector.
- .4 Provide for inspector to visually inspect welds during early stages of welding procedures in accordance with Welding Inspection Handbook. Repair or replace defects as required by codes and as specified.

3.5 SPECIALIST EXAMINATIONS AND TESTS

- .1 General:
 - .1 Perform examinations and tests by specialist qualified to CSA W178.1 and CSA W178.2 and approved by Department Representative.
 - .2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
 - .3 Inspect and test in accordance with "Inspection and Test Plan" by non-destructive visual examination and magnetic particle (hereinafter referred to as "particle") tests and/or spot or full gamma ray radiographic (hereinafter referred to as "radiography") tests.

- .4 As per applicable reference standard or as specified.
- .2 Hydrostatically test welds to ANSI/ASME B31.1.
- .3 Visual examinations: include entire circumference of weld externally and wherever possible internally.
- .4 Failure of visual examinations:
 - .1 Upon failure of welds by visual examination, perform additional testing as directed by Department Representative of total of up to 10% of welds, selected at random by Department Representative by radiographic tests.
- .5 Full radiographic tests for piping systems.
 - .1 Spot radiography to CAN/CGSB-48.2.
 - .1 Conduct spot radiographic tests of up to 10% of welds, selected at random by Department Representative from welds which would be most difficult to repair in event of failure after system is operational.
 - .2 Radiographic film:
 - .1 Identify each radiographic film with date, location, name of welder, and submit to Department Representative. Replace film if rejected because of poor quality.
 - .3 Interpretation of radiographic films:
 - .1 By qualified radiographer.
 - .4 Failure of radiographic tests:
 - .1 Extend tests to welds by welder responsible when those welds fail tests.
- .6 Magnetic particle tests for piping systems as indicated.

3.6 DEFECTS CAUSING REJECTION

- .1 As described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessels Code.
- .2 In addition, chilled water systems below 1,000 kPa:
 - .1 Undercutting greater than 0.8 mm adjacent to cover bead on outside of pipe.
 - .2 Undercutting greater than 0.8 mm adjacent to root bead on inside of pipe.
 - .3 Undercutting greater than 0.8 mm at combination of internal surface and external surface.
 - .4 Incomplete penetration and incomplete fusion greater than total length of 38 mm in 1,500 mm length of weld depth of such defects being greater than 0.8 mm.
 - .5 Repair cracks and defects in excess of 0.8 mm in depth.
 - .6 Repair defects whose depth cannot be determined accurately on basis of visual examination or radiographic tests.

3.7 REPAIR OF WELDS WHICH FAILED TESTS

- .1 Re-inspect and re-test repaired or re-worked welds at Contractor's expense.

3.8 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME Fluid Meter's Handbook: Their Theory and Application, Sixth Edition.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.2 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 2 copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Submittals to include:
 - .1 Piping configuration and sizing - straight pipe upstream and downstream, distances to first weld, protrusion, thermowell, pressure tap.
 - .2 Service conditions.
 - .3 Full details of primary element - standard of design and construction, materials, type serial number, flow rate, differential pressure, irrecoverable head loss (IHL), calculation sheets.
 - .4 Accuracy statements for each component at specified flow rates and other conditions.
 - .5 Flow and temperature ranges.
 - .6 Signal processor calibration data.
 - .7 Minimum turndown ratio.
- .4 Samples:
 - .1 Submit sample in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Samples to include:
- .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.
 - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
- .6 Closeout Submittals:
 - .1 Submit maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 78 00 - Closeout Submittals.

1.3 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 ACCURACY

- .1 Calculate overall accuracy of each installation using following expression: Overall accuracy = $(E (\text{accuracy of individual components of system})^2)^{1/2}$.
- .2 Components to include:
 - .1 Primary flow measuring elements.
 - .2 Transmitters: flow, differential pressure, pressure, temperature, temperature difference.
 - .3 RTDs.
 - .4 Signal processors, recorders.
 - .5 Calibration of signal processors: assume 0.20% per processor.
 - .6 Installation tolerances: assume 1% for concentricity of pipe, difference in height of transmitter piping.

- .3 Show in proposal overall accuracy at 100%, 70%, 10%, minimum specified design flow rate.
- .4 Indicate minimum measurable flow rate.

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 PREPARATION

- .1 Before final calculations for orifice diameter, and before purchase of orifice plate, nozzle, venturi, measure:
 - .1 Internal diameter of main at the primary element to +/-0.01 mm accuracy.
 - .2 For concentricity of pipe.

3.3 INSTALLATION OF PRIMARY ELEMENT

- .1 Follow manufacturer's instructions.

3.4 INSTALLATION OF DIFFERENTIAL PRESSURE TAPS AND PIPING

- .1 Differential pressure taps horizontal and level with each other to within +/- 1.5 mm.
- .2 Tubing: straight, supported throughout its length, sloped 5-10% upward to main for drainage and venting, without air pockets, with blowdown valves at bottom.

3.5 INSTALLATION OF TRANSMITTERS NOT FORMING INTEGRAL PART OF PRIMARY ELEMENT

- .1 Mount on pipe stand installed and located to ensure no damage by passing traffic.

3.6 INSTALLATION OF SIGNAL TRANSMISSION CABLE

- .1 Ground shielding at one point only.
- .2 Protect against RF interference.
- .3 Cross electrical cables, conduits at 90 degrees leaving at least 150 mm space between.

3.7 START-UP

- .1 Follow manufacturer's recommendations.

3.8 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B40.100, Pressure Gauges and Gauge Attachments.
 - .2 ASME B40.200, Thermometers, Direct Reading and Remote Reading.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-14.4, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.
 - .2 CAN/CGSB-14.5, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.
- .3 Efficiency Valuation Organization (EVO)
 - .1 International Performance Measurement and Verification Protocol (IPMVP)
- .4 Green Seal Environmental Standards (GS)
 - .1 GS-11, Standard for Paints and Coatings.
 - .2 GS-36, Standard for Commercial Adhesives.

1.2 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 and include product characteristics, performance criteria, physical size, finish and limitations. Submit for the following items:
 - .1 Thermometers
 - .2 Pressure Gauges
 - .3 Ball Valves
 - .4 Syphons
 - .5 Wells
- .3 Certificates:
 - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Test and Evaluation Reports:
 - .1 Submit certified test reports for product from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 GENERAL

- .1 Design point to be at mid-point of scale or range.
- .2 Ranges: dual metric and imperial.

2.2 DIRECT READING THERMOMETERS

- .1 Industrial, variable angle type, mercury-free, liquid filled, accuracy \pm one (1) scale division, 225 mm scale length: to CAN/CGSB-14.4 or ASME B40.200.
 - .1 Resistance to shock and vibration.
 - .2 Acceptable Manufacturers: Ashcroft, Terice, Wika, Winters

2.3 REMOTE READING THERMOMETERS

- .1 100 mm diameter, mercury-free, liquid filled or vapour activated dial type: to CAN/CGSB-14.5 or ASME B40.200, accuracy \pm one (1) scale division, brass movement, stainless steel capillary, stainless steel spiral armour, stainless steel bulb and polished brass or stainless steel case for wall mounting.
 - .1 Acceptable Manufacturers: Ashcroft, Terice, Wika, Winters

2.4 THERMOMETER WELLS

- .1 Copper pipe: copper or bronze.
- .2 Steel pipe: brass or stainless steel.

2.5 PRESSURE GAUGES

- .1 112 mm diameter, dial type: to ASME B40.100, Grade 2A, stainless steel or phosphor bronze bourdon tube having 0.5% accuracy full scale or 1% accuracy for liquid filled, unless otherwise specified.

- .1 Acceptable Manufacturers: Ashcroft, Terice, Wika, Winters.
- .2 Provide:
 - .1 Siphon for steam service.
 - .2 Snubber for pulsating operation.
 - .3 Diaphragm assembly for corrosive service.
 - .4 Gasketed pressure relief back with solid front.
 - .5 Bronze ball valve to Section 23 05 23.01 - Valves - Bronze.
 - .6 Oil filled for high vibration applications, including pumps.

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 material installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 GENERAL

- .1 Install thermometers and gauges so they can be easily read from floor or platform.
 - .1 If this cannot be accomplished, install remote reading units.
- .2 Install between equipment and first fitting or valve.

3.3 THERMOMETERS

- .1 Install in wells on piping. Include heat conductive material inside well.
- .2 Install on inlet and outlet of:
 - .1 Heat exchangers.
 - .2 Heating and cooling coils.
 - .3 Boilers.
 - .4 Chillers.
 - .5 Cooling towers, closed circuit coolers and evaporative condensers.
 - .6 DHW tanks.
 - .7 In other locations as indicated.
- .3 Install wells for balancing purposes.
- .4 Use extensions where thermometers are installed through insulation.

3.4 PRESSURE GAUGES

- .1 Install in locations as follows:
 - .1 Suction and discharge of pumps, using liquid filled type.
 - .2 Upstream and downstream of PRVs.
 - .3 Upstream and downstream of control valves.
 - .4 Inlet and outlet of coils.
 - .5 Inlet and outlet of heat exchangers.
 - .6 Outlet of boilers.
 - .7 In other locations as indicated.
- .2 Install balls valves for balancing purposes.
- .3 Use extensions where pressure gauges are installed through insulation.

3.5 NAMEPLATES

- .1 Install engraved lamicoid nameplates in accordance with Section 23 05 53.01 - Mechanical Identification, identifying medium.

3.6 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.7 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by thermometer and gauge installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B1.20.1, Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
 - .3 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- .2 ASTM International
 - .1 ASTM A276, Standard Specification for Stainless Steel Bars and Shapes.
 - .2 ASTM A536, Standard Specification for Ductile Iron Castings.
 - .3 ASTM B16, Standard Specification for Free-Cutting Brass Rod Bar and Shapes for Use in Screw Machines.
 - .4 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .5 ASTM B283, Standard Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
 - .6 ASTM B505/B505M, Standard Specification for Copper-Base Alloy Continuous Castings.
 - .7 ASTM B584, Specification for Copper Alloy Sand Castings for General Applications.
- .3 Canadian Standards Association (CSA)
 - .1 CSA B242, Groove and Solder Type Mechanical Pipe Couplings.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS-SP-25, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS-SP-80, Bronze Gate Globe, Angle and Check Valves.
 - .3 MSS-SP-110, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.2 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 equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.
 - .1 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 43 - Environmental Procedures and Section 01 35 29.06 - Health and Safety Requirements.

- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.
 - .2 Submit data for valves specified in this Section.

1.3 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
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .2 All grooved joint couplings, fittings, valves, and specialties to be the products of a single manufacturer. Grooving tools to be of the same manufacturer as the grooved components.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials/Spare Parts:
 - .1 Furnish following spare parts:
 - .1 Valve seats: one (1) for every ten (10) valves each size. Minimum one (1).
 - .2 Discs: one (1) for every ten (10) valves, each size. Minimum one (1).
 - .3 Stem packing: one (1) for every ten (10) valves, each size. Minimum one (1).
 - .4 Valve handles: two (2) of each size.
 - .5 Gaskets for flanges: one (1) for every ten (10) flanged joints.
 - .6 Grooved couplings: IPS and copper tube dimensioned, one (1) for every ten (10) grooved joints.
 - .2 Tools:
 - .1 Furnish special tools for maintenance of systems and equipment.
 - .2 Include following:
 - .1 Lubricant gun for expansion joints.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

- .1 Valves:
 - .1 Except for specialty valves, to be single manufacturer.
 - .2 Products to have CRN registration numbers.
- .2 End Connections:
 - .1 Connection into adjacent piping/tubing:
 - .1 Steel pipe systems: screwed ends to ANSI/ASME B1.20.1.
 - .2 Copper tube systems:
 - .1 Solder ends to ANSI/ASME B16.18.
 - .2 Grooved ends to copper tube dimensions and CSA B242.
- .3 Lockshield Keys:
 - .1 Where lockshield valves are specified, provide ten (10) keys of each size: malleable iron cadmium plated.

2.2 GATE VALVES

- .1 Requirements common to gate valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.
 - .4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Packing: high grade non-asbestos.
 - .6 Handwheel: non-ferrous.
 - .7 Handwheel Nut: bronze to ASTM B62.
 - .8 Class 125, 860 kPa steam working pressure; Class 200, 1,400 kPa water-oil-gas (WOG).
 - .9 Class 150, 1,030 kPa steam working pressure; Class 300, 2,070 kPa WOG.
- .2 DN 50 (NPS 2) and under, non-rising stem, solid wedge disc, Class 125
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: handwheel.
- .3 DN 50 (NPS 2) and under, non-rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: handwheel.
- .4 DN 50 (NPS 2) and under, rising stem, split wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Disc: split wedge, bronze to ASTM B283, loosely secured to stem.

- .3 Operator: handwheel.
- .5 DN 50 (NPS 2) and under, rising stem, solid wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Operator: handwheel.
- .6 DN 50 (NPS 2) and under, rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Operator: handwheel.

2.3 GLOBE VALVES

- .1 Requirements common to globe valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.
 - .4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.
 - .6 Handwheel: non-ferrous.
 - .7 Handwheel Nut: bronze to ASTM B62.
 - .8 Class 125, 860 kPa steam working pressure; Class 200, 1,400 kPa water-oil-gas (WOG).
 - .9 Class 150, 1,030 kPa steam working pressure; Class 300, 2,070 kPa WOG.
- .2 DN 50 (NPS 2) and under, composition disc, Class 125:
 - .1 Body and bonnet: screwed bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc in easily removable disc holder, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: handwheel.
- .3 DN 50 (NPS 2) and under, composition disc, Class 150:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc in easily removable disc holder, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: handwheel.
- .4 DN 50 (NPS 2) and under, plug disc, Class 150, screwed ends:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat ring: tapered plug type with disc stem ring of stainless steel to ASTM A276, loosely secured to stem.
 - .3 Operator: handwheel.
- .5 Angle valve, DN 50 (NPS 2) and under, composition disc, Class 150:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc in slip-on easily removable disc holder having integral guides, regrindable bronze seat, loosely secured to stem.

- .3 Operator: handwheel.

2.4 CHECK VALVES

- .1 Requirements common to check valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Connections: screwed with hexagonal shoulders.
 - .3 Class 125, 860 kPa steam working pressure; Class 200, 1,400 kPa water-oil-gas (WOG).
 - .4 Class 150, 1,030 kPa steam working pressure; Class 300, 2,070 kPa WOG.
 - .5 Class 200, 1,400 kPa cold working pressure (CWP).
- .2 DN 50 (NPS 2) and under, swing type, bronze disc, Class 125:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
- .3 DN 50 (NPS 2) and under, swing type, bronze disc, Class 150:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
- .4 DN 50 (NPS 2) and under, swing type, composition disc, Class 200:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc: renewable rotating disc of #6 composition to suit service conditions, bronze two-piece hinge disc construction.
- .5 DN 50 (NPS 2) and under, horizontal lift type, composition disc, Class 150:
 - .1 Body: with integral seat, union bonnet ring with hex shoulders, cap.
 - .2 Disc: renewable PTFE for steam, #6 composition rotating disc for water-oil-gas in disc holder having guides top and bottom, of bronze to ASTM B62.
- .6 DN 50 (NPS 2) and under, vertical lift type, bronze disc, Class 125:
 - .1 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.
- .7 DN 50 (NPS 2) and under, vertical or horizontal lift type, 1,380 kPa cold working pressure.
 - .1 Disc: 301 stainless steel, center guided.

2.5 SILENT CHECK VALVES

- .1 DN 50 (NPS 2) and under:
 - .1 Body: cast high tensile bronze to ASTM B62 with integral seat.
 - .2 Pressure rating: Class 125.
 - .3 Connections: screwed ends to ANSI B1.20.1 and with hex. shoulders.
 - .4 Disc and seat: renewable rotating disc.
 - .5 Heavy duty stainless steel spring required in vertical downflow applications.
 - .6 Seat: regrindable.

2.6 BALL VALVES

- .1 DN 50 (NPS 2) and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B16 or ASTM B62.
 - .2 Pressure rating: Class 125, 860 kPa steam.
 - .3 Connections: screwed ends to ANSI B1.20.1 and with hexagonal shoulders.
 - .4 Stem: tamperproof ball drive.
 - .5 Stem packing nut: external to body.
 - .6 Ball and seat: replaceable stainless steel or hard chrome plated solid brass ball and Teflon seats.
 - .7 Port: Standard or full port.
 - .8 Stem seal: TFE, EPDM, Nitrile, Fluoroelastomer with external packing nut.
 - .9 Operator: removable lever handle with extension for insulated pipe.
 - .10 Cap and drain for drain service.
- .2 DN 65 (NPS 2 ½) through DN 100 (NPS 4).
 - .1 Body and cap: cast high tensile bronze to ASTM B16 or ASTM B62.
 - .2 Pressure rating: Class 150, 1,030 kPa steam working pressure; Class 600, 4,140 kPa CWP.
 - .3 Connections: Solder ends to ANSI/ASME B16.18.
 - .4 Stem: tamperproof ball drive.
 - .5 Stem packing nut: external to body.
 - .6 Ball and seat: replaceable stainless steel or hard chrome plated solid brass ball and Teflon seats.
 - .7 Port: Standard or full port.
 - .8 Stem seal: TFE, EPDM, Nitrile, Fluoroelastomer with external packing nut.
 - .9 Operator: removable lever handle with extension for insulated pipe.

2.7 BUTTERFLY VALVES

- .1 DN 65 (NPS 2 ½) through DN 150 (NPS 6).
 - .1 Body: cast bronze per CDA-836 (85-5-5-5).
 - .2 Pressure rating: 2,065 kPa cold working pressure.
 - .3 Connections: copper tube dimensioned grooved ends.
 - .4 Disc: ductile iron per ASTM A536 with elastomer coating.
 - .5 Stem: integrally cast with disc.
 - .6 Stem Nuts: nickel plated 416 stainless steel.
 - .7 Operator:
 - .1 DN 80 (NPS 3) and under: removable lever handle with extension for insulated pipe.
 - .2 DN 100 (NPS 4) and over: gear operator.

2.8 ACCEPTABLE PRODUCT

- .1 Acceptable Product: Jenkins, Crane, Watts, Newman Hattersley, Milwaukee, Conbraco, Kitz, Red White, M.A. Stewart, Nibco, Victaulic.

Part 3 Execution

3.1 APPLICATION

- .1 Ball Valve: for fully open/closed service and frequent operation.
 - .1 Use for all fully open/closed service whenever possible.
- .2 Butterfly Valve: for fully open/closed or throttling service and frequent operation.
 - .1 Use for all fully open/closed service where ball valves are impractical and/or required size is not available.
- .3 Gate Valve: for limited use only; for fully open/closed service and infrequent operation.
 - .1 Use with rising stem only where valve position indication is required.
 - .1 Use solid wedge disc where severe turbulence is expected.
 - .2 Use with non-rising stem for fully open/closed service only where ball valves or butterfly valves are impractical.
 - .1 Use solid wedge disc where severe turbulence is expected.
- .4 Globe Valve: for throttling service and frequent operation.
 - .1 Use composition or plug disc for general service and tight seating only.
 - .2 Use PTFE disc for tight seating and close throttling.

3.2 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Remove internal parts before soldering.
- .3 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.

3.3 COMMISSIONING

- .1 As part of commissioning activities, develop schedule of valves and record thereon identifier, location, service, purchase order number and date, manufacturer, identification data specified above.

3.4 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Approved: 2009-06-30

Part 1 General

1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
- .2 ASTM International Inc.
 - .1 ASTM A49, Standard Specification for Heat-Treated Carbon Steel Joint Bars.
 - .2 ASTM A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .3 ASTM A536, Standard Specification for Ductile Iron Castings.
 - .4 ASTM B61, Standard Specification for Steam or Valve Bronze Castings.
 - .5 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .6 ASTM B85/B85M, Standard Specification for Aluminum-Alloy Die Castings.
 - .7 ASTM B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS SP-61, Pressure Testing of Steel Valves.
 - .2 MSS SP 67, Butterfly Valves.
 - .3 MSS SP-70, Grey Iron Gate Valves, Flanged and Threaded Ends.
 - .4 MSS SP-71, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
 - .5 MSS SP-82, Valve Pressure Testing Methods.
 - .6 MSS SP-85, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.2 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 valves and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 43 - Environmental Procedures and Section 01 35 29.06 - Health and Safety Requirements.
- .3 Shop Drawings:
 - .1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit 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 29.06 - Health and Safety Requirements.
- .2 All grooved joint couplings, fittings, valves, and specialties to be the products of a single manufacturer. Grooving tools to be of the same manufacturer as the grooved components.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials/Spare Parts:
- .2 Furnish following spare parts:
 - .1 Valve seats: one (1) for every ten (10) valves each size. Minimum one (1).
 - .2 Discs: one (1) for every ten (10) valves, each size. Minimum one (1).
 - .3 Stem packing: one (1) for every ten (10) valves, each size. Minimum one (1).
 - .4 Valve handles: two (2) of each size.
 - .5 Gaskets for flanges: one (1) for every ten (10) flanged joints.
 - .6 Grooved couplings: IPS and copper tube dimensioned, one (1) for every ten (10) grooved joints. Valve seats: one for every (10) valves each size, minimum (1).
- .3 Tools:
 - .1 Furnish special tools for maintenance of systems and equipment.
 - .2 Include following:
 - .1 Lubricant gun for expansion joints.

Part 2 Products

2.1 MATERIAL

- .1 Except for specialty valves, to be of single manufacturer.
- .2 Standard specifications:
 - .1 Gate valves: MSS SP-70.
 - .2 Globe valves: MSS SP-85.
 - .3 Check valves: MSS SP-71.
- .3 Requirements common to valves, unless specified otherwise:
 - .1 Body, bonnet: cast iron to ASTM B209 Class B.
 - .2 Connections: flanged ends, plain face to ANSI B16.1.
 - .3 Inspection and pressure testing: to MSS SP-82.
 - .4 Bonnet gasket: non-asbestos.
 - .5 Stem: to have precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.
 - .6 Stuffing box: non-galling two-piece ball-jointed packing gland, gland bolts and nuts.
 - .7 Gland packing: non-asbestos.
 - .8 Handwheel: die-cast aluminum alloy to ASTM B85/B85M or malleable iron to ASTM A49. Nut of bronze to ASTM B62.
 - .9 Identification tag: with catalogue number, size, other pertinent data.
- .4 All products to have Canadian Registration Numbers (CRN).
- .5 Bronze trim for steam, water, air or glycol service.
- .6 Iron trim for oil, gas, or gasoline.
- .7 Acceptable Product: Crane, Jenkins, Milwaukee, Newman Hattersley, Kitz, M.A. Stewart, NIBCO.

2.2 GATE VALVES

- .1 DN 50 (NPS 2 ½) through DN 200 (NPS 8): non rising stem, inside screw, bronze or iron trim, solid wedge disc.
 - .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, Class 125.
 - .2 Bronze trim:
 - .1 Disc: solid offset taper wedge, bronze to ASTM B62.
 - .2 Seat rings: renewable bronze to ASTM B62, screwed into body.
 - .3 Stem: bronze to ASTM B62.
 - .3 Iron trim:
 - .1 Disc: solid offset taper wedge, cast iron to ASTM A126 Class B, secured to wrought steel stem.
 - .2 Seat: integral with body.

- .3 Stem: wrought steel.
 - .4 Operator: handwheel.
- .2 DN 250 (NPS 10) through DN 600 (NPS 24): non rising stem, inside crew, bronze or iron trim, solid wedge disc.
 - .1 Body and multiple-bolted bonnet: cast iron to ASTM A126 Class B for sizes up to DN 350 (NPS 14), Class C for sizes DN 400 (NPS 16) and over, with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, body tie ribs between bonnet and end flanges.
 - .2 Pressure ratings: Class 125.
 - .3 Bronze trim:
 - .1 Disc: solid offset taper wedge, with bronze rings to ASTM B62 rolled into cast iron disc, secured to stem.
 - .2 Seat rings: renewable bronze to ASTM B62 screwed into body.
 - .3 Stem: bronze to ASTM B62.
 - .4 Iron trim:
 - .1 Disc: solid offset taper wedge, cast iron secured to stem.
 - .2 Seat: integral with body up to 350 DN (NPS 14), renewable nodular iron on other sizes.
 - .3 Stem: wrought steel.
 - .4 Operator: handwheel.
- .3 DN 65 (NPS 2 ½) through DN 200 (NPS 8): outside screw and yoke (OS&Y), bronze or iron trim, solid wedge disc.
 - .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, yoke, yoke hub, yoke sleeve and nut. Class 125.
 - .2 Bronze trim:
 - .1 Disc: solid offset taper wedge, bronze to ASTM B62 up to DN 80 (NPS 3), cast iron with bronze disc rings on other sizes, secured to stem through integral forged T-head disc-stem connection.
 - .2 Seat rings: renewable bronze screwed into body.
 - .3 Stem: manganese-bronze.
 - .3 Iron trim:
 - .1 Disc: solid offset taper all-cast iron, secured to stem through integral forged T-head disc-stem connection.
 - .2 Seat rings: integral with body.
 - .3 Stem: nickel-plated steel for iron trim.
 - .4 Pressure-lubricated operating mechanism.
 - .5 Operator: handwheel.
- .4 DN 250 (NPS 10) through DN 600 (NPS 24): outside screw and yoke (OS&Y), bronze or iron trim, solid wedge disc.

- .1 Body and multiple-bolted bonnet: With bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, body tie ribs between bonnet and end flanges, yoke, yoke hub, yoke sleeve and nut.
 - .1 DN 250-350 (NPS 10-14): cast iron to ASTM A126 Class B.
 - .2 DN 400-600 (NPS 16-24): cast iron to ASTM A126 Class B.
- .2 Pressure ratings: Class 125.
 - .1 DN 250-300 (NPS 10-12): WP = 1.4 MPa CWP.
 - .2 DN 350-600 (NPS 14-24): WP = 1.03 MPa CWP.
- .3 Bronze trim:
 - .1 Disc: solid offset taper wedge, bronze disc rings to ASTM B62 rolled into cast iron disc, secured to stem through integral forged T-head disc-stem connection.
 - .2 Seat rings: renewable bronze to ASTM B62 screwed into body.
 - .3 Stem: manganese-bronze.
- .4 Iron trim:
 - .1 Disc: solid offset taper all-cast iron, secured to stem through integral forged T-head disc-stem connection.
 - .2 Seat: integral with body up to DN 350 (NPS 14), renewable nodular iron on other sizes.
 - .3 Stem: nickel-plated steel.
- .5 Pressure-lubricated operating mechanism.
- .6 Operator: handwheel.

2.3

UNDERWRITERS APPROVED GATE VALVE

- .1 DN 65 (NPS 2 ½) through DN 350 (NPS 14), OS&Y:
 - .1 Approvals: UL and FM approved for fire service.
 - .2 UL and FM Label: on valve yoke.
 - .3 Body, Bonnet: cast iron to ASTM A126 Class B. Wall thicknesses to ANSI B16.1 and ULC C-262 (B).
 - .4 Bonnet bushing, yoke sleeve: bronze, to FM requirements.
 - .5 Packing gland: bronze.
 - .6 Stem: manganese bronze. Diameter to ULC C-262 (B).
 - .7 Stuffing box dimensions, gland bolt diameter: to ULC C-262 (B).
 - .8 Bosses for bypass valve, drain: on DN 100 (NPS 4) and over.
 - .9 Disc: solid taper wedge.
 - .1 Up to DN 80 (NPS 3): bronze.
 - .2 DN 100 (NPS 4) and over: EPDM coated cast iron with bronze disc rings.
 - .10 Disc seat ring: self-aligning, Milwood undercut on DN 80-300 (NPS 3-12).
 - .11 Pressure rating:
 - .1 DN 65-300 (NPS 2 ½-12): 1.7 MPa CWP.
 - .2 DN 350 (NPS 14): 1.2 MPa CWP.

- .12 Operator: handwheel.

2.4 GLOBE VALVES

- .1 DN 65 (NPS 2 ½) through DN 250 (NPS 10), OS&Y:
 - .1 Body: with multiple-bolted bonnet.
 - .2 WP: 860 kPa steam, 1.4 MPa CWP.
 - .3 Bonnet-yoke gasket: non-asbestos.
 - .4 Disc: bronze to ASTM B62, fully guided from bottom, securely yet freely connected to stem for swivel action and accurate engagement with disc.
 - .5 Seat ring: renewable, regrindable, screwed into body.
 - .6 Stem: bronze to ASTM B62.
 - .7 Operator: handwheel.

2.5 BYPASSES FOR GATE AND GLOBE VALVES

- .1 Locations: on valves as indicated.
- .2 Position of bypass valve on main valves: spindle uprights or parallel position.
- .3 Size of bypass valve:
 - .1 Main valve up to DN 200 (NPS 8): DN 20 (NPS ¾).
 - .2 Main valve DN 250 (NPS 10) and over: DN 25 (NPS 1).
- .4 Type of bypass valves:
 - .1 On gate valve: globe, with composition disc, trim, to Section 23 05 23.01 – Valves - Bronze. Pressure rating to match main valve.
 - .2 On globe valve: globe, with composition disc, bronze trim, to Section 23 05 23.01 - Valves - Bronze. Pressure rating to match main valve.

2.6 VALVE OPERATORS

- .1 Install valve operators as follows:
 - .1 Handwheel: on valves except as specified.
 - .2 Handwheel with chain operators: on valves installed more than 2,400 mm above floor in boiler rooms and mechanical equipment rooms.

2.7 CHECK VALVES

- .1 Swing check valves, Class 125:
 - .1 Body and bolted cover: with tapped and plugged opening on each side for hinge pin. Grooved or flanged ends: plain faced with smooth finish.
 - .1 Up to DN 400 (NPS 16): cast iron to ASTM A126 Class B.
 - .2 DN 450 (NPS 18) and over: cast iron to ASTM A126 Class C.
 - .2 Ratings:
 - .1 DN 65-300 (NPS 2 ½-12): 860 kPa steam; 1.4 MPa CWP.
 - .2 DN 350-400 (NPS 14-16): 860 kPa steam; 1.03 MPa CWP.
 - .3 DN 450 (NPS 18) and over: 1.03 MPa CWP.

- .3 Bronze trim:
 - .1 Disc: rotating for extended life.
 - .1 Up to DN 150 (NPS 6): bronze to ASTM B62.
 - .2 DN 200 (NPS 8) and over: bronze-faced cast iron.
 - .2 Seat rings: renewable bronze to ASTM B62 screwed into body.
 - .3 Hinge pin, bushings: renewable bronze to ASTM B62.
- .4 Iron trim:
 - .1 Disc: A126 Class B, secured to stem, rotating for extended life.
 - .2 Seat: cast iron, integral with body.
 - .3 Hinge pin: exelloy; bushings: malleable iron.
- .5 Identification tag: fastened to cover.
- .6 Hinge: galvanized malleable iron.
- .2 Swing check valves, DN 65 through DN 200 (NPS 2 1/2 through NPS 8) Class 250:
 - .1 Body and bolted cover: cast iron to ASTM A126 Class B with tapped and plugged opening on each side for hinge pin.
 - .2 Flanged ends: 2 mm raised face with serrated finish.
 - .3 Rating: 1.7 MPa steam; 3.4 MPa CWP.
 - .4 Disc: rotating for extended life.
 - .1 Up to DN 80 (NPS 3): bronze to ASTM B61.
 - .2 DN 100-200 (NPS 4-8): iron faced with ASTM B61 bronze.
 - .5 Seat rings: renewable bronze to ASTM B61, screwed into body.
 - .6 Hinge pin, bushings: renewable, bronze to ASTM B61.
 - .7 Hinge: galvanized malleable iron.
 - .8 Identification tag: fastened to cover.

2.8 SILENT CHECK VALVES

- .1 Body: malleable or ductile iron with integral seat.
- .2 Pressure rating: Class 125, WP = 860 kPa.
- .3 Connections: grooved ends or flanged.
- .4 Disc: bronze or stainless steel renewable rotating disc.
- .5 Seat: renewable, EPDM.
- .6 Stainless steel spring, heavy duty.

2.9 GROOVED-END BUTTERFLY VALVES

- .1 Butterfly valves: to MSS-SP-67.
 - .1 DN 50 (NPS 2) and over: Grooved ends.
 - .2 2,068 kPa WOG and be both bi-directional and dead end service capable to full rated pressure. Ductile iron body with blow-out proof stainless steel stems and nickel coated ductile iron disc. Seat shall be "EPDM" and have a full 360° continuous contact with the seating surface.

- .3 Valve Operators: Lever DN 50-100 (NPS 2-4); gear operator DN 150 (NPS 6) and over.
- .4 Application: Isolating cells or section of multiple component equipment (eg. multi section coils, multi cell cooling towers).

2.10 ACCEPTABLE PRODUCT

- .1 Jenkins, Crane, Milwaukee, Conbraco, Kitz, Red White, M. A. Stewart, Nibco, Victaulic.

Part 3 Execution

3.1 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal. Ensure sufficient room for valve stem in fully open position.
- .2 Grooved end valves to be supplied by the same manufacture of the grooved fittings.
- .3 Grooved end valves to be installed in accordance with the manufacturer's written installation instructions. Grooved ends to be clean and free from indentations and projections. Gaskets to be verified as suitable for the intended service prior to installation. Gaskets to be molded and produced by the coupling manufacturer. The grooved coupling manufacturer's factory trained representative to provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer's representative to periodically visit the jobsite and review installation. Contractor to remove and replace any joints deemed improperly installed.

3.2 COMMISSIONING

- .1 As part of commissioning activities, develop schedule of valves and record thereon identifier, location, service, purchase order number and date, manufacturer, identification data specified above.

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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Approved: 2012-12-31

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ASME B16, Fittings and Valves Package.
 - .2 ASME B16.5, Pipe Flanges and Flanged Fittings: NPS through NPS 24 Metric/Inch Standard.
 - .3 ANSI/ASME B16.10, Face-to-Face and End-to-End Dimensions Valves.
 - .4 ANSI/ASME B16.25, Buttwelding Ends.
 - .5 ANSI/ASME B16.34, Valves Flanged, Threaded and Welding End.
- .2 American Petroleum Institute (API)
 - .1 API STD 598, Valve Inspection and Testing.
- .3 ASTM International
 - .1 ASTM A49, Standard Specification for Heat-Treated Carbon Steel Joint Bars, Micro Alloyed Joint Bars, and Forged Carbon Steel Comprise Joint Bars.
 - .2 ASTM A182/A182M, Standard Specification for Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valve Parts for High Temperature Service.
 - .3 ASTM A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature or High Pressure Service and Other Special Purpose Applications.
 - .4 ASTM A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service, or Both.
 - .5 ASTM A216/A216M, Standard Specification for Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service.
 - .6 ASTM B85/B85M, Standard Specification for Aluminum-Alloy Die Castings.
- .4 Efficiency Valuation Organization (EVO)
 - .1 International Performance Measurement and Verification Protocol (IPMVP)
 - .1 IPMVP.
- .5 Green Seal Environmental Standards (GS)
 - .1 GS-11, Standard for Paints and Coatings.
 - .2 GS-36, Standard for Commercial Adhesives.
- .6 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .7 Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)
 - .1 MSS SP-25, Standard Marking System for Valves, Fittings, Flanges and Unions.

- .2 MSS SP-61, Pressure Testing of Valves.

1.2 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 valves and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 43 - Environmental Procedures and Section 01 35 29.06 - Health and Safety Requirements.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for valves for incorporation into manual.

1.4 QUALITY ASSURANCE

- .1 Health and Safety
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Extra Stock Materials:
- .3 Furnish following spare parts:
 - .1 Valve seats: one (1) for every ten (10) valves each size. Minimum one (1).
 - .2 Discs: one (1) for every ten (10) valves, each size. Minimum one (1).
 - .3 Stem packing: one (1) for every ten (10) valves, each size. Minimum one (1).
 - .4 Valve handles: two (2) of each size.
 - .5 Gaskets for flanges: one (1) for every ten (10) flanged joints.

Part 2 Products

2.1 MATERIAL

- .1 Except for specialty valves, to be of single manufacturer.
- .2 Valves to be individually tested.
- .3 Requirements common to valves, unless specified otherwise:
 - .1 Pressure-temperature ratings: to ANSI B16.34.
 - .2 Inspections and tests: to API 598.
 - .3 Pressure testing: to MSS SP-61.
 - .4 Flanged valves:
 - .1 Face-to-face dimensions: to ANSI B16.10.
 - .2 Flange dimensions: to ANSI B16.5 with 1.6 mm raised face.
 - .5 Butt-weld valves:
 - .1 End-to-end dimensions: to ANSI B16.10.
 - .2 End dimensions: to ANSI B16.25 bored for standard pipe schedule.
 - .6 Handwheel: non-heating type with raised rim of die-cast aluminum alloy to ASTM B85 or malleable iron to ASTM A49.
 - .7 Markings: to MSS SP-25.
 - .8 Identification:
 - .1 Plate showing catalogue number, size, material of body disc, stem seat, fluid, pressure-temperature rating.
 - .2 Body markings: manufacturer, size, primary service rating, material symbol.
 - .9 Canadian Registration Number (CRN) required for all products.

2.2 GATE VALVES

- .1 DN 65 through DN 300 (NPS 2 ½ through NPS 12), rising stem, OS&Y, flexible wedge disc, flanged ends, Class 150 or 300:

- .1 Body and multiple-bolted integral yoke and bonnet: cast steel to ASTM A216/A216M WCB, with full length disc guides designed to ensure correct re-assembly.
- .2 Body/bonnet joint: flat face with corrugated metallic gasket.
- .3 Bonnet studs: to ASTM A193/A193M Type B7.
- .4 Bonnet nuts: to ASTM A194/A194M Type 2H.
- .5 Stuffing box: including non-galling two-piece ball jointed packing gland, with swing-type eye bolts and nuts.
- .6 Gland packing: containing corrosion inhibitor to prevent stem pitting.
- .7 Yoke sleeve: Ni-Resist, minimum melting point above 954°C.
- .8 Hydraulic grease fitting: for lubrication of yoke sleeve bearing surfaces.
- .9 Disc: with disc stem ring to connect to stem, guided throughout its travel.
 - .1 DN 65-150 (NPS 2 ½-6): solid corrosion and heat resistant 13% chromium steel with minimum hardness of 350 HB.
 - .2 DN 200 (NPS 8) and larger: carbon steel faced with corrosion and heat resistant 13 chromium steel with minimum hardness of 350 HB.
- .10 Seat ring: seamless carbon steel with hard-faced cobalt-chromium-tungsten alloy seating surface, slipped in, seal welded, ground to match disc.
- .11 Stem: heat treated corrosion and heat resistant 13% chromium steel with accurately-cut precision-machined Acme or 60° V threads, top screwed for handwheel nut, T-head disc-stem connection.
- .12 Operator: see elsewhere in this Section.

2.3 GLOBE VALVES

- .1 DN 65 through DN 300 (NPS 2 ½ through NPS 12), rising stem, OS&Y, flanged ends, Class 150 or 300:
 - .1 Body and multiple-bolted integral yoke and bonnet: cast steel to ASTM A216/A216M WCB.
 - .2 Body/bonnet joint: male-female face with corrugated metallic gasket.
 - .3 Bonnet studs: to ASTM A193/A193M Type B7.
 - .4 Bonnet nuts: to ASTM A194/A194M Type 2H.
 - .5 Stuffing box: including non-galling two-piece ball-jointed packing gland, with swing-type eye bolts and nuts.
 - .6 Gland packing: containing corrosion inhibitor to prevent stem pitting.
 - .7 Yoke bushing: Ni-Resist, minimum melting point above 954°C.
 - .8 Hydraulic grease fitting: for lubrication of yoke sleeve bearing surfaces.
 - .9 Disc: plug type with 15° taper seat and bottom guide.
 - .10 Seat rings: with 1.6 mm thick cobalt-chromium-tungsten alloy facings with minimum hardness of 375 HB (cold), slipped in, seal welded, ground to match disc.
 - .11 Stem: heat treated corrosion and heat resistant 13% chromium steel with bonnet bushing, long engagement with yoke bushing for accurate seating, accurately-cut precision-machined Acme or 60° V threads, top screwed for handwheel nut.

- .12 Operator: see elsewhere in this Section.

2.4 VALVE OPERATORS

- .1 Handwheel: on all gate and globe valves except as specified.
- .2 Handwheel with chain operators: on valves installed more than 2,400 mm above floor in boiler rooms and mechanical equipment rooms.

2.5 BYPASSES FOR GATE AND GLOBE VALVES

- .1 Locations: on valves as indicated.
- .2 Position of bypass valve on main valves: stem vertical or parallel position.
- .3 Size of bypass valve:
 - .1 Main valve up to DN 200 (NPS 8): DN 20 (NPS ¾).
 - .2 Main valve DN 250 (NPS 10) and over: DN 25 (NPS 1).
- .4 Type of bypass valves:
 - .1 On gate valve: globe, with composition disc, bronze trim, to Section 23 05 23.01 - Valves - Bronze.
 - .2 On globe valve: globe, with composition disc, bronze trim, to Section 23 05 23.01 - Valves - Bronze.

2.6 CHECK VALVES

- .1 DN 65 (NPS 2 ½) and over, flanged ends, Class 150 or 300: swing check.
 - .1 Body and multiple-bolted cap: cast steel to ASTM A216/A216M WCB.
 - .2 Cap studs: to ASTM A193/A193M Type B7.
 - .3 Cap nuts: to ASTM A194/A194M Type 2H.
 - .4 Body/cap joint: male-female face with corrugated metallic gasket.
 - .5 Disc: heat treated corrosion and heat resistant 13% chromium steel.
 - .6 Seat rings: heat treated corrosion and heat resistant 13% chromium steel, slipped in, seal welded, ground to match disc.
 - .7 Hinge: ASTM A182/A182M.
 - .8 Hinge pin: 410 stainless steel.

2.7 SILENT CHECK VALVES

- .1 Construction:
 - .1 Body: cast steel to ASTM A216/A216M WCB with integral seat.
 - .2 Pressure rating: Class 125, 250.
 - .3 Connections: flanged ends.
 - .4 Double bronze disc with SS seat and stem. Renewable disc, seat, stem and spring. Spring rating must match system design for silent operation and installation.
 - .5 Stainless steel spring, heavy duty.

- .6 Seat: regrindable.

2.8 ACCEPTABLE PRODUCT

- .1 Crane, Jenkins, M. A. Stewart, Milwaukee (Silent Check Valves).

Part 3 Execution

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's recommendations in upright position with stem above horizontal.

3.2 COMMISSIONING

- .1 As part of commissioning activities, develop schedule of valves and record thereon identifier, location, service, purchase order number and date, manufacturer, identification data specified above.

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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Approved: 2009-06-30

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ASME B1.20.1, Pipe Threads, General Purpose (Inch).
 - .2 ASME B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125 and 250.
 - .3 ANSI/ASME B16.5, Pipe Flanges and Flanged Fittings: NPS through 24.
 - .4 ANSI/ASME B16.11, Forged Fittings, Socket-Welding and Threaded.
 - .5 ANSI/ASME B16.25, Buttwelding Ends.
 - .6 ANSI/ASME B16.34, Valves - Flanged, Threaded and Welding Ends.
- .2 American Petroleum Institute (API)
 - .1 API Std. 609, Butterfly Valves: Double Flanged, Lug- and Wafer-Type.
- .3 ASTM International Inc.
 - .1 ASTM A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .2 ASTM A536, Standard Specification for Ductile Iron Castings.
 - .3 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .4 ASTM B209M, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS SP-67, Butterfly Valves.

1.2 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, specifications and datasheets for valves and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 43 - Environmental Procedures and Section 01 35 29.06 - Health and Safety Requirements.

- .3 Shop Drawings:
 - .1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for valves for incorporation into manual.

1.4 QUALITY ASSURANCE

- .1 Health and Safety
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 – Health and Safety Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Extra Materials/Spare Parts:
- .3 Furnish following spare parts:
 - .1 Valve seats: one (1) for every ten (10) valves each size. Minimum one (1).
 - .2 Discs: one (1) for every ten (10) valves, each size. Minimum one (1).
 - .3 Stem packing: one (1) for every ten (10) valves, each size. Minimum one (1).
 - .4 Valve handles: two (2) of each size.
 - .5 Gaskets for flanges: one (1) for every ten (10) flanged joints.
- .4 Tools:
 - .1 Furnish special tools for maintenance of systems and equipment.
 - .2 Include following:
 - .1 Lubricant gun for expansion joints.

Part 2 Products

2.1 MATERIAL

- .1 Except for specialty valves, to be of single manufacturer.
- .2 Valves to be individually tested.
- .3 Requirements common to valves, unless specified otherwise:
 - .1 Pressure-temperature ratings: to ANSI B16.34.
 - .2 Identification:
 - .1 Plate showing catalogue number, size, material of body disc, stem seat, fluid, pressure-temperature rating.
 - .2 Body markings: manufacturer, size, primary service rating, material symbol.
 - .3 Canadian Registration Number (CRN) required for all products.

2.2 BUTTERFLY VALVES - RESILIENT SEAT – 1.4 MPAG

- .1 To be suitable for dead-end service.
- .2 Sizes:
 - .1 Wafer or Lug type: DN 50 (NPS 2) to DN 750 (NPS 30).
- .3 Pressure rating for tight shut-off at temperatures up to maximum for seat material.
 - .1 DN 50-300 (NPS 2-12): 1.4 MPa CWP.
 - .2 DN 350-1,200 (NPS 14-48): 1.4 MPa CWP.
- .4 Minimum seat temperature ratings to 135°C.
- .5 Application: on-off operation.
- .6 Full lug body (threaded).
- .7 Operators:
 - .1 DN 50-150 (NPS 2-6): handles capable of locking in any of ten (10) positions - 0° to 90°. Handle and release trigger - ductile iron. Return spring and hinge pin: carbon steel. Latch plate and mounting hardware: cadmium plated carbon steel. Standard coating: black laquer.
 - .2 DN 200-750 (NPS 8-30): manual enclosed gear operator.
- .8 Designed to comply with MSS SP-67 and API 609.
- .9 Compatible with ANSI Class 125/Class 150 flanges.
- .10 Construction:
 - .1 Body ductile iron.
 - .2 Disc: aluminum bronze.
 - .3 Seat: EPDM.
 - .4 Shaft: 416 stainless steel.
 - .5 Taper pin: 316 stainless steel.
 - .6 Key: carbon steel or stainless.

- .7 O-Ring: Buna-N.
- .8 Bushings: luberized bronze or Teflon.

2.3 BUTTERFLY VALVES - RESILIENT SEAT – 1.97 MPAG

- .1 Sizes:
 - .1 Lug type: DN 50 (NPS 2) to DN 1200 (48).
- .2 Pressure rating: 1.97 MPa at 135°C.
- .3 Lug body: 150 ANSI bolt pattern.
- .4 Full lug body (threaded).
- .5 Application: for on-off service.
- .6 Operators:
 - .1 DN 50-150 (NPS 2-6): handles capable of locking in any of ten (10) positions - 0° to 90°. Handle and release trigger - ductile iron. Return spring and hinge pin: carbon steel. Latch plate and mounting hardware: cadmium plated carbon steel.
 - .2 DN 200-600 (NPS 8-24): manual enclosed gear operator.
 - .3 Install parallel or perpendicular to pipeline.
- .7 Designed to comply with MSS SP-67 and API 609.
- .8 Compatible with ANSI B16.1 Class 125 (iron) and ANSI B16.5 Class 150 (steel) flanges.
- .9 Construction:
 - .1 Body: ductile iron.
 - .2 Disc: aluminum bronze.
 - .3 Seat: EPDM.
 - .4 Refer to manufacturer's literature for additional materials.
 - .5 Shaft:
 - .1 DN 50-300 (NPS 2-12): 416 stainless steel.
 - .2 DN 350-1200 (NPS 14-48): 316 stainless steel.
 - .6 Taper pin: 316 SS.
 - .7 Blowout proof stem.
 - .8 O-Ring: Buna-N.
 - .9 Bushings: Teflon.
 - .10 Disc shall not be pinned to shaft.
 - .11 Bubble tight shutoff with downstream flanges removed, class 6 shutoff.

2.4 BUTTERFLY VALVES – 2.1 MPAG

- .1 Sizes:
 - .1 Grooved ends: DN 50 (NPS 2) to DN 300 (NPS 12).
- .2 Pressure rating: 2.1 MPa WOG.
- .3 Body: Ductile Iron to ASTM A-536 with polypropylene coating.
- .4 Disc: Ductile Iron to ASTM A-536.

- .5 Disc coating: EPDM.
- .6 Body coating: Polyphenylene Sulfide Blend.
- .7 Drive Hub Adapter and Operation Bracket: hot rolled steel, enamel coated.
- .8 Upper bearing/lower Trunnion seals: EPDM
- .9 Upper bearing/lower Trunnion: Navel brass or Bronze alloy.
- .10 Bolts and washers: Cold rolled steel, zinc plated.
- .11 Operator:
 - .1 DN 50-75 (NPS 2-3): two position manual handle
 - .2 DN 75-150 (NPS 3-6): Manual level lock
 - .3 DN 200-300 (NPS 8-12): Manual gear operator with handwheel
 - .4 Handwheel with chain operator: on valves installed more than 2,400 mm above floor in boiler rooms and mechanical equipment rooms.

2.5 MOUNTING FLANGES

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

2.6 ELECTRIC ACTUATORS

- .1 Operation: designed to provide precise quarter turn electric operation.
 - .1 Torque range: up to 1,130 N-m and speed ranges from 10 seconds to 30 seconds to move from fully open to fully closed.
 - .2 Gear train within actuator to provide smooth continuous rotary power stroke for accurate automatic valve positioning. Factory-set, field adjustable cam-actuated travel limit switches to provide precise control of shaft rotation.
- .2 Construction:
 - .1 Castings: heavy duty industrial grade for rugged use.
 - .2 Actuators: continuous duty with high efficiency single phase reversing capacitor motor with thermal overload protection.
 - .3 Gears and pinions constructed from hardened steel.
 - .4 Gear train to be permanently lubricated.
 - .5 Mechanical brake to ensure that gear is locked in precise position.
- .3 Electrical:
 - .1 Standard voltage: 120 VAC. 60 Hz.
 - .2 Control options: 4-20 Ma DC or 0-10 V DC.
 - .3 CSA approved.
 - .4 Electrical rating: NEMA IV.

Part 3 Execution

3.1 PREPARATION

- .1 Valve and mating flange preparation.

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

3.2 INSTALLATION OF VALVES

- .1 Install in accordance with manufacturer's instructions.
- .2 Do not use gaskets between pipe flanges and valves unless instructed otherwise by valve manufacturer.
- .3 Verify suitability of valve for application by inspection of identification tag.
- .4 Mount actuator on to valve prior to installation.
- .5 Handle valve with care so as to prevent damage to disc and seat faces.
- .6 Valves in horizontal pipe lines should be installed with stem in horizontal position to minimize liner and seal wear.
- .7 Ensure that valves are centered between bolts before bolts are tightened and then opened and closed to ensure unobstructed disc movement. If interference occurs due, for example to pipe wall thickness, taper bore adjacent piping to remove interference.

3.3 ACTUATOR INSTALLATION

- .1 Air hoses or electrical connections to be made by actuator manufacturer.
- .2 Cycle valve operation from fully closed to fully open then back to fully closed.
- .3 At same time, check travel stop settings for proper disc alignment.

3.4 COMMISSIONING

- .1 As part of commissioning activities, develop schedule of valves and record thereon identifier, location, service, purchase order number and date, manufacturer, identification data specified above.

3.5 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Approved: 2009-12-31

Part 1 General

1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.1, Power Piping.
- .2 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.
- .3 Factory Mutual (FM)
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP58, 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.
- .6 National Resources Canada (NRC)
 - .1 Alberta Building Code (ABC).
 - .2 Alberta Fire Code (AFC).
 - .3 Alberta Plumbing Code (APC).
- .7 Underwriter's Laboratories of Canada (ULC)

1.2 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.
 - .2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 43 - Environmental Procedures and Section 01 35 29.06 - Health and Safety Requirements.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.

- .2 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.
 - .1 Department's Representative will make available one (1) copy of systems supplier's installation instructions.

1.3 CLOSEOUT SUBMITTALS

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

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition 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 Performance Requirements:
 - .1 Design supports, platforms, catwalks, hangers to withstand seismic events for location as per the Alberta Building Code.

2.2 GENERAL

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

2.3 PIPE HANGERS

- .1 Finishes:
 - .1 Pipe hangers and supports: galvanized or painted with zinc-rich paint after manufacture.
 - .2 Use electro-plating galvanizing process or hot dipped galvanizing process.
 - .3 Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
 - .1 Cold piping DN 50 (NPS 2) maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
 - .1 Rod: 9 mm UL listed, 13 mm FM approved.
 - .2 Cold piping DN 65 (NPS 2 ½) 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, FM approved where required to MSS-SP58 and MSS-SP69.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
 - .1 Cold piping DN 50 (NPS 2) maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed, FM approved where required to MSS SP69.
 - .2 Cold piping DN 65 (NPS 2 ½) or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut, UL listed, FM approved where required.
- .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, FM approved where required to MSS SP69.

- .5 Shop and field-fabricated assemblies:
 - .1 Trapeze hanger assemblies: to MSS SP89.
 - .2 Steel brackets: to MSS SP89.
 - .3 Sway braces for seismic restraint systems: to MSS SP89.
- .6 Hanger rods: threaded rod material to MSS SP58:
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
 - .3 Do not use 22 mm or 28 mm rod.
- .7 Pipe attachments: material to MSS SP58:
 - .1 Attachments for steel piping: carbon steel, galvanized.
 - .2 Attachments for copper piping: copper plated black steel.
 - .3 Use insulation shields for hot pipework.
 - .4 Oversize pipe hangers and supports for insulated pipe.
- .8 Adjustable clevis: material to MSS SP69, UL listed, FM approved where required, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
 - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.
- .9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .10 U-bolts: carbon steel to MSS SP69 with two (2) nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: galvanized.
 - .2 Finishes for copper, glass, brass or aluminum pipework: black, with formed portion plastic coated or epoxy coated.
- .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

2.4 RISER CLAMPS

- .1 Steel or cast iron pipe: galvanized carbon steel to MSS SP58, type 42, UL listed, FM approved where required.
- .2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.
- .3 Bolts: to ASTM A307.
- .4 Nuts: to ASTM A563.

2.5 INSULATION PROTECTION SHIELDS

- .1 Insulated cold piping:
 - .1 64 kg/m³ density insulation plus insulation protection shield to: MSS SP69, galvanized sheet carbon steel. Length designed for maximum 3 m span.

- .2 Insulated hot piping:
 - .1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes DN 300 (NPS 12) and over, carbon steel to comply with MSS SP69.

2.6 CONSTANT SUPPORT SPRING HANGERS

- .1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).
- .2 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.
- .3 Provide upper and lower factory set travel stops.
- .4 Provide load adjustment scale for field adjustments.
- .5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.
- .6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.7 VARIABLE SUPPORT SPRING HANGERS

- .1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.
- .2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with two (2) springs in series in single casing.
- .3 Variable spring hanger complete with factory calibrated travel stops. Provide certificate of calibration for each hanger.
- .4 Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/-5 % spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

2.8 EQUIPMENT SUPPORTS

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

2.9 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.10 PLATFORMS AND CATWALKS

- .1 To Section 05 50 10 - Metal Fabrications.

2.11 HOUSEKEEPING 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 by Division 03.

2.12 RUBBER SUPPORT SYSTEM FOR ROOF PIPE AND EQUIPMENT.

- .1 Furnishing all labor, equipment, materials and accessories, and performing all operations required for the correct installation of modular recycled rubber pipe/equipment supports.
- .2 Rubber base must be made of 100% recycled rubber and polyurethane prepolymer with a uniform load capacity per linear foot of support.
- .3 Steel frame: Steel, strut galvanized per ASTM A653 or strut galvanized per ASTM A653 for bridge series.
- .4 Attaching hardware: Zinc-plated threaded rod, nuts and attaching hardware per ASTM B633.
- .5 Any products claiming to be a similar, like, or equal must demonstrate (meet or exceed) the same physical and performance characteristics as specified on below:
 - .1 Density: 0.52 oz/cu in ASTM C642
 - .2 Durometer Hardness: 67.2A \pm 1 ASTM D2240
 - .3 Tensile Strength: 231 psi minimum ASTM D412
 - .4 Compression Deformation: 5% at 70psi and 72°F ASTM D395
 - .5 Brittleness at Low Temp: -50°F ASTM D746
 - .6 Freeze and thaw when exposed to deicing chemicals: No loss after 50 cycles ASTM C672
 - .7 Coefficient of Thermal Expansion: 8 x 10⁻⁶ in/in/°F (min) ASTM C531
 - .8 Weathering: 70 hours at 120°F ASTM D573
 - .1 Hardness retained: 100% (\pm 5%)
 - .2 Compressive strength: 100% (\pm 5%)
 - .3 Tensile strength: 100% (\pm 5%)
 - .4 Elongation retained: 100% (\pm 5%)
- .6 Rubber block supports Accessories are fastened directly into rubber material with weather resistant screws.
- .7 Continuous block channel supports shall include gaps between blocks for free flow of water. Standard strut accessories can be used for attachment.

2.13 OTHER EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports from structural grade steel meeting requirements of Structural Steel and Miscellaneous Metals.
- .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 four (4) minimum concrete inserts, one (1) at each corner.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .6 Use approved constant support type hangers where:
 - .1 Vertical movement of pipework is 13 mm or more,
 - .2 Transfer of load to adjacent hangers or connected equipment is not permitted.
- .7 Use variable support spring hangers where:
 - .1 Transfer of load to adjacent piping or to connected equipment is not critical.
 - .2 Variation in supporting effect does not exceed 25 % of total load.

3.3 HANGER SPACING

- .1 Plumbing piping: to Alberta Plumbing Code and authority having jurisdiction.
- .2 Fire protection: to Alberta Fire Code and authority having jurisdiction.
- .3 Gas and fuel oil piping: up to DN 10 (NPS ½): every 1.8 m.
- .4 Copper piping: up to DN 10 (NPS ½): every 1.5 m.
- .5 Hydronic, steam, condensate, rigid, and flexible joint roll groove pipe: in accordance with table below, but not less than one (1) hanger at joints.

Maximum Pipe Size: DN (NPS)	Maximum Spacing Steel	Maximum Spacing Copper
up to 32 (1 ¼)	2.1 m	1.5 m
40 (1 ½)	2.7 m	2.4 m
50 (2)	3.0 m	2.4 m
65 (2 ½)	3.4 m	2.7 m
80 (3)	3.7 m	3.0 m
90 (3 ½)	3.7 m	3.0 m
100 (4)	4.3 m	3.7 m
125 (5)	4.3 m	
150 (6)	5.2 m	
200 (8)	5.2 m	
250 (10)	6.1 m	
300 (12)	6.1 m	

- .6 Within 300 mm of each elbow.
- .7 Pipework greater than DN 300 (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, comprised of angle iron or c-channel.

3.5 HORIZONTAL MOVEMENT

- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 ° from vertical.
- .2 Where horizontal pipe movement is less than 13 m/m, 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 Verification requirements in accordance with Section 01 45 00 - Quality Control, 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 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 13, Standard for the Installation of Sprinkler Systems.
- .3 Natural Resource Canada (NRC)

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
 - .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 (2) copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 35 43 - Environmental Procedures and Section 01 35 29.06 - Health and Safety Requirements.
- .2 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Provide separate shop drawings for each isolated system complete with performance and product data.
 - .2 Provide detailed drawings of seismic control measures for equipment and piping.
- .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.
 - .1 Department's Representative will make available one (1) copy of systems supplier's installation instructions.
 - .3 Manufacturer's Field Reports: manufacturer's field reports specified.

1.3 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

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

- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 GENERAL

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

2.2 ELASTOMERIC PADS

- .1 Type EP1 - neoprene waffle or ribbed; 9 mm minimum thick; 50 durometer; maximum loading 350 kPa.
- .2 Type EP2 - rubber waffle or ribbed; 9 mm minimum thick; 30 durometer natural rubber; maximum loading 415 kPa.
- .3 Type EP3 - neoprene-steel-neoprene; 9 mm minimum thick neoprene bonded to 1.71 mm steel plate; 50 durometer neoprene, waffle or ribbed; holes sleeved with isolation washers; maximum loading 350 kPa.
- .4 Type EP4 - rubber-steel-rubber; 9 mm minimum thick rubber bonded to 1.71 mm steel plate; 30 durometer natural rubber, waffle or ribbed; holes sleeved with isolation washers; maximum loading 415 kPa.

2.3 ELASTOMERIC MOUNTS

- .1 Type M1 - colour coded; neoprene in shear; maximum durometer of 60; threaded insert and two (2) bolt-down holes; ribbed top and bottom surfaces.

2.4 SPRINGS

- .1 Design stable springs: ratio of lateral to axial stiffness is equal to or greater than 1.2 times the ratio of static deflection to working height. Select for 50% travel beyond rated load. Units complete with levelling devices.
- .2 Ratio of height when loaded to diameter of spring between 0.8 to 1.0.
- .3 Cadmium plate for outdoor and 100% relative humidity installations.
- .4 Colour code springs.

2.5 SPRING MOUNT

- .1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.
- .2 Type M2 - stable open spring: support on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad.
- .3 Type M3 - stable open spring: 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; levelling bolt for rigidly mounting to equipment.
- .4 Type M4 - restrained stable open spring: supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.
- .5 Type M5 - enclosed spring mounts with snubbers for isolation up to 950 kg maximum.
- .6 Acceptable Product: Korfund, Mason, Vibron, Vibro Acoustics.

2.6 HANGERS

- .1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30° arc without metal to metal contact.
- .2 Type H1 - neoprene - in-shear, moulded with rod isolation bushing which passes through hanger box.
- .3 Type H2 - stable spring, elastomeric washer, cup with moulded isolation bushing which passes through hanger box.
- .4 Type H3 - stable spring, elastomeric element, cup with moulded isolation bushing which passes through hanger box.
- .5 Acceptable Product: Korfund, Mason, Vibron, Vibro Acoustics.

2.7 ACOUSTIC BARRIERS FOR ANCHORS AND GUIDES

- .1 Acoustic barriers: between pipe and support, consisting of 25 mm minimum thick heavy duty duck and neoprene isolation material.

2.8 HORIZONTAL THRUST RESTRAINT

- .1 Spring and elastomeric element housed in box frame; assembly complete with rods and angle brackets for equipment and ductwork attachment; provision for adjustment to limit maximum start and stop movement to 9 mm.
- .2 Arrange restraints symmetrically on either side of unit and attach at centerline of thrust.

2.9 STRUCTURAL BASES

- .1 Type B1 - Prefabricated steel base: integrally welded on sizes up to 2,400 mm on smallest dimension, split for field welding on sizes over 2,400 mm on smallest dimension and reinforced for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; pre-drilled holes to receive equipment anchor bolts; and complete with adjustable built-in motor slide rail where indicated.

- .2 Type B2 - Steel rail base: structural steel, positioned for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; and pre-drilled holes to receive equipment anchor bolts.
- .3 Bases to clear housekeeping pads by 25 mm minimum.
- .4 Acceptable Product: Korfund, Mason, Vibron, Vibro Acoustics.

2.10 INERTIA BASE

- .1 Type B3 - Full depth perimeter structural or formed channels, frames: welded in place reinforcing rods running in both directions; spring mounted, carried by gusseted height-saving brackets welded to frame; and clear housekeeping pads by 50 mm minimum.
- .2 Pump bases: "T" shaped, where applicable, to provide support for elbows.
- .3 Concrete: to Section 03 30 00 - Cast-in-Place Concrete.
- .4 Acceptable Product: Korfund, Mason, Vibron, Vibro Acoustics.

2.11 ROOF CURB ISOLATION RAILS

- .1 General: complete factory assembled without need for sub-base.
- .2 Lower member: continuous rectangular steel tube or extruded aluminum channel.
- .3 Upper member: continuous rectangular steel tube or extruded aluminum channel to provide continuous support for equipment, complete with all-directional neoprene snubber bushings 6 mm thick to resist wind and seismic forces.
- .4 Springs: steel, adjustable, removable, selected for 25 mm maximum static deflection plus 50% additional travel to solid, cadmium plated, sized and positioned to ensure uniform deflection.
- .5 High frequency isolation: 6 mm minimum thick continuous gasket on top and bottom of complete assembly or pads on top and bottom of each spring. Material: closed cell neoprene.
- .6 Weatherproofing: continuous flexible counterflashing to curb and providing access to springs. Material: aluminum and/or neoprene.
- .7 Hardware: cadmium plated or galvanized.

2.12 SEISMIC CONTROL MEASURES

- .1 General:
 - .1 Following systems and/or equipment to remain operational during and after earthquakes:
 - .1 N/A

2.13 ISOLATION SCHEDULE

Isolated Equipment	Base		Isolation	
	Type	Thickness	Type	Deflection (mm)
Vertical Inline Pumps	None	N/A	EP1	2.5
Boilers	None	N/A	EP4	2.5
Centrifugal Fans	None	N/A	H2	20
Inline Fans	None	N/A	H2	20
Condensing Units	None	N/A	M4	20
Air Handling units on stand	None	N/A	M4	25
Roof mounted Utility fan	None	N/A	M4	25

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.
- .2 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
- .3 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:
 - .1 Up to DN 100 (NPS 4): first 3 points of support.
 - .2 DN 125 (NPS 5) to DN 200 (NPS 8): first 4 points of support.
 - .3 DN 250 (NPS 10) and Over: first 6 points of support.
 - .4 First point of support: static deflection of twice deflection of isolated equipment, but not more than 50 mm.
- .4 Where isolation is bolted to floor use vibration isolation rubber washers.
- .5 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:

- .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.
- .2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:
 - .1 After delivery and storage of Products.
 - .2 After preparatory work is complete but before installation commences.
 - .3 Twice during the installation, at 25% and 60% completion stages.
 - .4 Upon completion of installation.
- .3 Submit manufacturer's reports to Department's Representative within three (3) days of manufacturer representative's review.
- .4 Make adjustments and corrections in accordance with written report.
- .2 Inspection and Certification:
 - .1 Experienced and competent sound and vibration testing professional engineer to take vibration measurement for HVAC systems after start up and TAB of systems to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .3 Provide Departmental Representative with notice 24 h in advance of commencement of tests.
- .4 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations (including sound curves).
- .5 Submit complete report of test results including sound curves.

3.4 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian Gas Association (CGA)
 - .1 CSA/CGA B149.1, Natural Gas and Propane Installation Code.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.60, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3, Identification of Piping Systems.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .4 National Fire Protection Association (NFPA)
 - .1 NFPA 13, Standard for the Installation of Sprinkler Systems.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
- .2 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Product data to include paint colour chips, other products specified in this section.
- .4 Samples:
 - .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Samples to include nameplates, labels, tags, lists of proposed legends.

1.3 QUALITY ASSURANCE

- .1 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

- .1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.
- .2 Lettering and numbers raised or recessed.
- .3 Information to include, as appropriate:
 - .1 Equipment: manufacturer's name, model, size, serial number, capacity.
 - .2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 SYSTEM NAMEPLATES

- .1 Colours:
 - .1 Hazardous: red letters, white background.
 - .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).
- .2 Construction:
 - .1 3 mm thick laminated plastic or white anodized aluminum, matte finish, with square corners, letters accurately aligned and machine engraved into core.
- .3 Sizes:
 - .1 Conform to following table:

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

- .2 Use maximum of 25 letters/numbers per line.
- .4 Locations:
 - .1 Terminal cabinets, control panels: use size # 5.
 - .2 Equipment in Mechanical Rooms: use size # 9.

2.3 PIPING SYSTEMS GOVERNED BY CODES

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

- .2 Propane gas: to CSA/CGA B149.1 and authority having jurisdiction.
- .3 Sprinklers: to NFPA 13.

2.4 IDENTIFICATION OF PIPING SYSTEMS

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .2 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 plastic-coated cloth or vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150°C and intermittent temperature of 200°C.
- .7 Colours and Legends:
 - .1 Where not listed, obtain direction from Departmental Representative.
 - .2 Colours for legends, arrows: to following table:

Background Colour:	Legend, Arrows:
Yellow	BLACK
Green	WHITE
Red	WHITE

.3 Background colour marking and legends for piping systems:

Contents	Background Colour Marking	Legend
** Add design temperature		
++ Add design temperature and pressure		
City water	Green	CITY WATER
Treated water	Green	TREATED WATER
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
High temp HW Htg. supply	Yellow	HTHW HTG. SUPPLY++
High temp HW Htg. return	Yellow	HTHW HTG. RETURN++
Make-up water	Yellow	MAKE-UP WTR
Boiler feed water	Yellow	BLR. FEED WTR
Steam	Yellow	kPa STEAM
Steam condensate (gravity)	Yellow	ST.COND.RET (GRAVITY)
Steam condensate (pumped)	Yellow	ST.COND.RET (PUMPED)
Drinking water return	Green	CH. DRINK WTR. CIRC
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Waste water	Green	WASTE WATER
Storm water	Green	STORM
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
Refrigeration hot gas	Yellow	REF. HOT GAS
Natural gas	to Codes	
Propane	to Codes	
Gas regulator vents	to Codes	
Distilled water	Green	DISTILL. WTR
Demineralized water	Green	DEMIN. WATER
Compressed air	Green	COMP. AIR kPa
Compressed air (700kPa)	Yellow	COMP. AIR 700 kPa
Vacuum	Green	VACUUM
Fire protection water	Red	FIRE PROT. WTR
Sprinklers	Red	SPRINKLERS
Carbon dioxide	Red	CO2
Instrument air	Green	INSTRUMENT AIR
Control (EMCS) air tubing	To Section 25 05 54 – EMCS: Identification	To Section 25 05 54 – EMCS: Identification
Conduit for low voltage control wiring	To Section 25 05 54 – EMCS: Identification	To Section 25 05 54 – EMCS: Identification

2.5 IDENTIFICATION DUCTWORK SYSTEMS

- .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
- .2 Colours: back, or co-ordinated with base colour to ensure strong contrast.
- .3 Identify system: commodity with associated equipment (e.g. Supply AHU-1, Exhaust F-7).

2.6 VALVES, CONTROLLERS

- .1 Brass tags with 12 mm stamped identification data filled with black paint.
- .2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

2.7 CONTROLS COMPONENTS IDENTIFICATION

- .1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in Section 25 05 54 – EMCS: Identification. If no EMCS included in the project, identification as per this section.
- .2 Inscriptions to include function and (where appropriate) fail-safe position.

2.8 LANGUAGE

- .1 Identification in English.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 TIMING

- .1 Provide identification only after painting specified Section 09 91 00 - Painting has been completed.

3.3 INSTALLATION

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide ULC and/or CSA registration plates as required by respective agency.

3.4 NAMEPLATES

- .1 Locations:
 - .1 In conspicuous location to facilitate easy reading and identification from operating floor.
- .2 Standoffs:
 - .1 Provide for nameplates on hot and/or insulated surfaces.

.3 Protection:

.1 Do not paint, insulate or cover in any way.

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

- .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m intervals and more frequently if required to ensure that at least one (1) is visible from any one viewpoint in operating areas and walking aisles.
- .2 Adjacent to each change in direction.
- .3 At least once in each small room through which piping or ductwork passes.
- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 On both sides of separations such as walls, floors, partitions.
- .6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification easily and accurately readable from usual operating areas and from access points.
 - .1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.6 VALVES, CONTROLLERS

- .1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.
- .2 Install one (1) copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Departmental Representative. Provide one (1) copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively.

3.7 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 QUALIFICATIONS OF TAB PERSONNEL

- .1 Submit names of personnel certified to AABC, NBC, NEBB or SMACNA to perform TAB to Department Representative within 90 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience. TAB Contractor shall have a minimum of 5 (five) years related experience performing TAB to AABC, NBC, NEBB or SMACNA.
- .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 Balancing Council, (NBC) Certified Air Balancing Specifications and Certified Hydronic Balancing Specifications.
 - .3 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
 - .4 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, NBC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.2 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.

1.3 EXCEPTIONS

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

1.4 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.

1.5 PRE-TAB REVIEW

- .1 Review contract documents before project construction is started and confirm in writing to Department Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Department Representative 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.

1.6 START-UP

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in other Divisions.

1.7 OPERATION OF SYSTEMS DURING TAB

- .1 Operate systems for length of time required for TAB and as required by Department Representative for verification of TAB reports.

1.8 START OF TAB

- .1 Notify Department Representative seven (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 All pressure, leakage and other tests specified elsewhere in other Divisions.
 - .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.
- .3 Liquid systems:
 - .1 Flushed, filled, vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place, baskets clean.
 - .4 Isolating and balancing valves installed, open.
 - .5 Calibrated balancing valves installed, at factory settings.
 - .6 Chemical treatment systems complete, operational.

1.9 APPLICATION TOLERANCES

- .1 Do TAB to following tolerances of design values:
 - .1 HVAC systems: plus 5 %, minus 5 %.
 - .2 Hydronic systems: plus or minus 10 %.
 - .3 Refrigeration systems: plus or minus 10%.

1.10 ACCURACY TOLERANCES

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

1.11 INSTRUMENTS

- .1 Prior to TAB, submit to Department Representative list of instruments used together with serial numbers.
- .2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
- .3 Calibrate within three (3) months of TAB. Provide certificate of calibration to Department Representative.

1.12 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit, prior to commencement of TAB:
- .2 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.1 COOPERATION WITH CONTROLS

- .1 Cooperate with the controls contractor to balancing of systems in coordination with the controls settings relating to TAB values. This includes TAB for
 - .1 Pumps and pressure bypasses
 - .2 Air Handlers and damper positions
 - .3 VFDs and flow rates.

1.2 COOPERATION WITH COMMISSIONING TEAM

- .1 The Air balancer shall include labour for commissioning activities as per Section 01 91 13.
- .2 Inform Commissioning Team in advance of TAB activities.
- .3 Provide dedicated site visits to verify balanced values to the CX agent. Allow for work necessary to assist Commissioning Team in completion of the commissioning process.
- .4 Provide reports and check sheets for review by the Commissioning Team.
- .5 Resolve TAB issues noted by in the CX process.

1.3 PRELIMINARY TAB REPORT

- .1 Submit for checking and approval of Department Representative, 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.

1.4 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 three (3) copies of TAB Report to Department Representative for verification and approval, in English in D-ring binders, complete with index tabs.

1.5 VERIFICATION

- .1 Reported results subject to verification by Department Representative.
- .2 Provide personnel and instrumentation to verify up to 30 % of reported results.
- .3 Number and location of verified results shall be at the discretion of Department Representative.
- .4 Bear costs to repeat TAB as required to satisfaction of Department Representative.

1.6 SETTINGS

- .1 After TAB is completed to satisfaction of Department Representative, 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 in any way.

1.7 COMPLETION OF TAB

- .1 TAB considered complete when final TAB Report received and approved by Department Representative.

1.8 AIR SYSTEMS

- .1 Standard: TAB to most stringent of this section or TAB standards of AABC, NBC, NEBB, SMACNA or ASHRAE.
- .2 Do TAB of systems, equipment, components, controls specified under Division 23 and in other Divisions.
- .3 Qualifications: personnel performing TAB shall be qualified to standards of AABC, NBC or NEBB and be in good standing with the qualifying body.
- .4 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC, NBC or NEBB and be in good standing with the qualifying body.
- .5 Balance terminal boxes, fans, and air outlets to air quantities indicated on the drawings and under Division 23. Where outlet quantities are not indicated, divide box capacity equally among all outlets.
- .6 Permanently mark balanced settings to allow restoration at any time during life of facility. Markings are not to be eradicated or covered in any way.
- .7 Permanently mark setting on splitters, dampers and other adjustment devices.
- .8 Measurements: to include, but not limited to, the following 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, amperage, noise and vibration covering all stages of operation.
- .9 Locations of equipment measurements: to include, but not limited to, the following as appropriate:
 - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
- .10 Locations of systems measurements to include, but not limited to, the following as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.9 HYDRONIC SYSTEMS

- .1 Definitions: for purposes of this section, to include low pressure hot water heating, chilled water, condenser water, glycol systems.

- .2 Standard: TAB to most stringent of this section or TAB standards of AABC, NBC, NEBB, SMACNA or ASHRAE.
- .3 Do TAB of systems, equipment, components, controls specified under Division 23 and in other Divisions.
- .4 Qualifications: personnel performing TAB shall be qualified to standards of AABC, NBC or NEBB and be in good standing with the qualifying body.
- .5 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC, NBC or NEBB and be in good standing with the qualifying body.
- .6 Permanently mark setting on valves and other adjustment devices.
- .7 Measurements: to include, but not limited to, the following as appropriate for systems, equipment, components, controls: flow rate, static pressure, pressure drop (or loss), temperature, specific gravity, density, RPM, electrical power, voltage, amperage, noise and vibration covering all stages of operation.
- .8 Locations of equipment measurement: to include, but not limited to, the following as appropriate:
 - .1 Inlet and outlet of heat exchangers (primary and secondary sides), boiler, chiller, coil, humidifier, cooling tower, condenser, pump, PRV, control valve, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
- .9 Locations of systems measurements to include, but not limited to, the following as appropriate: supply and return of primary and secondary loops (main, main branch, branch, sub-branch) of all hydronic systems, inlet connection of make-up water.

1.10 DOMESTIC WATER SYSTEMS

- .1 Meet requirements as specified for hydronic systems.
- .2 Adjust PRV on main water supply line to 415 kPa (570 kPa maximum).
- .3 Balance domestic hot water circulating system piping to ensure flow from all points in system. Ensure all hot and cold water supply valves are fully open.
- .4 Test operation of water tempering valves.
- .5 Test operation of safety eyewash and shower equipment.
- .6 Test operation of backflow preventers and other safety devices.
- .7 Test plumbing fixture operation.
- .8 Locations of equipment measurements: To include, but not be limited to, following as appropriate: inlet and outlet of heaters, tank, pump, circulator, at controllers, controlled device.
- .9 Locations of systems measurements to include, but not be limited to, following as appropriate: main, main branch, branch, sub-branch.
- .10 Measure and record all tempered water set-point temperatures and the actual tempered water supply temperatures.
- .11 Measure and record domestic hot water heater set-point temperature.

- .12 Measure and record domestic hot and cold water distribution temperatures, including domestic hot water recirculation at Mechanical Room.

1.11 OTHER SYSTEMS

- .1 Plumbing systems:
 - .1 Standard: National Plumbing Code of Canada (NPC).
 - .2 TAB procedures:
 - .1 Flush valves: adjust to suit project pressure conditions.
 - .2 Pressure booster systems: test for capacity and pressures under all conditions and at all times.
 - .3 Controlled flow roof drain systems: adjust weirs to suit actual roof conditions, slopes, areas drained.
 - .4 Pumped sanitary and storm water systems: test for proper operation at all possible flow rates.
 - .5 Pressure reducing valves/stations:
 - .1 Record and measure each PRV pressure setting.
 - .2 Record and measure inlet and discharge water pressure measured at each PRV.
 - .3 For plumbing and drainage systems:
 - .1 Test plumbing fixture operation.
 - .2 Test sump pump operation and control.
 - .3 Test backflow valves.
 - .4 Test operation of drainage systems.
- .2 Wet and/or dry pipe sprinkler systems:
 - .1 Standard: NFPA.
 - .2 TAB procedures: Refer to NFPA 13, Standard for the Installation of Sprinkler Systems.
- .3 Wet and/or dry pipe standpipe systems:
 - .1 Standard: NFPA.
 - .2 TAB procedures: Refer to NFPA 14, Standard for the Installation of Standpipe and Hose Systems.
- .4 Clean agent fire suppression systems:
 - .1 Standard: NFPA.
 - .2 TAB procedures: Refer to NFPA 2001, Standard on Clean Agent Extinguishing Systems.
- .5 Refrigeration systems forming part of HVAC systems:
 - .1 Standard: CSA B52, Mechanical Refrigeration Code.
 - .2 TAB procedures: Refer to Standard as follows:
 - .1 Suction Pressure and Temperature.
 - .2 Discharge Pressure and Temperature.

- .3 Suction Superheat.
 - .4 Evaporation Pressure and Temperature.
 - .3 Record the air dry bulb and wet bulb temperatures on and off coils and for any other indoor air-conditioning equipment. Record the set-point temperature for coils and equipment. Record the corresponding outdoor air dry bulb and wet bulb temperatures near the corresponding condensing unit.
 - .4 Record refrigerant type and charge for all refrigerant systems.
- .6 Gas / Electric Heating Equipment
 - .1 Where gas-fired equipment is installed, operate on high fire and verify:
 - .1 Each combustion air intake is functioning properly.
 - .2 Flue gases are properly venting.
 - .3 Operation of each natural draft appliance and vent diverter for any back draft.
 - .2 Measure and record the air temperature in and out off all primary fan-powered equipment including unit heaters, force flow units, and furnaces. Record the set-point temperatures for equipment.
 - .3 Measure and record the air temperature in and out off all makeup air units. Record the set-point temperatures for equipment.
 - .4 Measure and record the room temperature and set-point temperature for rooms heated by radiant heaters, infrared heaters, baseboard heaters, unit heaters, force flow units, furnaces, air handling units, and any other gas / electric heating equipment.
 - .5 Measure and record the outdoor dry bulb temperature when balancing of equipment noted above is performed.
- .7 Expansion Tanks
 - .1 Record the pressure set-point.
- .8 Emergency Generator Systems Balance Sheet
 - .1 Air Side:
 - .1 Adjust air flows to design.
 - .2 Measure air flows, static pressure drops.
 - .3 Measure and record discharge air temperature off radiator.
 - .2 Measure and record room and outdoor air temperature when generator is operational
 - .3 Record and record modulating damper temperature control set-point
- .9 Mechanical Rooms:
 - .1 Where gas-fired appliances are installed, operate on high fire, and measure and record:
 - .1 Combustion air volume entering room from outside

1.12 OTHER TAB REQUIREMENTS

- .1 General requirements applicable to work specified this paragraph:

- .1 Qualifications of TAB personnel: as for air systems specified this section.
- .2 Quality assurance: as for air systems specified this section.
- .2 Laboratory fume hoods:
 - .1 Standard: ASHRAE 110 – Method of Testing Performance of Laboratory Fume Hoods, and applicable provincial standard.
 - .2 TAB procedures: as described in Standard and to suit provincial requirements.
- .3 Building pressure conditions:
 - .1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions at all times.
 - .2 The final balanced condition of each area shall include testing and adjusting of building pressure conditions. Test, adjust and record building and zone pressurization levels. Check doors, exits, stairwells and other structural openings for proper sealing such that exterior conditions do not cause excessive or abnormal pressures. Document abnormal building leakage conditions noted and review remedial action with Mechanical and General Contractor. Coordinate activities with other trades.
 - .3 Achieve a positive building pressurization relative to outside conditions of 25 Pa to 35 Pa measured with negligible outside wind velocity, unless otherwise instructed.
 - .4 Achieve a positive room pressurization of 12 Pa to 25 Pa for all MCC Rooms, Electrical Rooms, Control Rooms and Server Rooms relative to adjacent rooms, measured with negligible outside wind velocity.
 - .5 Achieve a positive room pressurization of at least 25 Pa relative to adjacent rooms and areas where air contamination and/or hazardous conditions exist, under all operating conditions. Obtain a list of rooms from Department Representative where such conditions may exist. Comply with Canadian Electrical Code and applicable NFPA requirements.
 - .1 Example rooms of concern are:
 - .1 Laboratories.
 - .2 Chemical storage areas including rooms where chemicals are handled, dispensed and/or mixed and these chemicals constitute a hazard and/or nuisance odours.
 - .3 Janitorial.
 - .4 Maintenance areas including rooms where welding, millwrights, wood working, vehicle maintenance and/or storage, and painting activities may occur.
- .4 Zone pressure differences:
 - .1 Adjust HVAC systems, equipment, controls to establish specified air pressure differentials, with all systems in all possible combinations of normal operating modes.
- .5 Smoke management systems:
 - .1 Test for proper operation of all smoke and fire dampers, sensors, detectors, installed as component parts of air systems specified in other Divisions.

- .6 Measurement of noise and vibration from equipment specified in Mechanical Divisions.
 - .1 Standard: as applicable, Section 23 05 48 – Vibration and Seismic Controls for HVAC Pipe and Equipment.
 - .2 Vibration measurements around each piece of rotating equipment.
 - .3 Sound measurements in each octave band around each piece of rotating equipment.
 - .4 In-duct sound measurements in each octave band at each fan inlet and discharge.
 - .5 In-duct sound measurements in each octave band at each air handling unit intake, return and discharge.
 - .6 Sound measurements in each octave band for each normally occupied rooms with operational air handling equipment.
 - .7 Sound measurements in each octave band in room(s) and corridor(s) adjacent to Mechanical Rooms with rotating equipment.
 - .8 Sound measurements in each octave band in rooms(s) and corridor(s) directly below rooftop mounted rotating equipment.

1.13 POST-OCCUPANCY TAB

- .1 Measure DBT, WBT (or %RH), air velocity, air flow patterns, NC levels, in occupied zone of following areas designated by Department Representative.
- .2 Participate in systems checks twice during Warranty Period - #1 approximately three (3) months after acceptance and #2 within one (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 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 B209M, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
 - .2 ASTM C335, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
 - .3 ASTM C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C547, Standard Specification for Mineral Fiber Pipe Insulation.
 - .6 ASTM C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .7 ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .8 ASTM C795, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .9 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 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-36, Commercial Adhesives.
 - .5 Natural Resources Canada (NRC)

- .1 National Energy Code for Buildings (NECB).
- .6 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1168, Adhesive and Sealant Applications.
- .7 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
- .8 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.

1.2 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 Shop Drawings:
 - .1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.
- .4 Samples:
 - .1 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed.
 - .2 Mount sample on 12 mm plywood board.
 - .3 Affix typewritten label beneath sample indicating service.
- .5 Manufacturers' Instructions:
 - .1 Provide manufacture's written duct insulation jointing recommendations. and special handling criteria, installation sequence, and cleaning procedures].
 - .2 Installation instructions to include procedures used and installation standards achieved.

1.3 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installer: specialist certified in performing work of this section, and have at least five (5) years successful experience in this size and type of project, qualified to standards of TIAC.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 FIRE AND SMOKE RATING

- .1 To CAN/ULC-S102:
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

2.2 INSULATION

- .1 Mineral fibre: as specified including glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 °C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code C-1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).
- .4 TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to ASTM C553.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to ASTM C553.

2.3 JACKETS

- .1 Canvas:
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .2 Lagging adhesive: compatible with insulation.
 - .1 Maximum VOC limit: to SCAQMD Rule 1168, and GSES GS-36.
- .3 Aluminum:
 - .1 To ASTM B209 with moisture barrier as scheduled in PART 3 of this section.

- .2 Thickness: 0.40 mm sheet.
- .3 Finish: Stucco embossed or corrugated.
- .4 Jacket banding and mechanical seals: 12 mm wide, 0.5 mm thick stainless steel.
- .4 Stainless steel:
 - .1 Type: 304 or 316 where additional corrosion protection is required.
 - .2 Thickness: 0.25 mm sheet.
 - .3 Finish: Corrugated or Stucco embossed.
 - .4 Jacket banding and mechanical seals: 12 mm wide, 0.5 mm thick stainless steel.
- .5 .PVC:
 - .1 Type: ASTM D1785, sheet material, off-white color.
 - .2 Thickness: 0.25 mm sheet.
 - .3 PVC with Flame rating below 25 and a smoke development rating below 50
 - .4 Use if surfaces are subjected to minimal and light impact, abuse, or high humidity environments or as alternative to canvas jacket. For indoor use only.
 - .5 Apply with solvent weld adhesive to seal and lap joints, tacks, and/or pressure sensitive tape suitable for the application.

2.4 ACCESSORIES

- .1 Vapour retarder lap adhesive:
 - .1 Water based, fire retardant type, compatible with insulation.
- .2 Indoor Vapour Retarder Finish:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
- .4 ULC Listed Canvas Jacket:
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921. Outdoor Vapour Retarder Mastic:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
 - .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m².
- .6 Tape: self-adhesive, aluminum, reinforced, 75 mm wide minimum.
- .7 Tie wire: 1.5 mm stainless steel.
- .8 Contact adhesive: quick-setting
- .9 Canvas adhesive: washable.
- .10 Banding: 12 mm wide, 0.5 mm thick stainless steel.
- .11 Facing: 25 mm galvanized steel hexagonal wire mesh stitched on one face of insulation.
- .12 Fasteners: 4 mm diameter pins with 35 mm diameter or square 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:

Item	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts	C-1	yes	50
Round cold and dual temperature supply air ducts	C-2	yes	50
Rectangular warm air ducts	C-1	no	50
Round warm air ducts	C-1	no	50
Supply, return and exhaust ducts exposed in space being served	none		
Outside air ducts to mixing plenum	C-1	yes	50
Mixing plenums	C-1	yes	50
Exhaust duct between dampers and louvres	C-1	no	50
Rectangular ducts outside	C-1	special	50
Round ducts outside	C-1	special	50
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:

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

3.5 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American Society for Testing and Materials (ASTM):
 - .1 ASTM B209M-14, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.
 - .2 ASTM C335-05, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411-11, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M-13, Standard Specification for Mineral Fibre-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C533-13 Standard specification for Calcium Silicate Insulation Block and Pipe.
 - .6 ASTM C547-15 Standard Specification for Mineral Fibre Pipe Insulation.
 - .7 ASTM C795-13, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .8 ASTM C921-15, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
 - .9 ASTM D1784-11, Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- .2 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) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts.
- .3 Department of Justice Canada (Jus):
 - .1 Canadian Environmental Assessment Act (CEAA), c. 37.
 - .2 Canadian Environmental Protection Act, (CEPA), c. 33.
 - .3 Transportation of Dangerous Goods Act (TDGA), c. 34.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets.
- .5 Manufacturer's Trade Associations:
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
- .6 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.
- .7 National Energy Code of Canada for Buildings (NECB).

1.2 DEFINITIONS

- .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - will mean "not concealed" as specified.
- .2 TIAC ss:
 - .1 CRF: Code Rectangular Finish.
 - .2 CPF: Code Piping Finish.

1.3 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 35 43 - Environmental Procedures and Section 01 35 29.06 - Health and Safety Requirements.
- .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 to Department Representative.

1.4 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installer: certified in performing work of this Section, and have at least 5 years successful experience in this size and type of project, qualified to standards of TIAC.

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 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .3 Deliver materials to site in original factory packaging, labeled 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 Place excess or unused insulation and insulation accessory materials in designated containers.
 - .2 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.
 - .3 Dispose of unused adhesive material at official hazardous material collections site approved by Departmental Representative.

Part 2 Products

2.1 FIRE AND SMOKE RATING

- .1 In accordance with CAN/ULC-S102:
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

2.2 INSULATION

- .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket:
 - .1 Mineral fibre: to ASTM C547.
 - .2 Maximum "k" factor: to CAN/ULC-S702.
- .4 TIAC Code A-3: Rigid moulded mineral fibre with factory applied vapour retarder jacket:
 - .1 Mineral fibre: to CAN/ULC-S702 and ASTM C547.
 - .2 Jacket: to CGSB 51-GP-52Ma.

- .3 Maximum "k" factor: to CAN/ULC-S702.
- .5 TIAC Code C-2: Mineral fibre blanket faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section):
 - .1 Mineral fibre: to ASTM C547.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702.
- .6 TIAC Code A-6: Flexible unicellular tubular elastomer, preformed, vapour sealed, to CAN/CGSB-51.50:
 - .1 Insulation: with vapour retarder jacket to ASTM C534.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: $0.039 \text{ W/m} - ^\circ\text{C}$.
 - .4 To be certified by manufacturer to be free of potential stress corrosion cracking corrodants
 - .5 Flame spread index less than 25, and smoke developed index less than 50.
- .7 TIAC Code A-2: Rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements:
 - .1 Insulation: to ASTM C533.
 - .2 Maximum "k" factor: to $0.075 \text{ W/m } ^\circ\text{C} @ 500^\circ\text{C}$.
 - .3 Design to permit periodic removal and re-installation.
- .8 Non-TIAC Code P-1: polyurethane rigid insulation, preformed, vapour sealed, for buried applications:
 - .1 Material: formed polyurethane rigid insulation.
 - .2 "k" Value: $0.020 \text{ to } 0.026 \text{ W/m}^\circ\text{C}$ at 24°C .
 - .3 Service Temperature: 45°C to 85°C .
 - .4 Jacket: UV inhibited high density polyethylene (HDPE) "yellow" jacket, specially formulated for cold weather resistance, 1.27 mm thickness.
 - .5 Pipe insulation shall be suitable to accept heat trace cabling, where required.

2.3 INSULATION SECUREMENT

- .1 Tape: Self-adhesive, aluminum, plain reinforced, 50 mm wide minimum.
- .2 Contact adhesive: Quick setting.
- .3 Canvas adhesive: Washable.
- .4 Tie wire: 1.5 mm diameter stainless steel.
- .5 Bands: Stainless steel, 19 mm wide, 0.5 mm thick.

2.4 CEMENT

- .1 Thermal insulating and finishing cement:
 - .1 Hydraulic setting or air drying on mineral wool, to ASTM C449/C449M.

2.5 VAPOUR RETARDER LAP ADHESIVE

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

2.6 INDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation.

2.7 OUTDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation.
- .2 Reinforcing fabric: fibrous glass, untreated 305 g/m².

2.8 JACKETS

- .1 Polyvinyl Chloride (PVC):
 - .1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.
 - .2 Colours: to match adjacent finish paint. Confirm colour with Departmental Representative.
 - .3 Minimum service temperatures: -20°C.
 - .4 Maximum service temperature: 65°C.
 - .5 Moisture vapour transmission: 0.02 perm.
 - .6 Thickness: 0.55 mm.
 - .7 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.
 - .8 Special requirements:
 - .1 Indoor: flame spread rating 25, smoke developed rating 50.
 - .2 Outdoor: UV rated material at least 0.5 mm thick.
- .2 Canvas:
 - .1 To be 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
 - .2 Lagging adhesive: Compatible with insulation.
- .3 Aluminum:
 - .1 To ASTM B209.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: Embossed or corrugated.
 - .4 Joining: Longitudinal and circumferential slip joints with 50 mm laps.
 - .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.

- .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.
- .4 Stainless steel:
 - .1 Type: 304 or type 316.
 - .2 Thickness: 0.25 mm.
 - .3 Finish: Smooth.
 - .4 Joining: Longitudinal and circumferential slip joints with 50 mm laps.
 - .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
 - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

2.9 WEATHERPROOF CAULKING FOR JACKETS INSTALLED OUTDOORS

- .1 Caulking to: Section 07 92 00 - Joint Sealing.

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 expansion joints, valves, primary flow measuring elements, flanges and unions at equipment.
- .2 Design: to permit movement of expansion joint, to permit periodic removal and replacement without damage to adjacent insulation.
- .3 Insulation:
 - .1 Insulation, fastenings and finishes: same as system.
 - .2 Jacket: to match pipe insulation jacket. PVC to be used instead of canvas.

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-1:
 - .1 Securements: SS bands at 300 mm on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code 1501-H.
- .3 TIAC Code: A-2:
 - .1 Insulation securements: SS bands at 300 mm on centre. oc.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code: 1501-H.
- .4 TIAC Code: A-3:
 - .1 Securements: SS bands at 300 mm on centre.
 - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .5 TIAC Code: A-6:
 - .1 Insulation securements: SS Bands at 300 mm oc.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: CANCGSB-51.40.
- .6 TIAC Code: C-2 with vapour retarder jacket:
 - .1 Insulation securements: SS bands at 300 mm oc.
 - .2 Seals: lap seal adhesive, lagging adhesive.

- .3 Installation: TIAC Code: 1501-C.
- .7 Thickness of insulation as listed in following table.
 - .1 Run-outs to individual units and equipment not exceeding 4000 mm long.
 - .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp °C	TIAC Code	Pipe Sizes (NPS) and Insulation Thickness (mm)					
			Run- out	to 1	1 ^{1/4} to 2	2 ^{1/2} to 4	5 to 6	8 & over
Steam, Saturated & Super Heated	over 175	A-1	38	65	65	75	90	90
Steam	up to 175	A-1	38	50	65	75	90	90
Condensate Return	60 - 94	A-1	25	25	25	38	38	38
Pumped Condensate Return	up to 94	A-1	25	25	25	38	38	38
Boiler Feed Water		A-1	25	25	25	25	25	25
Hot Water Heating	60 - 94	A-1	25	25	25	38	38	38
Hot Water Heating	up to 59	A-1	25	25	25	25	38	38
Glycol Heating	60 - 94	A-1	25	25	25	38	38	38
Glycol Heating	up to 59	A-1	25	25	25	25	38	38
Domestic HWS		A-1	25	25	25	38	38	38
Chilled Water	5- 13	A-3	25	25	25	25	25	25
Chilled Water or Glycol	below 5	A-3	25	25	38	38	38	38
Refrigerated Drinking Water		A-3	25	25	25	25	25	25
Domestic CWS		A-3	25	25	25	25	25	25
Domestic CWS with Vapour Retarder		C-2	25	25	25	25	25	25
Refrigerant	5- 13	A-6	25	25	25	25	25	25
Refrigerant [hot gas] [liquid] [suction]	below 5	A-6	25	25	38	38	38	38
RWL and RWP		C-2	25	25	25	25	25	25
Cooling Coil Cond. Drain		C-2	25	25	25	25	25	25
Diesel Generator Exhaust System		A-2	38	65	65	75	90	90

- .8 Finishes:
 - .1 Exposed indoors: aluminum or PVC jacket.
 - .2 Exposed in mechanical rooms: aluminum or PVC jacket.
 - .3 Concealed, indoors: canvas on valves, fittings. No further finish.
 - .4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.
 - .5 Outdoors: water-proof aluminum jacket.
 - .6 Finish attachments: SS bands, at 150 mm on centre. Seals: closed.
 - .7 Installation: to appropriate TIAC code CRF/1 through CPF/5.

3.7 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 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

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

1.2 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)

- .1 Perform hydronic systems performance verification after cleaning is completed and system is in full operation.
- .2 When systems are operational, perform following tests:
 - .1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.
 - .2 Verify performance of hydronic system circulating pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.
 - .1 Pump operation.
 - .2 Boiler and/or chiller operation.
 - .3 Pressure bypass open/closed.
 - .4 Control pressure failure.
 - .5 Maximum heating demand.
 - .6 Maximum cooling demand.
 - .7 Boiler and/or chiller failure.
 - .8 Cooling tower (and/or industrial fluid cooler) fan failure.
 - .9 Outdoor reset. Re-check heat exchanger output supply temperature at 100% and 50% reset, maximum water temperature.

1.3 HYDRONIC SYSTEM CAPACITY TEST

- .1 Perform hydronic system capacity tests after:
 - .1 TAB has been completed
 - .2 Verification of operating, limit, safety controls.
 - .3 Verification of primary and secondary pump flow rates.
 - .4 Verification of accuracy of temperature and pressure sensors and gauges.
- .2 Calculate system capacity at test conditions.
- .3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.
- .4 When capacity test is completed, return controls and equipment status to normal operating conditions.

- .5 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.
- .6 Heating system capacity test:
 - .1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:
 - .1 Increasing OA flow rates through heating coils (in this case, monitor heating coil discharge temperatures to ensure that coils are not subjected to freezing conditions) or
 - .2 Reducing space temperature by turning of heating system for sufficient period of time before starting testing.
 - .2 Test procedures:
 - .1 Open fully heat exchanger, heating coil and radiation control valves.
 - .2 With boilers on full firing and hot water heating supply temperature stabilized, record flow rates and supply and return temperatures simultaneously.
 - .3 Conduct flue gas analysis test on boilers at full load and at low fire conditions.

1.4 CONDENSER WATER AND HUMIDIFICATION SYSTEMS

- .1 In addition to procedures specified above, perform following:
 - .1 Add chemicals once per week as required.
 - .2 Perform TAB as specified Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .3 Set up and adjust drip feeders, timer controls, pump strokes as required to maintain required chemical feed rates.
 - .4 Inject inhibitor into cooling tower sump.

1.5 GLYCOL SYSTEMS

- .1 Test to prove concentration will prevent freezing to minus 40 degrees C Test inhibitor strength and include in procedural report. Refer to ASTM E202.

1.6 POTABLE WATER SYSTEMS

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

1.7 SANITARY AND STORM DRAINAGE SYSTEMS

- .1 Buried systems: perform tests prior to backfilling. Perform hydraulic tests to verify grades and freedom from obstructions.
- .2 Ensure that traps are fully and permanently primed.
- .3 Ensure that fixtures are properly anchored, connected to system.
- .4 Operate flush valves, tank and operate each fixture to verify drainage and no leakage.

1.8 REPORTS

- .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Reports, supplemented as specified herein.

1.9 TRAINING

- .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O&M Personnel, supplemented as specified herein.

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 REFERENCE STANDARDS

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.2 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 following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

1.3 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 CLEANING SOLUTIONS

- .1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.
- .2 Sodium carbonate: 0.40 kg per 100 L water in system.
- .3 Low-foaming detergent: 0.01 kg per 100 L water in system.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 CLEANING HYDRONIC AND STEAM SYSTEMS

- .1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
- .2 Cleaning Agency:
 - .1 Retain qualified water treatment specialist to perform system cleaning.
- .3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.
- .4 Cleaning procedures:
 - .1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:
 - .1 Cleaning procedures, flow rates, elapsed time.
 - .2 Chemicals and concentrations used.
 - .3 Inhibitors and concentrations.
 - .4 Specific requirements for completion of work.
 - .5 Special precautions for protecting piping system materials and components.
 - .6 Complete analysis of water used to ensure water will not damage systems or equipment.
- .5 Conditions at time of cleaning of systems:
 - .1 Systems: free from construction debris, dirt and other foreign material.
 - .2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.
 - .3 Strainers: clean prior to initial fill.
 - .4 Install temporary filters on pumps not equipped with permanent filters.
 - .5 Install pressure gauges on strainers to detect plugging.

- .6 Report on Completion of Cleaning:
 - .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.
- .7 Hydronic Systems:
 - .1 Fill system with water, ensure air is vented from system.
 - .2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).
 - .3 Use water metre to record volume of water in system to +/- 0.5%.
 - .4 Add chemicals under direct supervision of chemical treatment supplier.
 - .5 Closed loop systems: circulate system cleaner at 60 degrees C for at least 36 hours. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.
 - .6 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.
 - .7 Add chemical solution to system.
 - .8 Establish circulation, raise temperature slowly to 82 degrees C minimum maximum design. Circulate for 12 hours, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 hours at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).
- .8 Glycol Systems:
 - .1 In addition to procedures specified above perform specified procedures.
 - .2 Test to prove concentration will prevent freezing to minus 40 degrees C. Test inhibitor strength and include in procedural report. Refer to ASTM E202.

3.3 START-UP OF HYDRONIC SYSTEMS

- .1 After cleaning is completed and system is filled:
 - .1 Establish circulation and expansion tank level, set pressure controls.
 - .2 Ensure air is removed.
 - .3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
 - .4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.
 - .5 Clean out strainers repeatedly until system is clean.
 - .6 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.
 - .7 Repeat with water at design temperature.
 - .8 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.

- .9 Bring system up to design temperature and pressure slowly over a 48-hour period.
- .10 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .11 Adjust pipe supports, hangers, springs as necessary.
- .12 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
- .13 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.
- .14 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
- .15 Check operation of drain valves.
- .16 Adjust valve stem packings as systems settle down.
- .17 Fully open balancing valves (except those that are factory-set).
- .18 Check operation of over-temperature protection devices on circulating pumps.
- .19 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

3.4 FIELD QUALITY CONTROL

- .1 Verification requirements in accordance with Section 01 45 00 – Quality Control, 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.

3.5 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Approved: 2005-06-30

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.5, Pipe Flanges and Flanged Fittings.
 - .2 ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
 - .3 ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
 - .4 ASME B18.2.1, Square and Hex Bolts and Screws Inch Series.
- .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 ASTM B75M, Standard Specification for Seamless Copper Tube.
 - .4 ASTM B837, Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA W47.1, Certification of Companies for Fusion Welding of Steel.
- .4 Canadian Standards Association (CSA)/Canadian Gas Association (CGA)
 - .1 CAN/CSA B149.1HB, Natural Gas and Propane Installation Code Handbook.
 - .2 CAN/CSA B149.2, Propane Storage and Handling Code.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.2 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 for piping, fittings and equipment.
 - .2 Indicate on manufacturers catalogue literature following: valves.
 - .3 Submit WHMIS Material Safety Data Sheets in accordance with Section 01 35 43 - Environmental Procedures and Section 01 35 29.06 - Health and Safety Procedures. Indicate VOCs for adhesive and solvents during application and curing.
- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Instructions: submit manufacturer's installation instructions.
- .6 Closeout Submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.3 QUALITY ASSURANCE

- .1 Pre-Installation Meeting:
 - .1 Convene pre-installation meeting one week prior to beginning work of this Section in accordance with Section 01 32 16.07 - Construction Progress Schedules - Bar (GANTT) Chart.
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

- .1 Materials and products in accordance with Section 01 61 00 – Common Product Requirements.

2.2 PIPE

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

- .1 NPS 1/2 to 2, screwed.
- .2 NPS 2 1/2 and over, plain end.
- .2 Copper tube: to ASTM B837.

2.3 JOINTING MATERIAL

- .1 Screwed fittings: pulverized lead paste.
- .2 Welded fittings: to CSA W47.1.
- .3 Flange gaskets: nonmetallic flat.
- .4 Brazing: to ASTM B837.

2.4 FITTINGS

- .1 Steel pipe fittings, screwed, flanged or welded:
 - .1 Malleable iron: screwed, banded, Class 150.
 - .2 Steel pipe flanges and flanged fittings: to ASME B16.5.
 - .3 Welding: butt-welding fittings.
 - .4 Unions: malleable iron, brass to iron, ground seat, to ASTM A47/A47M.
 - .5 Bolts and nuts: to ASME B18.2.1.
 - .6 Nipples: schedule 40, to ASTM A53/A53M.
- .2 Copper pipe fittings, screwed, flanged or soldered:
 - .1 Cast copper fittings: to ASME B16.18.
 - .2 Wrought copper fittings: to ASME B16.22.

2.5 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, CAN/CSA B149.2, applicable Provincial/Territorial Codes, CAN/CSA B149.1, supplemented as specified.
- .2 Install drip points:
 - .1 At low points in piping system.
 - .2 At connections to equipment.

3.3 VALVES

- .1 Install valves with stems upright or horizontal unless otherwise approved Departmental Representative.
- .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 After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.
 - .2 Twice during progress of work at 25% and 60% complete.
 - .3 Upon completion of work, after cleaning is carried out.
- .3 Obtain reports within 3 days of review and submit immediately to Departmental Representative.
- .4 Verification requirements in accordance with Section 01 45 00 – Quality Control, 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 Performance Verification:
 - .1 Refer to Section 23 08 01 - Performance Verification of Mechanical Piping Systems.
- .6 PV procedures:
 - .1 Test performance of components.

3.5 ADJUSTING

- .1 Purging: purge after pressure test in accordance with CAN/CSA B149.2, 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 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 ASME
 - .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII.
- .2 ASTM International
 - .1 ASTM A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A278/A278M, Standard Specification for Grey Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (350 degrees C).
 - .3 ASTM A516/A516M, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
 - .4 ASTM A536, Standard Specification for Ductile Iron Castings.
 - .5 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .3 CSA Group
 - .1 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.

1.2 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 expansion tanks, air vents, separators, valves, and strainers and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic specialties for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 AUTOMATIC AIR VENT

- .1 Standard float vent: brass body and NPS 1/8 connection and rated at 1000 kPa working pressure.
- .2 Industrial float vent: ASTM A48 Class 30 cast iron body and NPS 1/2 connection and rated at minimum 860 kPa working pressure.
- .3 Float: solid material suitable for 115°C working temperature.

2.2 AIR SEPARATOR - EXPANSION TANK FITTING

- .1 Complete with adjustable vent tube and built-in manual vent valve.
- .2 Working pressure: 860 kPa.

2.3 AIR SEPARATOR - IN-LINE

- .1 Working pressure: 860 kPa.
- .2 Size: for 0.15 m/s
- .3 Shell: steel to ASME BPVC Section VIII.
- .4 Removable stainless steel collection tube.

2.4 COMBINATION SEPARATORS/STRAINERS

- .1 Steel, tested and stamped in accordance with ANSI/ASME BPVC, for 860 kPa operating pressure, with stainless steel integral strainer with 5 mm perforations, tangential inlet and outlet connections, and internal stainless steel air collector tube.

2.5 COMBINATION LOW PRESSURE RELIEF AND REDUCING VALVE

- .1 Adjustable pressure setting: 206 kPa relief, 55 to 172 kPa reducing or as indicated.
- .2 Low inlet pressure check valve.
- .3 Removable strainer.

2.6 PIPE LINE STRAINER

- .1 NPS 1/2 to 2: 1.7 MPa steam non-shock bronze body to ASTM B62, screwed or grooved connections, Y pattern.
- .2 NPS 2 1/2 to 12: Class 150 cast steel body to ASTM A216 GR.WCB or cast iron body Class 125 to ASTM-A48, Class 30, flanged connections.
- .3 NPS 2 to 12: T type 2.1 MPa with ductile iron body to ASTM A536 or malleable iron body to ASTM A47M, grooved ends.
- .4 Blowdown connection: NPS 1.

- .5 Screen: stainless steel with 1.19 mm perforations.
- .6 Working pressure: 860 kPa.

2.7 SUCTION DIFFUSER

- .1 Body: cast iron with flanged or grooved ductile iron connections 2.1 MPa.
- .2 Strainer: with built-in, disposable 1.19 mm mesh, start-up strainer, low pressure drop screen and NPS 1 blowdown connection.
- .3 Permanent magnet particle trap.
- .4 Full length straightening vanes.
- .5 Pressure gauge tapings.
- .6 Adjustable support leg.

2.8 Triple Duty Valve

- .1 Center-guided non-slam drip tight check valve.
- .2 Positive shut-off valve.
- .3 Calibrated system balance valve.
- .4 Straight pattern as indicated.
- .5 Flanged or Grooved end connections.
- .6 Soft seat design for positive sealing.
- .7 Construction:
 - .1 Body: cast iron with bronze seat.
 - .2 Disc: bronze with EPDM seat insert.
 - .3 Stem: stainless steel.
 - .4 Spring: stainless steel.
 - .5 Packing: Teflon-Graphite (Asbestos-free).
 - .6 Gasket: asbestos-free.
 - .7 Readout valve: brass with EPT insert, check valve and gasket.
- .8 Maximum operating temperature: 121°C.
- .9 Maximum working pressure: 1.2 MPa.
- .10 Valve design shall permit repacking under full system pressure.
- .11 Provide complete with brass readout valves, with integral check feature, to facilitate taking differential pressure readings across the orifice for accurate system balance.
- .12 Provide CV rating at 10% increments. Manufacturer shall supply the CV rating for read-out of flow determination and system pressure drop.
- .13 Capacity: see schedule on drawings for performance criteria and model selections.

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 material installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 APPLICATION

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

3.3 GENERAL

- .1 Run drain lines [and blow off connections] to terminate above nearest drain.
- .2 Maintain adequate clearance to permit service and maintenance.
- .3 Should deviations beyond allowable clearances arise, request and follow Departmental Representative's directive.
- .4 Check shop drawings for conformance of tappings for ancillaries and for equipment operating weights.

3.4 STRAINERS

- .1 Install in horizontal or down flow lines.
- .2 Ensure clearance for removal of basket.
- .3 Install ahead of each pump.
- .4 Install ahead of each automatic control valve larger than NPS 1 and radiation and as directed.
- .5 Clean Strainers upon completion of start-up.

3.5 AIR VENTS

- .1 Install at high points of systems.
- .2 Install gate valve on automatic air vent inlet. Run discharge to nearest drain or service sink or funnel floor drain.

3.6 EXPANSION TANKS

- .1 Adjust expansion tank pressure to suit design criteria.

- .2 Install lockshield type valve at inlet to tank.

3.7 PRESSURE SAFETY RELIEF VALVES

- .1 Run discharge pipe to terminate above nearest drain.

3.8 SUCTION DIFFUSERS

- .1 Install on inlet to pumps having suction size greater than 50.

3.9 Performance Verification

- .1 In accordance with Section 23 08 01 - Performance Verification of Mechanical Piping Systems, supplemented as specified herein.
- .2 Provide copies of test reports for Commissioning Manuals.

3.10 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IES Standard 90.1-[2010], Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 CSA Group
 - .1 CAN/CSA-B214-[12], Installation Code for Hydronic Heating Systems.
- .3 Electrical Equipment Manufacturers Association of Canada (EEMAC)
- .4 National Electrical Manufacturers' Association (NEMA)
 - .1 NEMA MG 1-[2011], Motors and Generators.

1.2 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 pump, circulator, and equipment and include product characteristics, performance criteria, physical size, finish and limitations indicate point of operation, and final location in field assembly.
- .3 Shop Drawings:
 - .1 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic pumps for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.

- .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 EQUIPMENT

- .1 Refer to Equipment schedule on drawings.

2.1 IN-LINE CIRCULATORS

- .1 Volute: cast iron radially split, with screwed or flanged design suction and discharge connections.
- .2 Impeller: alloy steel, cast bronze, or cast iron to suit application.
- .3 Shaft: stainless steel with bronze sleeve bearing, integral thrust collar.
- .4 Seal assembly: mechanical for service to 135 °C.
- .5 Coupling: flexible self-aligning.
- .6 Motor: as per Section 23 05 13 – Common Motor Requirements for HVAC Equipment and as per manufacturer's recommendations. Speed and power as indicated in the pump schedule.
- .7 Capacity: as indicated in the pump schedule.
- .8 Design pressure: 1200 kPa.

2.2 VERTICAL IN-LINE CIRCULATORS

- .1 Volute: cast iron radially split, with tapped openings for venting, draining and gauge connections, with screwed or flanged suction and discharge connections.
- .2 Impeller: bronze, cast iron, stainless steel dynamically balanced.
- .3 Shaft: stainless steel with bronze sleeve bearing, integral thrust collar.
- .4 Seal assembly: outside balanced, mechanical for service to 135 °C. Flush line fittings to include 50 micron filter and sight flow indicator, if pump differential exceeds 200 kPa replace filter with cyclone type separator.
- .5 Coupling: flexible self-aligning.
- .6 Motor: NEMA base, drip proof, ball bearing as per Section 23 05 13 – Common Motor Requirements for HVAC Equipment, speed and power as indicated in pump schedule.
- .7 Capacity: as indicated in pump schedule.
- .8 Design pressure: 1200 kPa.

2.3 SINGLE SUCTION CENTRIFUGAL PUMP

- .1 General: all iron pump complete with motor.

- .2 Base: common cast iron or fabricated steel with drip rim and tapping for drain connection.
- .3 Volute: cast iron radially split, back pull out end suction, screwed or flanged suction and discharge, with drain plug and vent cock, suction and discharge pressure gauge tappings.
- .4 Impeller: cast iron or stainless steel enclosed type, keyed drive with locking nut or screw, dynamically balanced.
- .5 Shaft: stainless steel with two-point support for ball bearing mounting hardened wear rings at packing gland.
- .6 Seal assembly: mechanical seal, oil or grease lubricated. On open system, flush line with 50 micron filter and site flow indicator. When differential exceeds 200 kPa use cyclone type separator.
- .7 Coupling: flexible self-aligning complete with coupling guard.
- .8 Motor: NEMA Class B, squirrel cage induction, premium efficiency continuous duty, drip proof, ball bearing, maximum temperature rise 50 °C, as per Section 23 05 13 - Common Motor Requirements for HVAC Equipment , speed and power as indicated in pump schedule.
- .9 Capacity: as indicated in pump schedule.
- .10 Design pressure: 1200 kPa.

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 material installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 APPLICATION

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

3.3 INSTALLATION

- .1 Install hydronic pumps to: [CAN/CSA-B214].
- .2 In line circulators: install as indicated by flow arrows.
 - .1 Support at inlet and outlet flanges or unions.

- .2 Install with bearing lubrication points accessible.
- .3 Base mounted type: supply templates for anchor bolt placement.
 - .1 Include anchor bolts with sleeves. Place level, shim unit and grout.
 - .2 Align coupling in accordance with manufacturer's recommended tolerance.
 - .3 Check oil level and lubricate. After run-in, tighten glands.
- .4 Ensure that pump body does not support piping or equipment.
 - .1 Provide stanchions or hangers for this purpose.
 - .2 Refer to manufacturer's installation instructions for details.
- .5 Pipe drain tapping to floor drain.
- .6 Install volute venting pet cock in accessible location.
- .7 Check rotation prior to start-up.
- .8 Install pressure gauge test cocks.

3.4 START-UP

- .1 General:
 - .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements; supplemented as specified herein.
 - .2 In accordance with manufacturer's recommendations.
- .2 Procedures:
 - .1 Before starting pump, check that cooling water system over-temperature and other protective devices are installed and operative.
 - .2 After starting pump, check for proper, safe operation.
 - .3 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.
 - .4 Check base for free-floating, no obstructions under base.
 - .5 Run-in pumps for 12 continuous hours minimum.
 - .6 Verify operation of over-temperature and other protective devices under low- and no-flow condition.
 - .7 Eliminate air from scroll casing.
 - .8 Adjust water flow rate through water-cooled bearings.
 - .9 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.
 - .10 Adjust alignment of piping and conduit to ensure true flexibility.
 - .11 Eliminate cavitation, flashing and air entrainment.
 - .12 Adjust pump shaft seals, stuffing boxes, glands.
 - .13 Measure pressure drop across strainer when clean and with flow rates as finally set.
 - .14 Replace seals if pump used to degrease system or if pump used for temporary heat.

- .15 Verify lubricating oil levels.

3.5 PERFORMANCE VERIFICATION (PV)

- .1 General:
 - .1 Verify performance in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified herein.
 - .2 Verify that manufacturer's performance curves are accurate.
 - .3 Ensure valves on pump suction and discharge provide tight shut-off.
 - .4 Net Positive Suction Head (NPSH):
 - .1 Application: measure NPSH for pumps which operate on open systems and with water at elevated temperatures.
 - .2 Measure using procedures prescribed in Section 01 91 13 - General Commissioning (Cx) Requirements.
 - .3 Where procedures do not exist, discontinue PV, report to Departmental Representative and await instructions.
 - .5 Multiple Pump Installations - Series and Parallel:
 - .1 Repeat PV procedures specified above for pump performance and pump BHP for combinations of pump operations.
 - .6 Mark points of design and actual performance at design conditions as finally set upon completion of TAB.
 - .7 Commissioning Reports: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements reports supplemented as specified herein. Reports to include:
 - .1 Record of points of actual performance at maximum and minimum conditions and for single and parallel operation as finally set at completion of commissioning on pump curves.
 - .2 Use Report Forms specified in Section 01 91 13 - General Commissioning (Cx) Requirements: Report Forms and Schematics.
 - .3 Pump performance curves (family of curves).

3.6 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 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, 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 ASTM International
 - .1 ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, and Threaded Rod 60,000 PSI Tensile Strength.
 - .2 ASTM B280, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- .3 CSA Group
 - .1 CSA B52, B52 Package, Mechanical Refrigeration Code.
- .4 Canada Federal Halocarbon Regulations, 2003
- .5 Canadian Correctional Service Canada
 - .1 Internal Service Directive (ISD) 318-4 – Environmental Management of Halocarbons
- .6 Environment Canada (EC)
 - .1 Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems. (2015)

1.2 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-installation Meetings:
 - .1 Convene pre-installation meeting 1 week prior to beginning work of this Section, with Departmental Representative in accordance with Section 01 31 19 - Project Meetings to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building construction subtrades.
 - .4 Review manufacturer's written installation instructions and warranty requirements.

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 refrigerant piping, fittings and equipment and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 43 - Environmental Procedures and Section 01 35 29.06 - Health and Safety Requirements. Indicate VOCs for adhesive and solvents during application and curing.
- .3 Complete the forms noted within CSC ISD 318-4.
- .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.

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 refrigerant equipment for incorporation into manual.
- .3 Submit the form for Halocarbon tracking per the CSC ISD 318-4.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 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.

2.2 FITTINGS

- .1 Service: design pressure 4275 kPa and temperature 121 degrees C.
- .2 Brazed:
 - .1 Fittings: wrought copper to ASME B16.22.
 - .2 Joints: silver solder, 45% Ag - 80% Cu - 5% P and non-corrosive flux for copper to steel or brass; Silfoss-15 for copper to copper.
- .3 Flanged:
 - .1 Bronze or brass, to ASME B16.24, Class 150 and Class 300.
 - .2 Gaskets: suitable for service.
 - .3 Bolts, nuts and washers: to ASTM A307, heavy series.
- .4 Flared:
 - .1 Bronze or brass, for refrigeration, to ASME B16.26.

2.3 PIPE SLEEVES

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

2.4 VALVES

- .1 22 mm and under: Class 500, 3.5 Mpa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moisture proof seal for below freezing applications, brazed connections.
- .2 Over 22 mm: Class 375, 2.5 Mpa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and bonnet, moisture proof seal for below freezing applications, brazed connections.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for material installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 GENERAL

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

3.4 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.

3.5 PIPING INSTALLATION

- .1 General:
 - .1 Hard drawn copper tubing: do not bend. Minimize use of fittings Soft annealed copper tubing: bend without crimping or constriction.
- .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 m³/s at minimum load. Connect upstream of traps on large riser.

3.6 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 2 MPa and 1 MPa 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.

3.7 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 5 Pa 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 hours.
 - .2 Break vacuum with refrigerant to 14 kPa.
 - .3 Final to 5 Pa absolute and hold for at least 12 hours.
 - .4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.
 - .5 Submit test results to Departmental Representative.
- .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.
 - .2 Record and report measurements to Departmental Representative.
- .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 product[s] 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 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.

- .3 Upon completion of the Work, after cleaning is carried out.
- .4 Obtain reports, within 3 days of review, and submit, immediately, to Departmental Representative.

3.8 DEMONSTRATION

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

3.9 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION



INTERNAL SERVICES DIRECTIVE 318-4

In Effect: 2015-01-05

Last Review: 2015-01-05

Due for Review: 2017-01-05

Environmental Management of Halocarbons

PROGRAM ALIGNMENT

Internal Services

OFFICE(S) OF PRIMARY INTEREST

Corporate Services Sector

ONLINE @

- <http://infonet/cds/cds/318-4-isd-eng.pdf>
- <http://infonet/cds/cds/318-4-isd-fra.pdf>
- <http://www.csc-scc.gc.ca/acts-and-regulations/318-4-isd-eng.shtml>
- <http://www.csc-scc.gc.ca/lois-et-reglements/318-4-isd-fra.shtml>

AUTHORITIES

- *Canadian Environmental Protection Act*, 1999
- *Federal Halocarbon Regulations*, 2003
- *Ozone-Depleting Substances Regulations*, 1998
- *Environmental Code of Practice for Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems*, 1996
- *Canada's Strategy to Accelerate the Phase-Out of CFC and Halons Uses and to Dispose of the Surplus Stocks*, CCME, 2001

PURPOSE

- To protect the stratospheric ozone layer
- To prevent halocarbon emissions originating from federal installations on federal lands
- To formalize practices regarding the management of halocarbons in order to ensure compliance with federal and, where applicable, provincial regulatory requirements

APPLICATION

All Correctional Service of Canada (CSC) facilities that manage, internally or through external contractors, chillers, refrigeration and/or air-conditioning systems containing halocarbons

CONTENTS

SECTIONS

1 – 3

[Responsibilities](#)

4 – 6

[Procedures](#)

4 – 6	Prohibitions
7 – 18	Requirements
7 – 12	Installation, Servicing, Leak Testing and Charging
13 – 15	Recovery
16 – 17	Requirements for Small Systems
18	Phase-Out of Halocarbons Listed in Any Items 1 to 9 of Schedule 1
19 – 25	Reporting
19 – 21	Records
22 – 23	Release Reports
24 – 25	Inventory
26	Training
27	Enquiries
Annex A	Cross-References and Definitions
Annex B	List of Halocarbons
Annex C	Inventory Information for Chillers, Refrigeration and Air-Conditioning Systems

Note: The Environment Canada's *Federal Halocarbon Regulations*, 2003 (referred to as the "Regulations" henceforward) will in all cases take precedence over this directive. Institutions should always refer to the Regulations for detailed clarification on specific halocarbons management issues pertaining to applicability, scope, and required technical specifications.

RESPONSIBILITIES

1. The Institutional Head and his/her delegates will be accountable to ensure compliance with the provisions of this directive.
2. The Environmental Officer will assist in meeting compliance with the requirements of the Regulations by advising on implementation aspects.

3. The Chief, Facility Management, and his/her delegates will be responsible for informing all external contractors that are hired to work on institutional [chillers](#), [refrigeration systems](#) and [air-conditioning systems](#) of the requirements set out in this directive.

PROCEDURES

Prohibitions

4. No person will release or allow or cause the release of a [halocarbon](#) that is contained in a refrigeration system, an air-conditioning system or any associated container or device (see [section 2.9 of the Refrigerant Code of Practice](#)).
5. No person will store, transport or purchase a halocarbon unless it is in a container designed and manufactured to be refilled and to contain that specific type of halocarbon.
6. As of January 1, 2015, no person will operate or permit the operation of any chiller that contains a halocarbon listed in any of [items 1 to 9 of Schedule 1](#).

REQUIREMENTS

Installation, Servicing, Leak Testing and Charging

7. Only a [certified person](#), as defined by the Regulations, may install, [service](#), [leak](#) test or [charge](#) a halocarbon to a refrigeration or air-conditioning system or do any other work on the [system](#) that may result in the release of a halocarbon. A person who does any of the work referred above must do it in accordance with the [Refrigerant Code of Practice](#). When installing a new system, the certified person must complete form [CSC/SCC 1265-01f](#) upon commissioning.
8. Any person who repairs or decommissions an apparatus that contains a halocarbon must be certified, as defined by the Regulations, and properly equipped in case the procedure causes the halocarbon to be released. The certified person must be appropriately equipped in accordance with the [Refrigerant Code of Practice](#) when assigned to leak test, repair, or decommission the parts of any apparatus that contain halocarbons.
9. For each system with a capacity over 19 kilowatts or 5.4 tons (or 64 828 BTU/hr), the Chief, Facility Management, will arrange for a certified person to conduct a leak test at least once every 12 months (on or before the exact date of the previous leak test), of all the components of a refrigeration or air-conditioning system that come into contact with a halocarbon, and confirm that the system meets all current design criteria and that the [installation](#) is equipped with halocarbon leak sensors if required by regulation (see [section 2.6.6 of the Refrigerant Code of Practice](#)).
10. A certified person who repairs and/or conducts a leak test on a refrigeration or air-conditioning system must place a permanent notice (label) on the system containing the information set out in form [CSC/SCC 1265-01c](#). In addition:
 - a. no person will remove this notice except to replace it with another such notice
 - b. the [owner](#) will keep a record of the information contained in the notice in the refrigeration and air-conditioning system [service log](#) (see [section 2.7.4 of the Refrigerant Code of Practice](#)).

11. No person will charge a refrigeration or air-conditioning system unless the system has been leak tested before charging and any leak has been repaired.
12. If a halocarbon leak is detected at any time, the assigned responsible person must, through the service of a certified person:
 - a. immediately repair the leaking portion of the system, or
 - b. if repairs are not likely to be initiated within seven days, immediately isolate the leaking portion of the system and [recover](#) the halocarbons from the leaking portion of the system pending repair of the leak in accordance with approved practices in this field.

Recovery

13. A certified person that installs, services, leak tests or charges a halocarbon to a refrigeration or air-conditioning system, or that does any other work on any of those systems that may result in the release of a halocarbon, must recover, into an [appropriate container](#), any halocarbon that would otherwise be released during those procedures (see [sections 2.10 and 3.5 of the Refrigerant Code of Practice](#)).
14. Before dismantling, [decommissioning](#) or disposing of any system, measures must be taken as listed below:
 - a. recover halocarbons into an appropriate container and dispose of as hazardous waste (see [sections 2.9 and 3.4 to 3.8 of the Refrigerant Code of Practice](#))
 - b. place a notice (label) on the system containing the information set out in form [CSC/SCC 1265-01d](#) (it is prohibited to remove this notice except to replace it with another such notice)
 - c. once the decommissioning is completed, ensure that the dismantled system can never be reused.
15. In case of the dismantling, disposing or decommissioning of any system, a record of the information contained in this notice (label) must be kept on site in the service log (see form [CSC/SCC 1265-01e](#)).

Requirements for Small Systems

16. When dismantling, disposing or decommissioning of equipment that contains a small air-conditioning or refrigeration system (i.e. with a refrigeration capacity of less than 19 kilowatts or 5.4 tons [or 64 828 BTU/hr]), the parts of the apparatus that contain halocarbon must be decommissioned before disposal. However, when selling or transferring used equipment containing a small system that a new owner is expected to continue to operate, it is not necessary to decommission the small system unless it leaks while in CSC custody.

17. The Chief, Facility Management, will arrange for a certified person to recover the halocarbons from any small system in which a halocarbon leak has been discovered, or which is being decommissioned (dismantled or disposed). In this situation, a notice (label) will be placed on the small system containing the information set out in form [CSC/SCC 1265-01d](#). No person will remove this notice except to replace it with another such notice. The information set out in form [CSC/SCC 1265-01e](#) will be recorded when a small system is purged.

Phase-Out of Halocarbons Listed in Any Items 1 to 9 of Schedule 1

18. If any equipment is found containing any halocarbons listed in [items 1 to 9 of Schedule 1 of the Regulations](#), it must be immediately retrofitted or removed from service.

REPORTING

Records

19. Whenever a refrigeration or air-conditioning system is decommissioned, the Chief, Facility Management, will arrange for a written record containing the information set out in form [CSC/SCC 1265-01d](#) to be kept on site in the service log.
20. Whenever a refrigeration or air-conditioning system is installed, serviced, leak tested, repaired or charged, a written record containing the information set out in form [CSC/SCC 1265-01e](#) must be kept on site.
21. All the documents required in this directive must be kept on site in the form of a central register of halocarbons or integrated in the Environmental Information System, for a period of at least five years beginning on the date of their issuance (see [section 2.11 of the Refrigerant Code of Practice](#)).

Release Reports

22. In the event of an accidental release of 100 kg or more of any halocarbon, the following reports must be submitted to:
- the appropriate regional division of Environment Canada (in priority)
 - the Regional Coordinator, Environmental Programs
 - the Environmental Protection Programs at CSC National Headquarters
- a. within 24 hours after the day on which the release is detected, a verbal or written report that indicates the type of halocarbon released and the type of system from which it was released
- b. within 14 days after the day on which the release is detected, a written report that indicates the information set out in form [CSC/SCC 1265-01a](#).

23. If more than 10 kg but less than 100 kg of a halocarbon is released, the Chief, Facility Management, will write a report that contains the information set out in form CSC/SCC 1265-01a and submit it twice a year (mid-July and mid-January) to the Regional Coordinator, Environmental Programs. The Regional Coordinator will forward this report to the Environmental Programs Section at CSC National Headquarters to allow National Headquarters to submit semi-annual corporate reports to the appropriate regional division of Environment Canada.

Inventory

24. Each institution must keep an up-to-date inventory of all refrigeration and air-conditioning systems and chillers containing halocarbons that have a refrigeration capacity over 19 kilowatts or 5.4 tons. To the extent possible, the inventory will also include small refrigeration and air-conditioning systems.
25. The institutional inventory will clarify and formalize the custody and maintenance arrangements for each system with a capacity over 19 kilowatts or 5.4 tons (or 64 828 BTU/hr). Among other things, the inventory must uniquely identify and characterize each system, name its custodian, list the amount and type of halocarbon it contains, and describe its maintenance and inspection arrangements. For each of these systems, the inventory will at least contain the information set out in Annex C – Inventory Information for Chillers, Refrigeration and Air-conditioning Systems.

TRAINING

26. Staff with responsibilities within this ISD must complete environmental awareness training covering all aspects of the Regulations as provided by Environment Canada. Note that this training does not replace provincial or territorial trade qualifications and certifications.

ENQUIRIES

27. Environmental Protection Program
National Headquarters
Email: GEN-NHQ-ENV@csc-scc.gc.ca

Assistant Commissioner,
Corporate Services

Original Signed by:

Liette Dumas-Sluyter

ANNEX A

CROSS-REFERENCES AND DEFINITIONS

CROSS-REFERENCES

Canada's Strategy to Accelerate the Phase-Out of CFC and Halons Uses and to Dispose of the Surplus Stocks, CCME, May 2001
Environmental Code of Practice for Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems, Report EPS 1/RA/2, Environment Canada, March 1996. ISBN 0-660-95256-4. Cat. No. En49-26/1-2E
Federal Halocarbon Regulations, 2003
Halocarbon regulations and compliance guides
<http://www.ec.gc.ca/ozone/> (for more information on issues related to halocarbons)
Ozone-Depleting Substances Regulations, 1998
Canadian Environmental Protection Act, 1999

DEFINITIONS

Air-conditioning system: an air-conditioning system, including any associated equipment, that contains or is designed to contain a halocarbon refrigerant.

Appropriate container: in respect of halocarbon management, a container that is designed and manufactured to be refilled and to contain a specific type of halocarbon.

Certified person: in respect of a refrigeration system or an air-conditioning system, a service technician who holds a certificate.

Charging: adding a halocarbon to a system (includes recharging or refilling).

Chiller: an air-conditioning system or a refrigeration system that has a compressor, an evaporator and a secondary refrigerant.

Decommissioning: the process of withdrawing an air-conditioning or refrigeration system to an inactive status. If the system is leaking, recover (the recovery should be done by a certified technician) the remaining halocarbon, place a notice (label) on the system, dismantle the system, dispose of the halocarbon as hazardous waste and properly dispose of the system. If the system is intended to be reused, recover halocarbon (the recovery will be done by a certified technician), place notice (label) on the system and relocate/transfer.

Halocarbon: a substance set out in Schedule 1, whether existing alone or in a mixture, and includes isomers of any such substance. Halocarbons consist of a group of ozone depleting substances (mainly CFCs, halons and HCFCs) largely used in refrigeration and air-conditioning systems, some fire extinguishing systems and solvent systems.

Installation: does not include the reactivation of a system by the same owner at the same site.

Leak: the release of a halocarbon from a system.

Owner: to hold a right in or to have possession, control or custody of, to be responsible for the maintenance, operation or management of, or to have the power to dispose of a system.

Recovery: in respect of a halocarbon:

- a. collection after it has been used, or
- b. collection from machinery, equipment, a system or a container during servicing or before dismantling, decommissioning or destruction of the machinery, equipment, system or container.

Refrigeration system: a refrigeration system, including any associated equipment, that contains or is designed to contain a halocarbon refrigerant.

Service: includes any modification, charging, maintenance, repair, moving, dismantling, decommissioning, destruction, start-up and testing of the system, but does not include testing related to the manufacture and production of the system.

Service log: in respect of halocarbon management, the institutional service log book or maintenance records of refrigeration or air-conditioning system(s) in which the information concerning the work conducted on the system(s) is entered as it is being done.

System: unless the context requires otherwise, an air-conditioning system, a fire extinguishing system, a refrigeration system or a solvent system.

ANNEX B**LIST OF HALOCARBONS**

Extract from Schedule 1 of the *Federal Halocarbon Regulations*, 2003

1. Tetrachloromethane (carbon tetrachloride)
 2. 1,1,1-trichloroethane (methyl chloroform), not including 1,1,2-trichloroethane
 3. Chlorofluorocarbons (CFC)
 4. Bromochlorodifluoromethane (Halon 1211)
 5. Bromotrifluoromethane (Halon 1301)
 6. Dibromotetrafluoroethane (Halon 2402)
 7. Bromofluorocarbons other than those set out in items 4 to 6
 8. Bromochloromethane (Halon 1011)
 9. Hydrobromofluorocarbons (HBFC)
 10. Hydrochlorofluorocarbons (HCFC)
 11. Hydrofluorocarbons (HFC)
 12. Perfluorocarbons (PFC)
-

Note: As prescribed in the present document, the requirements affecting the items in the yellow shaded area are more restrictive because of the important ozone layer depletion potential of these halocarbons.

ANNEX C**INVENTORY INFORMATION FOR CHILLERS, REFRIGERATION AND AIR-CONDITIONING SYSTEMS****Institution**

Inventory of chillers, refrigeration and air-conditioning systems	System Identification Code			
	Serial no.	Serial no.	Serial no.	Serial no.
Building no. where the system is located				
Location (name and/or room no.)				
System make				
System model				
Date of manufacture of system				
Description of system (type of system)				
Capacity of system (kW or tons or BTUs)				
Type of halocarbon				
Quantity of halocarbon (kg or lbs)				
Remarks				

Part 1 General

1.1 REFERENCE STANDARDS

- .1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

1.2 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 air duct accessories and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate:
 - .1 Flexible connections.
 - .2 Duct access doors.
 - .3 Turning vanes.
 - .4 Instrument test ports.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21- Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 GENERAL

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

2.2 FLEXIBLE CONNECTIONS

- .1 Frame: galvanized sheet metal frame 0.66 mm thick with fabric clenched by means of double locked seams.

- .2 Material:
 - .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at -40°C to +90°C, density of 1.3 kg/m².

2.3 ACCESS DOORS IN DUCTS

- .1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.
- .2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
- .3 Gaskets: neoprene.
- .4 Hardware:
 - .1 Up to 300 x 300 mm: two sash locks complete with safety chain.
 - .2 301 to 450 mm: four sash locks complete with safety chain.
 - .3 451 to 1000 mm: piano hinge and minimum two sash locks.
 - .4 Doors over 1000 mm: piano hinge and two handles operable from both sides.
 - .1 Hold open devices.
 - .2 300 X 300 mm glass viewing panels.

2.4 TURNING VANES

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

2.5 INSTRUMENT TEST

- .1 1.6 mm thick steel zinc plated after manufacture.
- .2 Cam lock handles with neoprene expansion plug and handle chain.
- .3 28 mm minimum inside diameter. Length to suit insulation thickness.
- .4 Neoprene mounting gasket.

2.6 SPIN-IN COLLARS

- .1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.
- .2 Sheet metal thickness to co-responding round duct standards.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for material installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.

- .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Flexible Connections:
 - .1 Install in following locations:
 - .1 Inlets and outlets to supply air units and fans.
 - .2 Inlets and outlets of exhaust and return air fans.
 - .3 As indicated.
 - .2 Length of connection: 100 mm.
 - .3 Minimum distance between metal parts when system in operation: 75 mm.
 - .4 Install in accordance with recommendations of SMACNA.
 - .5 When fan is running:
 - .1 Ducting on sides of flexible connection to be in alignment.
 - .2 Ensure slack material in flexible connection.
- .2 Access Doors and Viewing Panels:
 - .1 Size:
 - .1 600 x 600 mm for person size entry.
 - .2 450 x 450 mm for servicing entry.
 - .3 300 x 300 mm for viewing.
 - .4 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 In mixed air applications in locations as approved by Departmental Representative.
 - .3 At inlet and outlet of coils.
 - .4 Downstream of junctions of two converging air streams of different temperatures.
 - .5 And as indicated.
- .4 Turning Vanes:
 - .1 Install in accordance with recommendations of SMACNA and as indicated.

3.3 CLEANING

- .1 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 Sheet Metal and Air Conditioning National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible.

1.2 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 dampers and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for dampers for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 GENERAL

- .1 Manufacture to SMACNA standards.

2.2 SPLITTER DAMPERS

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

- .2 Single 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.

2.3 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 bronze end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.

2.4 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.
- .7 Low leakage construction

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 material installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

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.
- .7 Corrections and adjustments conducted by Departmental Representative.

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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Approved: 2013-06-30

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute (ANSI) / Air Movement and Control Association (AMCA)
 - .1 ANSI/AMCA Standard 500-D, Laboratory Methods of Testing Dampers for Rating.
- .2 American Society for Testing and Materials (ASTM International)
 - .1 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.

1.2 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 dampers and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for dampers for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MULTI-LEAF DAMPERS

- .1 Opposed or parallel blade type as indicated.
- .2 Structurally formed steel or extruded aluminum, interlocking blades complete with extruded vinyl or EPDM seals, spring stainless steel or silicon side seals, structurally formed and welded galvanized steel or extruded aluminum frame.
- .3 Blade depth: 152 mm
- .4 Pressure fit self-lubricated bronze bearings.
- .5 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.
- .6 Operator: to Section 23 30 02 - EMCS: Field Control Devices.
- .7 Performance:
 - .1 Leakage: in closed position less than 2% of rated air flow at 500 Pa differential across damper.
 - .2 Pressure drop: at full open position less than 25 Pa differential across damper at 10 m/s.
 - .3 AMCA certified for leakage and air performance.
- .8 Insulated aluminum dampers:
 - .1 Frames: 6063-T5 extruded aluminum, thermally broken frame coupled with polyurethane or polystyrene foam, with RSI factor of 0.4, flanged type.
 - .2 Seals: silicone side seals and EPDM blade seals.
 - .3 Blades: 6063-T5 extruded aluminum, air-foil profile, with internal hollows insulated with polyurethane or polystyrene foam with RSI factor of 0.4.
 - .4 Leakage: AMCA Class 1A at 250 Pa static pressure differential.
- .9 Design Standard: Tamco
- .10 Acceptable Manufacturers: Alumavent (Ventex), Ruskin, Tamco

2.2 DISC TYPE DAMPERS

- .1 Frame: insulated brake formed, welded, 1.6 mm thick, galvanized steel to ASTM A653/A653M.
- .2 Disc: insulated spin formed, 1.6 mm thick, galvanized steel to ASTM A653/A653M.
- .3 Gasket: extruded neoprene, field replaceable, with 10-year warranty.
- .4 Bearings: roller self lubricated and sealed.
- .5 Operator: compatible with damper, linear stroke operator, spring loaded actuator, zinc-aluminum foundry alloy casting cam follower.
- .6 Performance:

- .1 Leakage: in closed position less than 2% of rated air flow at 500 Pa differential across damper.
- .2 Pressure drop: at full open position less than 25 Pa differential across damper at 10 m/s.
- .3 AMCA certified for leakage and air performance.
- .7 Design Standard: Tamco
- .8 Acceptable Manufacturers: Alumavent (Ventex), Ruskin, Tamco

2.3 BACK DRAFT DAMPERS

- .1 Automatic gravity operated, multi-leaf, aluminum or steel construction with nylon bearings, centre pivoted, spring assisted or counterweighted, as indicated.

2.4 RELIEF DAMPERS

- .1 Automatic multi-leaf steel or aluminum dampers with ball bearing centre pivoted and counter-weights set to open, as indicated.

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 material installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Seal multiple damper modules with silicon sealant.
- .4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.
- .5 Ensure dampers are observable and accessible.

3.3 CLEANING

- .1 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Approved: 2013-06-30

Part 1 General

1.1 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .3 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S112, Standard Test Method of Fire Test of Fire Damper Assemblies.
 - .2 CAN/ULC-S112.2, Standard Method of Fire Test of Ceiling Fire Stop Flap Assemblies.
 - .3 ULC-S505, Standard for Fusible Links for Fire Protection Service.

1.2 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 fire and smoke dampers and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate the following:
 - .1 Fire dampers.
 - .2 Smoke dampers.
 - .3 Fire stop flaps.
 - .4 Operators.
 - .5 Fusible links.
 - .6 Design details of break-away joints.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for fire and smoke dampers for incorporation into manual.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials:
 - .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Provide:
 - .1 Six (6) fusible links of each type.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 FIRE DAMPERS

- .1 Fire dampers: arrangement Type B or C with blades out of air stream, listed and bear label of ULC, meet requirements of authorities having jurisdiction and NFPA 90A. Fire damper assemblies to be fire tested in accordance with CAN/ULC-S112.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
 - .1 Fire dampers: 1½ hour fire rated unless otherwise indicated.
 - .2 Fire dampers: automatic operating type and have dynamic rating suitable for maximum air velocity and pressure differential to which it will be subjected.
- .3 Top hinged: multi-blade hinged or interlocking type; sized to maintain full duct cross section [as indicated].
- .4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.
- .5 40 x 40 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
- .6 Equip fire dampers with steel sleeve or frame installed disruption ductwork or impair damper operation.

- .7 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.
- .8 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.
- .9 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness.
- .10 Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

2.2 SMOKE DAMPERS

- .1 Smoke Dampers: to be ULC or UL listed and labelled.
- .2 Motorized S/D-M: folding blade type, normally open with power on. When power is interrupted damper shall close automatically. Both damper and damper operator shall be ULC listed and labelled.

2.3 COMBINATION FIRE AND SMOKE DAMPERS

- .1 Damper: similar to smoke dampers specified above.
- .2 Combined actuator: electrical control system actuated from smoke sensor or smoke detection system and from fusible link.

2.4 FIRE STOP FLAPS

- .1 Fire smoke flaps: ULC listed and labelled and fire tested in accordance with CAN/ULC-S112.2.
- .2 Construct of minimum 1.5 mm thick sheet steel with 1.6 mm thick non-asbestos ULC listed insulation and corrosion-resistant pins and hinges.
- .3 Flaps held open with fusible link conforming to ULC-S505 and close at 74 degrees C.

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 material installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Install in accordance with 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 fire stopping.
- .6 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.
- .7 Install break-away joints of approved design on each side of fire separation.

3.3 CLEANING

- .1 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)
- .2 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.
- .3 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible.
 - .2 SMACNA IAQ Guideline for Occupied Buildings under Construction.
- .4 Underwriters' Laboratories (UL)
 - .1 UL 181, Standard for Factory-Made Air Ducts and Air Connectors.
- .5 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S110, Standard Methods of Tests for Air Ducts.

1.2 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 flexible ducts and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate:
 - .1 Thermal properties.
 - .2 Friction loss.
 - .3 Acoustical loss.
 - .4 Leakage.
 - .5 Fire rating.
- .3 Test and Evaluation Reports:
 - .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.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 GENERAL

- .1 Factory fabricated to CAN/ULC-S110.
- .2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.
- .3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

2.1 METALLIC - UNINSULATED

- .1 Type 1: spiral wound flexible aluminum, as indicated.
- .2 Performance:
 - .1 Factory tested to 1.0 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.

2.2 METALLIC - INSULATED

- .1 Type 2: spiral wound flexible aluminum with factory applied, 37mm thick flexible glass fibre thermal insulation with vapour barrier and vinyl or reinforced mylar/neoprene laminate jacket.
- .2 Performance:
 - .1 Factory tested to 1000 Pa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.
 - .3 Thermal loss/gain: 1.3 W/m².°C. mean.

2.3 NON-METALLIC - UNINSULATED

- .1 Type 3: non-collapsible, coated mineral base fabric or aluminum foil mylar type, mechanically bonded to, and helically supported by, external steel wire.
- .2 Performance:
 - .1 Factory tested to 1000 Pa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.

2.4 NON-METALLIC - INSULATED

- .1 Type 4: non-collapsible, coated mineral base fabric or aluminum foil mylar type mechanically bonded to, and helically supported by, external steel wire with factory applied, 25 mm thick flexible glass fibre thermal insulation with vapour barrier and vinyl or reinforced mylar/neoprene laminate jacket.
- .2 Performance:
 - .1 Factory tested to 1000 Pa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.
 - .3 Thermal loss/gain: 1.3 W/m².°C mean.

2.5 METALLIC ACOUSTIC INSULATED - MEDIUM PRESSURE

- .1 Type 5: Spiral wound, flexible perforated aluminum with factory applied 25 mm thick flexible glass fibre thermal insulation and sleeved by aluminum foil and mylar laminate vapour barrier.
- .2 Performance:
 - .1 Factory tested to 3 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.
 - .3 Acoustical performance: Minimum attenuation (dB/m) to following table:

Frequency (Hz)					
Duct Diam:	125	250	500	1000	2000
100	0.6	3	12	27	0
150	1.2	3	12	22	27
200	2.0	5	12	19	20
300	2.4	5	12	16	15

2.6 METALLIC - ACOUSTIC INSULATED - HIGH PRESSURE

- .1 Type 6: Spiral wound, flexible perforated aluminum with factory applied 37 mm thick flexible glass fibre thermal insulation and encased in spiral wound flexible aluminum jacket, as indicated.

- .2 Performance:
- .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.
 - .3 Acoustical performance: Minimum attenuation (dB/m) to following table:

Frequency (Hz)					
Duct Diam:	125	250	500	1000	2000
100	0.6	3	12	27	0
150	1.2	3	12	22	27
200	2.0	5	12	19	20
300	2.4	5	12	16	15

2.7 NON-METALLIC - ACOUSTIC INSULATED

- .1 Type 7: Non-collapsible, coated mineral base perforated fabric type helically supported by and mechanically bonded to steel wire with factory applied flexible glass fibre acoustic insulation and encased in aluminum foil and mylar laminate vapour barrier.
- .2 Performance:
 - .1 Factory tested to 3 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.
 - .3 Acoustical performance: Minimum attenuation (dB/m) to following table:

Frequency (Hz)					
Duct Diam:	125	250	500	1000	2000
100	0.6	3	12	27	0
150	1.2	3	12	22	27
200	2.0	5	12	19	20
300	2.4	5	12	16	15

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 material installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 DUCT INSTALLATION

- .1 Install in accordance with: SMACNA.

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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American National Standards Institute/Air Movement and Control Association (ANSI/AMCA)
 - .1 ANSI/AMCA Standard 99, Standards Handbook.
 - .2 ANSI/AMCA Standard 210/(ANSI/ASHRAE 51-07), Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 - .3 ANSI/AMCA Standard 300, Reverberant Room Method for Sound Testing of Fans.
 - .4 ANSI/AMCA Standard 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .2 The Master Painters Institute (MPI)
 - .1 Architectural Painting Specification Manual.
 - .1 MPI #18, Primer, Zinc Rich, Organic.

1.2 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 HVAC fans and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Provide:
 - .1 Fan performance curves showing point of operation, kW/bhp and efficiency.
 - .2 Sound rating data at point of operation.
 - .2 Indicate:
 - .1 Motors, sheaves, bearings, shaft details
 - .2 Minimum performance achievable with as variable speed controllers.

1.3 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials:
 - .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Provide:
 - .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.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 SYSTEM DESCRIPTION

- .1 Refer to Equipment schedule on drawings.

2.2 FANS GENERAL

- .1 Motors:
 - .1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.
 - .2 For use with variable speed controllers.
- .2 Factory primed before assembly in colour standard to manufacturer.
- .3 Scroll casing drains: as indicated.
- .4 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .5 Vibration isolation: to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .6 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

2.3 DIRECT DRIVEN BACKWARD INCLINED CENTRIFUGAL INLINE FANS

- .1 General Description:
 - .1 Ducted inline fan
 - .2 Normal operating temperature up to 130 Fahrenheit (54.4 Celsius)
 - .3 Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number

- .2 Wheel:
 - .1 Non-overloading, backward inclined centrifugal wheel
 - .2 Constructed of aluminum
 - .3 Statically and dynamically balanced in accordance to AMCA Standard 204-05
 - .4 The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency
 - .5 Single thickness blades are securely riveted or welded to a heavy gauge back plate and wheel cone.
- .3 Motors:
 - .1 Electronically Commutated Motor
 - .1 Motor enclosures: Open type
 - .2 Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors.
 - .3 Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
 - .4 Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor
 - .5 Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
 - .6 Motor shall be a minimum of 85% efficient at all speeds.
- .4 Housing/Cabinet Construction
 - .1 Construction material: Galvanized
 - .2 Square design constructed of heavy gauge galvanized steel and shall include square duct mounting collars
 - .3 Housing and bearing supports shall be constructed of heavy gauge bolted and welded steel construction to prevent vibration and to rigidly support the shaft and bearing assembly.
- .5 Housing Supports and Drive Frame:
 - .1 Housing supports are constructed of structural steel with formed flanges
 - .2 Drive frame is welded steel which supports the motor
- .6 Disconnect Switches:
 - .1 NEMA rated: 4
 - .2 Positive electrical shut-off
 - .3 Wired from fan motor to junction box
- .7 Duct Collars:
 - .1 Square design to provide a large discharge area
 - .2 Inlet and discharge collars provide easy duct connection

- .3 Provide Flexible connection to ductwork.
- .8 Access Panel:
 - .1 Two-sided access panels, permit easy access to all internal components
 - .2 Located perpendicular to the motor mounting panel
- .9 Options/Accessories:
 - .1 Isolation:
 - .1 Housed Spring sized to match the weight of each fan
 - .2 Motor Cover:
 - .1 Constructed of galvanized steel
 - .2 Covers motor and drives for safety
 - .3 Standard on unit specified with UL
 - .3 Wiring Pigtail:
 - .1 Direct hook-up to the power supply

2.4 CEILING FAN – AIR CIRCULATOR

- .1 General Description:
 - .1 Ceiling mounted variable speed, reversible air circulation fan.
- .2 Blades
 - .1 Painted steel blades (3) with curved ends. White
 - .2 1200 mm blade diameter
 - .3 400 mm downrod
- .3 Motors and controls:
 - .1 Thermally protected PSC type variable speed with permanently lubricated bearings.
 - .2 Wall mounted remote controller capable of controlling up to 4 fans with forward and reverse switch and variable speed operation.

2.5 DIRECT DRIVE ROOF UPBLAST CENTRIFUGAL EXHAUST FANS

- .1 General Description:
 - .1 Discharge air directly away from the mounting surface
 - .2 Roof mounted applications
 - .3 Maximum continuous operating temperature 200 Celsius.
 - .4 Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number.
- .2 Wheel:
 - .1 Material type: aluminum
 - .2 Non-overloading, backward inclined centrifugal
 - .3 Statically and dynamically balanced in accordance to AMCA Standard 204-05
 - .4 The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency.

- .3 Motors:
 - .1 Electronically Commutated Motor
 - .1 Motor enclosures: Open type
 - .2 Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors.
 - .3 Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
 - .4 Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor
 - .5 Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
 - .6 Motor shall be a minimum of 85% efficient at all speeds.
- .4 Housing:
 - .1 Constructed of heavy gauge aluminum includes exterior housing, curb cap, windband, and motor compartment housing. Galvanized material is not acceptable.
 - .2 Housing shall have a rigid internal support structure. Windband to be one piece uniquely spun aluminum construction and maintain original material thickness throughout the housing.
 - .3 Windband to include an integral rolled bead for strength.
 - .4 Curb cap base to be fully welded to windband to ensure a leak proof construction. Tack welding, bolting, and caulking are not acceptable.
 - .5 Curb cap to have integral deep spun inlet venturi and pre-punched mounting holes to ensure correct attachment to curb.
 - .6 Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.
 - .7 Breather tube shall be 10 square inches in size for fresh air motor cooling, and designed to allow wiring to be run through it.
 - .8 Motor Cover:
 - .1 Constructed of aluminum
 - .9 Vibration Isolation:
 - .1 Double studded true isolators
 - .2 No metal to metal contact
 - .3 Sized to match the weight of each fan
- .5 Disconnect Switches:
 - .1 NEMA rated: 4X
 - .2 Positive electrical shut-off
 - .3 Wired from fan motor to junction box installed within motor compartment

- .6 Drain Trough:
 - .1 Allows for one-point drainage of water, grease, and other residues
- .7 Dampers:
 - .1 Type: Insulated Motorized
 - .2 Prevents outside air from entering back into the building when fan is off per NECB.

2.6 DIRECT DRIVE SIDEWALL MOUNTED PROPELLER

- .1 General Description:
 - .1 Sidewall mounted applications
 - .2 Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number
- .2 Wheel:
 - .1 Propeller shall be aluminum blade riveted to steel hub
 - .2 A standard square key and set screw or tapered bushing shall lock the propeller to the motor shaft
 - .3 Statically and dynamically balanced in accordance with AMCA Standard 204-05
 - .4 The propeller and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency
- .3 Motors:
 - .1 Electronically Commutated Motor
 - .1 Motor enclosures: Open type
 - .2 Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors.
 - .3 Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
 - .4 Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor
 - .5 Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
 - .6 Motor shall be a minimum of 85% efficient at all speeds.
- .4 Drive Frame:
 - .1 Drive frame assemblies and fan panels shall be galvanized steel
 - .2 Drive frame shall have welded wire or formed channels and fan panels shall have pre-punched mounting holes, formed flanges and a deep formed one piece inlet venturi

- .5 Disconnect Switches:
 - .1 NEMA rated: 4X
 - .2 Positive electrical shut-off
 - .3 Wired from fan motor to junction box
- .6 Options/Accessories:
 - .1 Dampers:
 - .1 Type: Insulated Motorized
 - .2 Prevents outside air from entering back into the building when fan is off per NECB.
 - .2 Wall Housing:
 - .1 Mounting arrangement: Flush Interior
 - .2 Constructed of galvanized steel with heavy gauge mounting flanges and pre-punched mounting holes
 - .3 Wall Collar:
 - .1 Constructed of galvanized steel with heavy gauge mounting flanges and pre-punched mounting holes
 - .4 Weatherhood:
 - .1 Shall shield wall opening and dampers from rain and snow with a lockable hinged connection to allow access to fan.
 - .2 Material type: Galvanized
 - .3 Turndown Angle: 90 degrees
 - .4 Screen: Birdscreen
 - .5 Finishes: Permatector

2.7 Centrifugal Fume Exhaust with Integral Stack

- .1 General:
 - .1 Single Width Centrifugal Fume Exhaust with Integral Stack.
 - .2 Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.
 - .3 Each fan shall be belt drive in AMCA arrangement 10.
 - .4 Fans are to be equipped with lifting lugs.
 - .5 When properly anchored to the roof structure, the standard fan / stack assembly shall withstand wind loads of up to 1 kPa equivalent to 41m/s windspeed, without the need for guy wires or additional structural support.
- .2 Fan Housing and Integral Stack:
 - .1 Fan housing is to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
 - .2 Fan shall be of airtight construction with the scroll panel material formed and embedded into the side panels.
 - .3 Housing and bearing support shall be constructed of galvanized material and bolted framework.

- .4 Housing shall include discharge stack of same material as fan housing to increase the overall discharge height of the unit. Minimum overall unit height with stack to be 7 feet (2.1m) from the roof deck.
 - .5 Stack material to be a minimum of 18 gauge. Stack to match outlet dimensions of the fan and shall not add additional static pressure drop to the exhaust fan. Stack discharge shall have tapered design increasing exit velocity and not adding additional static pressure drop to the exhaust fan.
 - .6 No discharge rain caps or flapper caps are permitted as to interfere with exhaust airflow.
 - .7 Drain port shall be located at lowest part of scroll housing to prevent moisture build-up in the interior of fan.
 - .8 An OSHA compliant weatherhood shall be included to completely cover the motor pulley and belt(s).
- .3 Fan Wheel:
- .1 The fan wheel shall be of the non-overloading single width backward inclined centrifugal type. Wheels shall be statically and dynamically balanced to balance grade G6.3 per ANSI S2.19.
 - .2 Fan wheel shall be manufactured of single thickness blades securely riveted or welded to a heavy gauge back plate and wheel cone.
 - .3 The wheel and fan inlet shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.
- .4 Fan Motors and Drive:
- .1 Motors shall meet or exceed EISA (Energy Independence and Security Act) efficiencies. Motors to be NEMA T-frame, 1800 or 3600 RPM, Open Drip Proof (ODP) with a 1.15 service factor.
 - .2 Drive belts and sheaves shall be sized for 150% of the fan operating brake horsepower, and shall be readily and easily accessible for service, if required.
 - .3 Fan shaft to be turned and polished steel that is sized so the first critical speed is at least 25% over the maximum operating speed for each pressure class.
 - .4 Fan shaft bearings shall be Air Handling Quality, bearings shall be heavy-duty grease lubricated, self-aligning or roller pillow block type.
 - .5 Air Handling Quality bearings to be designed with low swivel torque to allow the outer race of the bearing to pivot or swivel within the cast pillow block. Bearings shall be 100% tested for noise and vibration by the manufacturer. Bearings shall be 100% tested to insure the inner race diameter is within tolerance to prevent vibration.
 - .6 Bearings shall be selected for a basic rating fatigue life (L-10) of 80,000 hours at maximum operating speed for each pressure class.
 - .7 Bearings shall have Zerk fittings to allow for lubrication.

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 material installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 FAN INSTALLATION

- .1 Install fans as indicated, complete with resilient mountings specified in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment, flexible electrical leads and flexible connections in accordance with Section 23 33 00 - Air Duct Accessories.
- .2 Provide sheaves and belts required for final air balance.
- .3 Bearings and extension tubes to be easily accessible.
- .4 Access doors and access panels to be easily accessible.

3.3 ANCHOR BOLTS AND TEMPLATES

- .1 Size anchor bolts to withstand seismic acceleration and velocity forces.

3.4 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 45 00 - Quality Control.
- .3 Section 01 74 21 - Construction/Demolition Waste Submittal and Disposal.
- .4 Section 01 78 00 - Closeout Submittals.

1.2 REFERENCES

- .1 American National Standards Institute/Air Movement and Control Association (ANSI/AMCA):
 - .1 ANSI/AMCA Standard 210 (ANSI/ASHRAE 51), Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
- .2 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
 - .1 ASHRAE 130, Methods of Testing for Rating Ducted Air Terminal Units.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets (MSDS).
- .4 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.
- .5 National Fire Protection Association (NFPA):
 - .1 NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .6 Underwriter's Laboratories (UL):
 - .1 UL 181, Factory-Made Air Ducts and Air Connectors.

1.3 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 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 air terminal units and include product characteristics, performance criteria, physical size, finish and limitations.

- .2 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 drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.
 - .2 Indicate the following:
 - .1 Capacity.
 - .2 Pressure drop.
 - .3 Noise rating.
 - .4 Leakage.
 - .5 Dimensions.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Instructions: submit manufacturer's installation instructions.
- .6 Test and Evaluation Reports:
 - .1 Test data: to ANSI/AMCA Standard 210:
 - .1 Submit published test data on DIN (Direct Internal Noise), in accordance with ISO 3741 made by independent testing agency for 0, 2.5 and 6 m/s branch velocity or inlet velocity.
 - .2 Sound power level with minimum inlet pressure of 0.25, 0.5, 1, 1.5 kPa in accordance with ISO 3741 for 2nd through 7th octave band, also made by independent testing agency.
 - .3 Pressure loss through silencer shall not exceed 60% of inlet velocity pressure maximum.
- .7 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

1.5 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for air terminal units for incorporation into manual.

1.6 QUALITY ASSURANCE

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and 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 indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect air terminal units from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Waste Reduction Work plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse and return of pallets, crates, padding, and packaging materials as specified in Waste Reduction Work plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 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.

2.2 TERMINAL BOX - VARIABLE VOLUME BOXES

- .1 Pressure independent factory reset to air flow between minimum and maximum air volume.
- .2 Sizes, capacities and differential pressures: as indicated in schedule.
- .3 Sound ratings of assembly not to exceed 35 NC at 750 Pa.
- .4 Complete with:
 - .1 Operator and controller: as specified under Section 25 30 02 - EMCS: Field Control Devices.
 - .2 Sound attenuator at discharge of unit.
 - .3 Reheat coil mounted integral with casing as indicated.
- .5 Adjustable reset start point.
- .6 Operator to be factory mounted and calibrated:
 - .1 Gauge taps for balancing with standard pressure gauge.
 - .2 Controller to have adjustable flow settings.

- .7 Casing: constructed of 0.75 mm thick galvanized steel, internally lined with 25 mm, 0.7 kg density fibrous glass, to UL181 and ANSI/NFPA 90A. Mount control components inside protective metal shroud.
- .8 Damper: galvanized steel with peripheral gasket and self-lubricating bearings. Air leakage past closed damper not to exceed 2% of nominal rating at 750 Pa inlet static pressure, in accordance with Air Diffusion Council test procedure.
- .9 Terminal Boxes shall meet or exceed that performance requirements, features and options indicated on drawings.
- .10 Hydronic reheat coils shall have a maximum of 29kPa fluid pressure drop.

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 air terminal units' installation in accordance with manufacturer's written instructions.
 - .1 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Install in accordance with manufacturers recommendations.
- .2 Support independently of ductwork.
- .3 Install with at least 1000 mm of flexible inlet ducting and minimum of four duct diameters of straight inlet duct, same size as inlet.
- .4 Locate controls, dampers and access panels for easy access.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning:
- .2 Leave Work area clean at end of each day.
- .3 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning:
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 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 diffusers, registers and grilles and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate following:
 - .1 Capacity.
 - .2 Throw and terminal velocity.
 - .3 Noise criteria.
 - .4 Pressure drop.
 - .5 Neck velocity.
 - .6 Security features

1.2 MAINTENANCE MATERIAL SUBMITTALS

- .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.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 GENERAL

- .1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as indicated.
- .2 Frames:
 - .1 Full perimeter gaskets.
 - .2 Plaster frames and as specified
 - .3 Concealed fasteners.
- .3 Concealed manual volume control damper operators.
- .4 Colour: standard.

2.2 MANUFACTURED UNITS

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

2.3 SUPPLY GRILLES AND REGISTERS

- .1 Refer to Equipment schedule on drawings.

2.4 RETURN AND EXHAUST GRILLES AND REGISTERS

- .1 Refer to Equipment schedule on drawings.

2.5 DIFFUSERS

- .1 Refer to Equipment schedule on drawings.

2.6 MAXIMUM SECURITY FEATURES

- .1 Grilles and diffusers with Maximum security requirements shall:
 - .1 Not be removable from the cell block.
 - .2 Structural quality steel bars not less than 12 mm diameter on 137 mm centers (2 bars of radius 6 mm plus a 125-mm gap = 137 mm), except that where the opening is between an inmate area and a security corridor the bars shall be of Tool Resistant Homogenous Steel.
 - .3 Maximum bar length without cross bars not to exceed 610 mm and all bars shall be welded together where they intersect.
 - .4 Bars to be welded to a flat steel frame secured to masonry/concrete. Acceptable method: bolts set a minimum of 50 mm into expansion shields. Bolt spacing not exceeding 400 mm on centers. No less than 4 bolts per grille

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 material installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Install in accordance with manufacturers instructions.
- .2 Bolt grilles, registers and diffusers, in place, in gymnasium and similar game rooms.

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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 ASTM International
 - .1 ASTM E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .3 National Research Council Canada (NRC)
 - .1 National Building Code of Canada (NBC).
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
- .5 Society of Automotive Engineers (SAE)

1.2 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 louvres, intakes and vents and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate following:
 - .1 Pressure drop.
 - .2 Face area.
 - .3 Free area.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Test Reports: submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.

- .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 SYSTEM DESCRIPTION

- .1 Refer to Equipment schedule on drawings.

2.2 GRAVITY ROOF OUTSIDE AIR INTAKES AND RELIEF VENTS

- .1 Factory manufactured aluminum hinged at curb line.
 - .1 Complete with integral birdscreen of 2.7 mm diam 12 mm mesh aluminum wire.
 - .2 Vertical or horizontal backdraft dampers on four faces.
 - .3 Maximum throat velocity: 3.3 m/s intake.
 - .4 Maximum loss through unit: 15 Pa exhaust static pressure.
 - .5 Maximum velocity through damper area: 1.5 m/s.
 - .6 Shape: as indicated.

2.3 GOOSENECK HOODS

- .1 Thickness: to SMACNA.
 - .1 Kitchen: to ANSI/NFPA 96.
 - .2 Elsewhere: to SMACNA.
- .2 Fabrication: to SMACNA.
 - .1 Kitchen: to ANSI/NFPA 96.
 - .2 Elsewhere: to SMACNA.
- .3 Joints: to SMACNA or proprietary manufactured duct joint. Proprietary manufactured flanged duct joint shall be considered to be a class A seal.
- .4 Supports: as indicated.
- .5 Complete with integral birdscreen of 2.7 mm diameter aluminum wire. Use 12 mm mesh on exhaust and intake.
- .6 Horizontal backdraft dampers.

2.4 FIXED LOUVRES - ALUMINUM

- .1 Construction: welded with exposed joints ground flush and smooth.
- .2 Material: extruded aluminum alloy 6063-T5.
- .3 Blade: drainable, stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm.
- .4 Frame, head, sill and jamb: 150 mm deep one piece extruded aluminum, minimum 3 mm thick with approved caulking slot, integral to unit.

- .5 Mullions: at 1500 mm maximum centres.
- .6 Fastenings: stainless steel SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.
- .7 Screen: 12 mm on exhaust and intake mesh, 2.0 mm diameter wire aluminum or galvanized birdscreen on inside face of louvres in formed U-frame.
- .8 Finish: factory applied enamel. Colour: to Departmental Representative's approval.

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 material installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

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 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
- .2 Underwriters' Laboratories of Canada (ULC)

1.2 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 chimneys and stacks and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Indicate following:
 - .1 Methods of sealing sections.
 - .2 Methods of expansion.
 - .3 Details of thimbles.
 - .4 Bases/Foundations.
 - .5 Supports.
 - .6 Guy details.
 - .7 Rain caps.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.3 QUALITY ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with applicable Provincial/Territorial regulations.
- .2 Certifications:
 - .1 Catalogued or published ratings: obtained from tests carried out by independent testing agency or manufacturer signifying adherence to codes and standards.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

- .2 Store and protect materials from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 TYPE B GAS VENT

- .1 ULC labelled, 288 degrees C rating maximum, atmospheric gas vent only.
- .2 Sectional, prefabricated, double wall with 13 mm air space. Aluminum inner wall. Galvanized steel outer wall. Mated fittings and couplings.

2.2 ACCESSORIES

- .1 Cleanouts: bolted, gasketed type, full size of breeching, as indicated.
- .2 Hangers and supports: in accordance with recommendations SMACNA.
- .3 Rain cap.
- .4 Expansion sleeves with heat resistant caulking, held in place as indicated.

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 material installation in accordance with manufacturer's written instructions.
 - .1 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION - GENERAL

- .1 Follow manufacturer's and SMACNA installation recommendations for shop fabricated components.
- .2 Suspend breeching at 1.5 m centres and at each joint.
- .3 Support chimneys at bottom, roof and intermediate levels as indicated.
- .4 Install thimbles where penetrating roof, floor, ceiling and where breeching enters masonry chimney. Pack annular space with heat resistant caulking.
- .5 Install flashings on chimneys penetrating roofs, as indicated.
- .6 Install rain caps and cleanouts, as indicated.

3.3 CLEANING

- .1 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American Boiler Manufacturers Association (ABMA)
- .2 ASME
 - .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII.
- .3 CSA Group
 - .1 CAN1-3.1-77, Industrial and Commercial Gas-Fired Package Boilers.
 - .2 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.
 - .3 CSA B139, Installation Code for Oil Burning Equipment.
 - .4 CSA B140.7, Oil Burning Equipment: Steam and Hot-Water Boilers.
 - .5 CSA B149.1, Natural Gas and Propane Installation Code.
 - .6 ANSI Z21.13-/CSA 4.9, Gas-Fired Low-Pressure Steam and Hot Water Boilers.
- .4 Electrical and Electronic Manufacturers Association of Canada (EEMAC)

1.2 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 heating boilers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Indicate on drawings:
 - .1 General arrangement showing terminal points, instrumentation test connections.
 - .2 Clearances for operation, maintenance, servicing, tube cleaning, tube replacement.
 - .3 Foundations with loadings, anchor bolt arrangements.
 - .4 Piping hook-ups.
 - .5 Equipment electrical drawings.
 - .6 Burners and controls.
 - .7 All miscellaneous equipment.
 - .8 Flame safety control system.
 - .9 Breeching and stack configuration.
 - .2 Engineering data to include:
 - .1 Boiler efficiency at 25%, 50%, 75%, 100%, of design capacity.
 - .2 Radiant heat loss at 100% design capacity.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for heating boilers for incorporation into manual.

1.4 QUALITY ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with applicable Provincial /Territorial regulations.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra materials:
 - .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Special tools for burners, access opening, handholes and Operation and Maintenance.
 - .2 Spare parts for 1 year of operation.
 - .3 Spare gaskets.
 - .4 Spare gauge glass inserts.
 - .5 Probes and sealants for electronic indication.
 - .6 Spare burner tips.
 - .7 Spare burner gun.
 - .8 Safety valve test gauge.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 Supplier Requirements

- .1 Supplier Service and Support
 - .1 The supplier must have existing factory trained sales force locally available for applications assistance and to answer maintenance questions.

- .2 The Supplier is to provide a 24 hour, seven (7) day a week, assistance call line for maintenance and troubleshooting requirements with the equipment operation.
- .3 Supplier is to be capable of providing factory trained on-site technical support of the within a four (4) hour time period from notification.
- .2 Supplier Spare Parts Availability
 - .1 The supplier is to have a distributor organization, which locally stocks standard parts, modification kits, and spare parts.
 - .2 Components not regularly stocked are to be capable of being provided to the site in less than 36 hours.
- .3 Supplier Organization
 - .1 The supplier must have been in operation within the local Edmonton area for at least 5 years with product installed within the local area.
 - .2 The local supplier must have at least 5 years of representation history of the equipment brand.
 - .3 The supplier must have factory trained service representatives within the local Edmonton area. The factory representatives must be trained in the maintenance and troubleshooting of the equipment as specified herein.
 - .4 The factory representative is to be conversant in the requirements of the specific equipment.
- .4 Supplier Maintenance and Training Schools
 - .1 Supplier must offer maintenance and training in North America on the equipment supplied.
 - .2 Training programs are to be offered by the supplier on a yearly cycle (minimum).

2.2 GENERAL

- .1 Boiler shall be natural gas fired, fully condensing, and fire tube design. The boiler shall be factory-fabricated, factory-assembled, and factory-tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.
- .2 Heat Exchanger: The heater exchanger shall bear the ASME "H" stamp for 160 psi working pressure and shall be National Board listed. The heat exchanger shall be constructed of a fully welded 316L stainless steel and of fire tube design. The heat exchanger shall be designed for a single-pass water flow to limit the water side pressure drop. Cast iron, aluminum, or condensing copper tube boilers will not be accepted.
- .3 Efficiency: Boilers shall have an AHRI certified minimum thermal efficiency of 97 percent.
- .4 Condensate Collection Basin: Fully welded 316L stainless steel and shall include a stainless steel combustion analyzer test port.
- .5 Pressure Vessel: The pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The pressure vessel shall be designed for a single-pass water flow to limit the water side pressure drop. The pressure vessel shall contain a volume of water no less than 60L.

- .6 Burner: Natural gas, forced draft single burner premix design. The burner shall be high temperature stainless steel with a woven Fecralloy outer covering to provide modulating firing rates. The burner shall be capable of the stated gas train turndown without loss of combustion efficiency.
- .7 Blower: Boiler shall be equipped with a pulse width modulating blower system to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The burner firing sequence of operation shall include pre-purge, firing, modulation, and post-purge operation.
- .8 Gas Train: The boiler shall be supplied with a negative pressure regulation gas train and shall be capable of the following minimum turndowns:
- .9 Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
- .10 High Altitude: Boiler shall operate at altitudes up to 1372 m above sea level without additional parts or adjustments. High altitude operation shall be certified at a minimum of 1372 m above sea level by a third party organization.
- .11 Casing:
 - .1 Jacket: Heavy gauge primed and painted steel jacket with snap-in closures.
 - .2 Control Compartment Enclosures: NEMA 250, Type 1A.
 - .3 Combustion-Air Connections: Inlet and vent duct collars.
- .12 Characteristics and Capacities:
 - .1 Heating Medium: Hot water.
 - .2 Design Water Pressure Rating: 160 psi working pressure.
 - .3 Safety Relief Valve Setting: 50 psig
 - .4 Minimum Water Flow Rate at max output of not more than 1.25 L/s. and 0.26 L/s at minimum fire.
- .13 Start-up, instruction, on-site performance tests: 3 days per boiler.
- .14 Trial usage:
 - .1 Departmental Representative may use boilers for test purposes prior to acceptance and commencement of warranty period.
 - .2 Supply labour, materials and instruments required for tests.
- .15 Temporary use by contractor:
 - .1 Contractor may use boilers only after written approval from Departmental Representative.
 - .2 Monitor and record performance continuously. Keep log of maintenance activities carried out.
 - .3 Refurbish to as-new condition before final inspection and acceptance.

2.3 AUXILIARIES

- .1 Provide auxiliaries for each boiler and to meet ASME requirements.
- .2 Hot water boilers:
 - .1 Relief valves: ASME rated, set at 345 kPa. to release entire boiler capacity.

- .2 Pressure gauge: 90 mm diameter complete with shut-off clock.
- .3 Thermometer: 115 mm diameter range 10 to 150 degrees C.
- .4 Low water cut-off: with visual and audible alarms.
- .5 Auxiliary low water cut-off: with separate cold water connection to boiler.
- .6 Isolating gate valves: on supply and return connections.
- .7 Drain valve: NPS 2.
- .8 Stack thermometer: range 65 to 400 degrees C.
- .9 Outdoor controller: to reset operating temperature controller.
- .3 Condensate Neutralization Kit: Factory supplied condensate trap with condensate trip sensor, high capacity condensate receiver prefilled with appropriate medium.

2.4 CONTROLS

- .1 Boiler controls shall feature a standard, factory installed multi-color graphic LCD screen display with navigation dial and includes the following standard features:
 - .1 Boiler shall have the ability to communicate remotely using Ethernet connection.
 - .2 Variable Speed Boiler Pump Control: Boiler may be programmed to send a 0-10V DC output signal to an ECM or VFD boiler pump to maintain a designed temperature rise across the heat exchanger. The boiler shall be able to operate in this mode with a minimum temperature rise of 11°C (20°F) and a maximum temperature rise of 33.4°C (60°F).
 - .3 Password Security: Boiler shall have a different password security code for the User and the Installer to access adjustable parameters.
 - .4 Outdoor air reset: Boiler shall calculate the set point using a field installed, factory supplied outdoor sensor and an adjustable reset curve.
 - .5 Pump exercise: Boiler shall energize any pump it controls for an adjustable time if the associated pump has been off for a time period of 24 hours.
 - .6 Four pump control: Boiler shall have the ability to control the boiler pump, a system pump, a domestic hot water pump, and a domestic hot water recirculation pump.
 - .7 Ramp delay: Boiler may be programmed to limit the firing rate based on six limits steps and six time intervals.
 - .8 Boost function: Boiler may be programmed to automatically increase the set point a fixed number of degrees (adjustable by installer) if the setpoint has been continuously active for a set period of time (time adjustable by installer). This process will continue until the space heating demand ends.
 - .9 Domestic hot water priority: Boiler shall make the domestic hot water call for heat a priority over any space heating call and adjust the boiler setpoint to the domestic hot water boiler setpoint.
 - .10 Domestic hot water modulation limiting: Boiler may be programmed to limit the maximum domestic hot water firing rate to match the input rating of the indirect tank coil.
 - .11 Domestic hot water night setback: Boiler may be programmed to reduce the domestic hot water tank set point during a certain time of the day.
 - .12 PC port connection: Boiler shall have a PC port allowing the connection of PC boiler software.

- .13 Time clock: Boiler shall have an internal time clock with the ability to time and date stamp lock-out codes and maintain records of runtime.
- .14 Maintenance reminder: Boiler shall have the ability to display a yellow colored, customizable maintenance notification screen. All notifications are adjustable by the installer based upon months of installation, hours of operation, and number of boiler cycles.
- .15 English Error codes: Boiler shall have a user interface that displays a red error screen with fault codes that are displayed in English and include a date and time stamp for ease of servicing.
- .16 Anti-cycling control: Boiler shall have the ability to set a time delay after a heating demand is satisfied allowing the boiler to block a new call for heat. The boiler will display an anti-cycling blocking on the screen until the time has elapsed or the water temperature drops below the anti-cycling differential parameter. The anti-cycling control parameter is adjustable by the installer.
- .17 Space Heating Night setback: Boiler may be programmed to reduce the space heating temperature set point during a certain time of the day.
- .18 Freeze protection: Boiler shall turn on the boiler and system pumps when the boiler water temperature falls below 45 degrees. When the boiler water temperature falls below 37 degrees the boiler will automatically turn on. Boiler and pumps will turn off when the boiler water temperature rises above 43 degrees.
- .19 Isolation valve control: Boiler shall have the ability to control a 2-way motorized control valve. Boiler shall also be able to force a fixed number of valves to always be energized regardless of the number of boilers that are firing.
- .20 BMS integration with 0-10V DC input: The Control shall allow an option to Enable and control set point temperature or control firing rate by sending the boiler a 0-10V input signal.
- .21 Data logging: Boiler shall have non-volatile data logging memory including last 10 lockouts, space heat run hours, domestic hot water run hours and ignition attempts. All data should be visible on the boiler screen.
- .2 The boiler shall have a built-in Cascade controller to sequence and rotate lead boiler to ensure equal runtime while maintaining modulation of up to 8 boilers of different inputs without utilization of an external controller. The factory installed, internal cascade controller shall include:
 - .1 Lead lag: The Control module shall allow only one boiler to fire at the beginning of a call for heat. Once the lead boiler is in full fire and the control calculates that additional heat is required it will call on an additional boiler as needed.
 - .2 Efficiency optimization: The Control module shall allow multiple boilers to simultaneously fire at minimum firing rate in lieu of Lead/Lag.
 - .3 Front end loading: The Control module shall allow the cascading and functional control of several non-condensing products alongside this boiler.
- .3 Boiler operating controls shall include the following devices and features:
 - .1 Set-Point Adjust: Set points shall be fully adjustable by the installer.
 - .2 Sequence of Operation: Factory installed controller to modulate burner firing rate to maintain system water temperature in response to call for heat.

- .4 Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation and include:
 - .1 High Temperature Limit: Automatic and manual reset stops burner if operating conditions rise above maximum boiler design temperature. Limit switch to be manually reset on the control interface.
 - .2 Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manually reset on the control interface.
 - .3 Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
 - .4 High and Low Gas Pressure Switches: Pressure switches shall prevent burner operation on low or high gas pressure. Pressure switches to be manually reset on the control interface.
 - .5 Blocked Drain Switch: Blocked drain switch shall prevent burner operation when tripped. Switch to be manually reset on the control interface.
 - .6 Low air pressure switch: Pressure switches shall prevent burner operation on low air pressure. Switch to be manually reset on the control interface.
- .5 Building Automation System Interface:
 - .1 Boiler shall have the ability to receive a 0-10V system from a building management system and control by the following:
 - .1 0-10V DC input to control Modulation or Setpoint
 - .2 0-10V DC input from Variable speed Boiler pump
 - .3 0-10V DC output signal to a Variable speed system pump
 - .4 0-10V DC input Enable/Disable signal
 - .2 Factory installed gateway interface to enable BACnet MSTP building automation system to monitor, control, and display boiler status and alarms.

2.5 ELECTRICAL POWER

- .1 Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.
- .2 Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
- .3 Electrical Characteristics:
 - .1 See Drawings

2.6 VENTING

- .1 Exhaust flue must be Category IV approved stainless steel sealed vent material from one of the approved manufacturers listed in the Installation and Operation manual. Boilers exhaust vent length must be able to extend to 30.5 equivalent metres.
- .2 Intake piping must be of approved material as listed in the Installation and Operations manual. Boilers intake pipe length must be able to extend to 30.5 equivalent metres.
- .3 Boiler venting and intake piping configuration shall be installed per one of the approved venting methods shown in the Installation and Operation manual.

- .4 Boilers using common venting must only include like models and the optional common vent damper. Contact the factory for common vent sizing.
- .5 Boiler shall come standard with a flue sensor to monitor and display flue gas temperature on factory provided LCD display.
- .6 Refer to manufacturer's Installation and Operations manual for detailed venting instructions and approved manufacturers.

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 material installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 INSTALLATION

- .1 Install in accordance with ASME Boiler and Pressure Vessels Code, regulations of Province having jurisdiction, except where specified otherwise, and manufacturers recommendations.
- .2 Make required piping connections to inlets and outlets recommended by boiler manufacturer.
- .3 Maintain clearances as indicated or if not indicated, as recommended by manufacturer for operation, servicing and maintenance without disruption of operation of any other equipment/system.
- .4 Mount unit level using specified vibration isolation in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .5 Pipe hot water relief valves full size to nearest drain.
- .6 Natural gas fired installations: in accordance with CSA B149.1.

3.4 MOUNTINGS AND ACCESSORIES

- .1 Safety valves and relief valves:
 - .1 Run separate discharge from each valve.
 - .2 Terminate discharge pipe as indicated.

- .3 Run drain pipe from each valve outlet and drip pan elbow to above nearest drain.
- .2 Blowdown valves:
 - .1 Run discharge to terminate as indicated.

3.5 FIELD QUALITY CONTROL

- .1 Commissioning:
 - .1 Manufacturer to:
 - .1 Certify installation.
 - .2 Start up and commission installation.
 - .3 Carry out on-site performance verification tests.
 - .4 Demonstrate operation and maintenance.
 - .2 Provide Departmental Representative at least 24 hours notice prior to inspections, tests, and demonstrations. Submit written report of inspections and test results.

3.6 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

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

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for duct heaters/coils and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit product data and include:
 - .1 Element support details.
 - .2 Heater: total kW rating, voltage, phase.
 - .3 Number of stages.
 - .4 Rating of stage: rating, voltage, phase.
 - .5 Heater element watt/density and maximum sheath temperature.
 - .6 Maximum discharge temperature.
 - .7 Unit support.
 - .8 Clearance from combustible materials.
 - .9 Internal components wiring diagrams.
 - .10 Minimum operating airflow.
 - .11 Pressure drop operating / minimum airflow.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 ELECTRIC DUCT HEATERS

- .1 Duct heaters: flange type.
- .2 Elements:
 - .1 Helical coils of nickel chrome alloy resistance wire.
 - .2 Finned tubular.
 - .3 Incoloy sheathed.
- .1 Terminal box:
 - .1 NEMA 1 general purpose enclosure.
 - .2 Hinged, latching cover.
 - .3 Multiple concentric knockouts to accept field wiring.
 - .4 Terminal blocks to accommodate field wiring.
 - .5 All internal wiring to be complete with 105°C rated insulation.
- .2 Staging:
 - .1 Staged heaters: balanced line current at each stage.
 - .2 Each stage: uniform face distribution.
- .3 Controls:
 - .1 Factory mounted and wired in control box. Use terminal blocks for power and control wiring to BMS and sail switch.
 - .2 Remote mounted as indicated with terminal strips in heater terminal box for power and control wiring.
 - .3 High temperature cutout and air proving switch.
 - .4 Controls to include:
 - .1 Magnetic contactors.
 - .2 Manual and automatic reset high limit.
 - .3 Control transformers.
 - .4 Solid state relays.
 - .5 Door interlocked disconnect switch (non-fused).
 - .6 HRC load fuses.
 - .7 Heater to be controlled by 0 – 10 VDC or 4-20mA remote control signal from the building automation system supplied and installed by the EMCS Contractor.
 - .5 Performance: see schedule.
 - .6 Provide heater complete with protective screens on inlet/outlet.
- .4 Main isolation disconnect switch.

2.2 HYDRONIC COILS

- .1 Capacity: as indicated on schedule.

- .2 Ratings: all coils shall meet or exceed all capacities specified on the mechanical schedule for the project.
- .3 Construction:
 - .1 Hot water coils:
 - .1 Tubes: 0.508 mm thick copper
 - .2 Fins: 0.1905 mm aluminum.
 - .3 Headers: headers shall be constructed from UNS 12200 seamless copper conforming to ASTM B75 and ASTM B251.
 - .4 Pressure tests: 1.7 MPa.

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 material installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Make power and control connections to CSA C22.2 No.46.
- .2 When wireway is used, remove knock-outs and insert insulating bushing between units.
- .3 Install grounding wire to maintain ground integrity between heating, blank, and auxiliary sections.
- .4 Install thermostats in locations indicated.
- .5 Make power and control connections.
- .6 Provide each coil unit with shut-off valve on supply and lockshield balancing valve on return piping.
- .7 Provide each unit at high points with easily accessible manual air vent. If not easily accessible, extend vent to exterior surface of cabinet for each servicing.
- .8 Copper tube elements to be joined by sweat solder joints using 95-5 solder for working pressure of 345 kPa (50 psi) and less, and silver brazing for higher pressures.

3.3 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Ensure heaters and controls operate correctly.

3.4 COMMISSIONING

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical and Section 01 91 13 - General Commissioning (Cx) Requirements.
- .2 Ensure that heaters and thermostatic controls operate correctly.
- .3 Provide reports in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements.

3.5 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 ASTM International
 - .1 ASTM A48/A48M Standard Specification for Grey Iron Castings.
 - .2 ASTM A123/A123M, 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 B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
 - .5 ASTM C67, Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.
 - .6 ASTM D520, Standard Specification for Zinc Dust Pigment.
- .2 CSA Group
 - .1 CSA B52, Mechanical Refrigeration Code.
 - .2 CAN/CSA-Z809, Sustainable Forest Management.
- .3 Canada Federal Halocarbon Regulations, 2003
- .4 Canadian Correctional Service Canada
 - .1 Internal Service Directive 318-4 – Environmental Management of Halocarbons
- .5 Environment Canada (EC)
 - .1 Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems. (2015)
- .6 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA MG 1, Motors and Generators.
- .7 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102.2, Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings and Miscellaneous Materials and Assemblies.

1.1 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 cooling units and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Include information as follows:
 - .1 Replacement data for motor element, thermostat and switch.
 - .2 Mounting methods.

- .3 kW rating.
- .4 Cabinet material thicknesses.
- .5 Cabinet surface temperature.
- .6 Thermostat, transformer, controls where integral.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Complete the forms noted within CSC ISD 318-4.
- .5 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .6 Manufacturer's Field Reports: Submit manufacturer's field reports specified.

1.2 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Submit the form for Halocarbon tracking per the CSC ISD 318-4.
- .3 Operation and Maintenance Data: submit operation and maintenance data for cooling units for incorporation into manual.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and 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 indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect cooling units from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 PERFORMANCE REQUIREMENTS

- .1 Refer to drawings.

2.2 AIR COOLED CONDENSERS

- .1 Air cooled: free standing, coated steel unit construction, corrosion protected.
- .2 Capacity: to heat rejection capacity to meet indoor unit capacity at 35°C.

- .3 General
 - .1 Weatherproofed steel mounting/lifting rails
 - .2 Hermetic scroll compressors
 - .3 Microchannel condenser coils
 - .4 Fans and motors
 - .5 Standard operating range 0°F-125°F (min. 0°F with low ambient accessory)
 - .6 Nitrogen holding charge
 - .7 Certified and rated in accordance with AHRI and DOE standards
 - .8 Certified to UL 1995
- .4 Casing
 - .1 Zinc coated, heavy gauge, galvanized steel
 - .2 Weather resistant baked enamel finish
 - .3 Meets ASTM B117, 672 hour salt spray test
 - .4 Removable single side maintenance access panels
 - .5 Lifting handles in maintenance access panels
 - .6 Unit base provisions for forklift and/or crane lifting
- .5 Single Compressor
 - .1 Single refrigeration circuit with integral subcooling circuit
 - .2 2-stage direct drive hermetic scroll compressor
 - .3 Suction gas-cooled motor w/ $\pm 10\%$ voltage utilization range of unit nameplate voltage
 - .4 Crankcase heater
 - .5 Internal temperature and current sensitive motor overloads
 - .6 No compressor suction and/or discharge valves (reduced vibration/sound)
 - .7 Factory installed liquid line filter drier
 - .8 Phase loss/reverse rotation monitor
 - .9 Liquid line service valve (with gauge port)
 - .10 Suction line service valve (with gauge port)
 - .11 External high pressure cutout device
 - .12 External low pressure cutout device
 - .13 Evaporator defrost control
 - .14 Loss of charge protection (discharge temperature limit)
- .6 Dual Compressor
 - .1 Two (2) separate and independent refrigerant circuits
 - .2 Each refrigeration circuit equipped with integral subcooling circuit
 - .3 Two (2) direct drive hermetic scroll compressor
 - .4 Suction gas-cooled motors w/ $\pm 10\%$ voltage utilization range of unit nameplate voltage
 - .5 Crankcase Heaters

- .6 Internal temperature and current sensitive motor overloads
- .7 Factory installed liquid line filter driers
- .8 Phase loss/reverse rotation monitor
- .9 Liquid line service valves (with gauge port)
- .10 Suction line service valves (with gauge port)
- .11 No compressor suction and/or discharge valves (reduced vibration/sound)
- .12 External high pressure cutout devices
- .13 External low pressure cutout devices
- .14 Evaporator defrost control
- .15 Loss of charge protection (discharge temperature limit)
- .7 Condenser Fan
 - .1 660 mm propeller fan(s)
 - .2 Direct drive
 - .3 Statically and dynamically balanced
- .8 Condenser Motor(s)
 - .1 Permanently lubricated totally enclosed or open construction
 - .2 Built-in current and thermal overloads
 - .3 Ball or sleeve bearing type
- .9 Controls
 - .1 Factory installed microprocessor
 - .2 Completely internally wired
 - .3 Numbered and colored wires
 - .4 Contactor pressure lugs or terminal block
 - .5 Unit external mounting location for disconnect device
 - .6 Single point power entry
- .10 BACnet Communication Interface
 - .1 Communicates directly with a generic open protocol BACnet MS/TP Network building automation system control
- .11 Low Ambient (Fan ON/OFF)
 - .1 Provides unit cooling operation to outdoor ambient of 0°F
 - .2 Liquid line temperature controls condenser fan operation
 - .3 1 kit per condenser fan required
- .12 Hail Guards
 - .1 Condenser coil protection from hail, vandals, etc.
 - .2 Perforated, painted galvanized steel
 - .3 Factory or field installed

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 material installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 GENERAL

- .1 Mount on structural supports and vibration isolators as indicated 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 supervise start up and to instruct operators.
- .4 Complete and submit the form for Halocarbon tracking per the CSC ISD 318-4.

3.3 ADJUSTING

- .1 Lubricate bearings with oil or grease as recommended by manufacturer.
- .2 Tighten belts to manufacturer's specified tension.

3.4 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American National Standards Institute/Air-Conditioning, Heating and Refrigeration Institute (ANSI/AHRI)
 - .1 ANSI/AHRI 430, Performance Rating of Central Station Air-Handling Units.
- .2 American National Standards Institute/American Society of Heating, Refrigeration and Air Condition Engineers/Illuminating Engineering Society (ANSI/ASHRAE/IES)
 - .1 ANSI/ASHRAE 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
 - .2 ANSI/ASHRAE/IES 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .3 Green Seal (GS)
 - .1 GS-11, Standard for Paints and Coatings.
 - .2 GS-36, Standard for Adhesives for Commercial Use.
- .4 Master Painters Institute (MPI)
 - .1 Architectural Painting Specification Manual - [current edition].
 - .1 MPI #18.
- .5 South Coast Air Quality Management District (SCAQMD)
 - .1 SCAQMD Rule 1113, Architectural Coatings.
 - .2 SCAQMD Rule 1168, Adhesives and Sealants.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data shall include dimensions, weights, capacities, certifications, component performance, electrical characteristics, casing construction details, wiring interconnections, gauges and finishes of materials.
- .3 Provide all technical information relevant to the product being provided, including but not limited to all the information shown in the schedules of this specification. It is the responsibility of the supplier to highlight any variances that his equipment has with the requirements of this specification whether or not pre-approval has been obtained. Provide the information in the same measurement units as indicated elsewhere in this specification.
- .4 Provide fan curves (not fan tables), with specified operating points clearly plotted.
- .5 Provide coil selection worksheets, clearly showing proper consideration for altitude, air density, and glycol corrections. Indicate coil tube fin and casing construction.
- .6 Provide filter information, including initial APD, final APD, dust spot efficiency, final dust holding capacity, filter media description, filter frame details, and filter removal details.

- .7 Submit sound power levels for both air handling unit inlet, outlet and radiated at rated capacity. If unit exceeds sound power levels at scheduled conditions, manufacturer must provide sound attenuators and meet specified BHP.
- .8 Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
- .9 Submit manufacturer's recommended installation instructions.
- .10 Omission of any of the above information will cause shop drawings to be immediately returned without review.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for air handling equipment for incorporation into manual.
- .3 Include following: performance data as noted in equipment schedules.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Provide 1 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 Departmental Representative, supply 1 complete set of filters for each filter unit or filter bank.
- .5 Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 Supplier Requirements

- .1 Supplier Service and Support
 - .1 The supplier must have existing factory trained sales force locally available for applications assistance and to answer maintenance questions.
 - .2 The Supplier is to provide a 24 hour, seven (7) day a week, assistance call line for maintenance and troubleshooting requirements with the equipment operation.
 - .3 Supplier is to be capable of providing factory trained on-site technical support of the within a four (4) hour time period from notification.
- .2 Supplier Spare Parts Availability
 - .1 The supplier is to have a distributor organization, which locally stocks standard parts, modification kits, and spare parts.
 - .2 Components not regularly stocked are to be capable of being provided to the site in less than 36 hours.
- .3 Supplier Organization
 - .1 The supplier must have been in operation within the local Edmonton area for at least 5 years with product installed within the local area.
 - .2 The local supplier must have at least 5 years of representation history of the equipment brand.
 - .3 The supplier must have factory trained service representatives within the local Edmonton area. The factory representatives must be trained in the maintenance and troubleshooting of the equipment as specified herein.
 - .4 The factory representative is to be conversant in the requirements of the specific equipment.
- .4 Supplier Maintenance and Training Schools
 - .1 Supplier must offer maintenance and training in North America on the equipment supplied.
 - .2 Training programs are to be offered by the supplier on a yearly cycle (minimum).

2.1 CASINGS

- .1 Casing shall be constructed of 16-gauge galvanized steel reinforced 51mm thick acoustic thermal panels and braced for rigidity.
 - .1 Inspection doors: provide access for maintenance of internal parts.
 - .2 Insulation: provide 51mm thick, 1.36 kg density fiberglass. Provide neoprene coated with mylar liner to seal insulation. Insulation shall meet flame spread rating of less than 25 and a smoke developed rating of less than 50 when measured in accordance with ASTM E84. All insulation edges shall be joined on 203 mm centers using zinc plated TEK screws or metal clinches. All insulation edges shall be protected with metal lagging. Insulation systems using stickpins or adhesives are not acceptable.

- .3 Sealing: All permanently joined flanged panel surfaces shall be sealed with an individual strip of 3.2 mm x 9.5 mm tape sealer. Wall and roof seams shall be turned inward to provide a clean flush exterior finish. All panel seams shall be sealed during assembly to produce an airtight unit.
- .4 Unit shall be finished painted with two components, etch bond primer and finish painted with alkyd enamel, as selected by Department Representative. All uncoated steel shall be painted with grey enamel. All metal surfaces shall be pre-painted with vinyl wash primer to ensure paint bonds to metal.
- .2 Line casing with perforated 22 gauge galvanized steel liner.
- .3 All walls shall be 51 mm thick.
- .4 All roof panels shall be 51 mm thick.

2.2 ACOUSTIC LINER

- .1 Ensure that expanded polystyrene and polyurethane insulation materials were not produced with ozone depleting substances.
- .2 Test methods and facilities used to establish sound transmission loss values shall conform explicitly with the ASTM designation E90-85 and E413-73. Sound Transmission Loss DB ASTM E-90 & E413-73, STC 40.
- .3 Test methods and facilities used to establish sound absorption values shall conform explicitly with the requirements of the ASTM Standard Test Method for Sound Absorption Coefficients by the Reverberation Method: ASTM C423-84A and E795-83. Sound Absorption ASTM C423-84A & E795-83. STC-40.

2.3 DRAIN PANS

- .1 Construction: stainless steel, rounded corners.
- .2 Insulation: external foam type, minimum 13 mm thick.
- .3 Drain connection: in bottom at low point.
- .4 Installation: slope without sag minimum 1% to ensure no standing water at any time or at any point.
- .5 Dimensions: minimum 75 mm from upstream face of coil to 150 mm beyond downstream face of coil or eliminator and to include return bends and headers.

2.4 FANS

- .1 All fans shall be tested in accordance with AMCA Standards 210-70 and 310 Test Codes for Air Moving Devices. Backward inclined fans shall bear the AMCA sticker for both air and sound performance.
- .2 Fan housing shall be constructed of steel, adequately braced with structural steel for rigidity.
- .3 Fan shafts are to solid, ground and polished, carbon steel, SAE 1045 material, machined to close tolerances, keyed to the fan wheel. Coat the fan shaft with a rust inhibitor after machining. Hollow shafts will not be acceptable.

- .4 Fan bearings shall be in self aligning pillow block, grease lubricated, extra heavy duty anti-friction ball or spherical roller type, selected for an L10 200,000 hour life at design operating conditions. Bearings are to be mounted on the fan structural bracing. Provide extended lubrication line to permit lubrication for both bearings to be performed from the access door side of the air handling unit.
- .5 Provide adjustable inlet vanes and linkage where indicated in the schedules. Inlet vanes are to be designed and manufactured by the fan manufacturer, and all fan performance data is to be corrected to allow for inlet vane losses. Vane and linkage bearings are to be bronze type.
- .6 Fan and motor are to be mounted on an all welded, structural steel, prime coated, internal isolation base with springs selected to provide 99% isolation efficiency from the building structure. Isolator deflection shall be 2". The outlet of the fan shall be separated from the unit casing by means of a factory installed flexible fabric connection. The internally mounted motor shall be provided on a slide rail base to allow proper adjustment of belt tension.
- .7 Provide an OSHA approved fully enclosed metal belt guard having side of galvanized steel and expanded metal face. Belt guard shall be sized to allow either sheave to be increased by two sizes.
- .8 Fans shall have inlet OSHA approved inlet screens.

2.5 VIBRATION ISOLATION

- .1 Flexible connections at inlet and outlet of fan: to Section 23 33 00 - Air Duct Accessories.
- .2 An integral all welded epoxy coated steel vibration isolation base shall be provided for the fan and motor.
- .3 Isolators shall be free standing with sound deadening pads and leveling bolts.
- .4 Spring diameter to compressed operating height ratio shall be 1 to 1.
- .5 Spring deflection shall be a minimum of 25.4mm.
- .6 Isolators shall have seismic restraints designed to meet IBC 2006 requirements. Manufacturer shall provide seismic calculations upon request.
- .7 Fan systems which are provided without integral fan vibration isolation as specified shall include complete vibration isolation around the entire perimeter of the unit and under all splits to the level of the vibration isolation specified above. Flexible mounted ductwork and piping shall also be provided in conjunction with the perimeter vibration isolation to ensure the complete unit is isolated from the adjacent systems.
- .8 Air handling units which are provided with external vibration isolation shall include a finite element analysis to demonstrate the specified level of vibration isolation has been met. The analysis shall also determine if any natural frequencies occur in the system over the entire operating range of the AHU. A detailed report shall be submitted with the quote to ensure the proposed system meets specifications.

2.6 FILTER BOX

- .1 Material to match casing complete with V type filter arrangement using disposable type filters. Provide access to filter through hinged door.
- .2 Filters:
 - .1 50 mm, pleated filter, average efficiency minimum Efficiency Reporting Value (MERV) value 8 filtration media to ANSI/ASHRAE 52.2, to be used upstream of coil section of air handling unit.
- .3 Filters containing urea formaldehyde or fiberglass are not acceptable.
- .4 Galvanized mounting racks to suit specified filter type.
- .5 Limit filter velocity based on face area to less than 2.5 m/s.
- .6 Provide one Dwyer 2000 magnehelic filter gauge for each bank of filters, including for each position of pre-filter. Flush mount gauge on the exterior of the unit.
- .7 Provide blank off plates around filters.

2.7 MIXING BOX

- .1 Dampers for mixing boxes: Section 23 33 15- Dampers - Operating.
- .2 Material to match casing and produce uniformly mixed air temperature within plus or minus 5 degrees C of design across face of outlet.
- .3 Dampers for mixing boxes:
 - .1 Aluminum airfoil frames and blades shall be a minimum of 12 gauge extruded aluminum. Blades shall be of a single unit airfoil design 6" wide.
 - .2 Frames shall be extruded aluminum channel with grooved inserts for vinyl seals. Standard frames: 2" x 4" x 5/8" on linkage side, 1" x 4" x 1" on the other 3 sides.
 - .3 Pivot rods shall be 7/8" hexagon extruded aluminum interlocking into blade section. Bearings shall be of a double sealed type with a Celcon inner bearing on a rod within a Polycarbonate outer bearing inserted into frame so that the outer bearing cannot rotate.
 - .4 Bearing shall be designed so that there is not metal-to-metal or metal-to-bearing riding surfaces. Interconnecting linkage shall have a separate Celcon bearing to eliminate friction in linkage.
 - .5 Blade linkage hardware shall be installed in frame out of air-stream. All hardware shall be on non-corrosive, reinforced material of cadmium plated steel.
 - .6 Damper seals shall be designed for minimum air leakage by means of overlapping seals.

2.8 COILS

- .1 Capacity: as indicated on schedule.
- .2 Ratings: all coils shall meet or exceed all capacities specified on the mechanical schedule for the project. All coil performance shall be certified by the manufacturer in accordance with ARI Standard 410.

- .3 Construction:
 - .1 Casings: 16 gauge thick galvanized sheet steel.
 - .1 Supports of galvanized steel channel.
 - .2 Hot water coils:
 - .1 Tubes: 0.508 mm thick copper
 - .2 Fins: 0.1905 mm aluminum.
 - .3 Headers: headers shall be constructed from UNS 12200 seamless copper conforming to ASTM B75 and ASTM B251.
 - .4 Pressure tests: 1.7 MPa.

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 material installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

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 and trap seal primer on drip lines.
 - .1 Depth of water seal to be 1.5 times static pressure at this point.

3.5 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Approved: 2013-12-31

Part 1 General

1.1 REFERENCE STANDARDS

- .1 American Gas Association (AGA)
- .2 American National Standards Institute/Air-Conditioning, Heating and Refrigeration Institute (ANSI/AHRI)
 - .1 ANSI/AHRI 210/240-[08], Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
 - .2 ANSI/AHRI 270-[08], Sound Rating of Outdoor Unitary Equipment.
- .3 CSA Group
 - .1 CSA B52-[05], Mechanical Refrigeration Code.
 - .2 CSA C22.1-[12], Canadian Electrical Code, Part 1 (22nd Edition), Safety Standard for Electrical Installations.
- .4 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-[12], Standard for the Installation of Air Conditioning and Ventilating Systems.
- .5 Underwriters Laboratories (UL)
 - .1 UL 1995-[11], Standard for Heating and Cooling Equipment.

1.2 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 outdoor HVAC equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Drawings to indicate project layout and dimensions; indicate:
 - .1 Equipment, piping, and connections, together with valves, strainers, control assemblies, thermostatic controls, auxiliaries and hardware, and recommended ancillaries which are mounted, wired and piped ready for final connection to building system, its size and recommended bypass connections.
 - .2 Piping, valves, fitting shipped loose showing final location in assembly.
 - .3 Control equipment shipped loose, showing final location in assembly.
 - .4 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes and location of mounting bolt holes; include mass distribution drawings showing point loads.

- .5 Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices of ancillaries, accessories, controllers.
- .6 Pump and fan performance curves.
- .7 Details of vibration isolation.
- .8 Estimate of sound levels to be expected across individual octave bands in dB referred to A rating.
- .9 Type of refrigerant used.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .6 Manufacturer's Field Reports:
 - .1 Submit manufacturer's field reports specified.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for outdoor HVAC equipment for incorporation into manual.
 - .1 Indicate: brief description of unit, indexed, with details of function, operation, control, and service for components.
 - .2 Provide for units, manufacturer's name, type, year, number of units, and capacity.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.5 WARRANTY

- .1 For Work of this Section 23 74 00 - Packaged Outdoor HVAC Equipment, 12-month warranty period is extended to 60 months.

Part 2 Products

2.1 GENERAL

- .1 Roof mounted, self-contained single zone, indirect fired unit with gas burner and DX refrigeration and bear label of CSA, CGA, and ULC.
- .2 Units to be complete with of cabinet and frame, supply fan, heat exchanger, burner with integral induced draft fan, heater control, air filter, refrigerant cooling coil, compressor, condenser coil and fans, motorized outside air damper, return damper, gravity exhaust damper.
- .3 Conform to ANSI/ARI 210/240, rating for unit larger than 40 kW nominal.
- .4 Units shall be Energy Star Certified and meet ASHRAE 90.1 minimum efficiency requirements.
- .5 Refer to Equipment schedule on drawings.

2.2 Supplier Requirements

- .1 Supplier Service and Support
 - .1 The supplier must have existing factory trained sales force locally available for applications assistance and to answer maintenance questions.
 - .2 The Supplier is to provide a 24 hour, seven (7) day a week, assistance call line for maintenance and troubleshooting requirements with the equipment operation.
 - .3 Supplier is to be capable of providing factory trained on-site technical support of the within a four (4) hour time period from notification.
- .2 Supplier Spare Parts Availability
 - .1 The supplier is to have a distributor organization, which locally stocks standard parts, modification kits, and spare parts.
 - .2 Components not regularly stocked are to be capable of being provided to the site in less than 36 hours.
- .3 Supplier Organization
 - .1 The supplier must have been in operation within the local Edmonton area for at least 5 years with product installed within the local area.
 - .2 The local supplier must have at least 5 years of representation history of the equipment brand.
 - .3 The supplier must have factory trained service representatives within the local Edmonton area. The factory representatives must be trained in the maintenance and troubleshooting of the equipment as specified herein.
 - .4 The factory representative is to be conversant in the requirements of the specific equipment.
- .4 Supplier Maintenance and Training Schools
 - .1 Supplier must offer maintenance and training in North America on the equipment supplied.
 - .2 Training programs are to be offered by the supplier on a yearly cycle (minimum).

2.3 CABINET

- .1 Cabinets: weatherproofing tested and certified to AGA rain test standards and soundproofing tested to AHRI 270.
- .2 Framing and supports: 2 mm thick welded steel, galvanized after manufacture, with lifting lugs.
- .3 Outer casing: weathertight 1.0 mm thick galvanized steel with baked enamel finish, complete with flashing.
- .4 Access: gasketted hinged doors or panels with quick locking door handle type fasteners.
- .5 Insulation: neoprene coated glass fibre on surfaces where conditioned air is handled, 50 mm thick, 32 kg/m³ density.

2.4 FANS

- .1 Centrifugal, forward curved impellers, statically and dynamically balanced. V-belt drive with adjustable variable pitch motor pulley, fan and motor integrally mounted on isolation base, separated from unit casing with flexible connections and spring isolators. Vibration isolators: 95% efficiency.

2.5 AIR FILTERS

- .1 50 mm thick, MERV 8. standard to unit manufacture.

2.6 HEAT EXCHANGERS AND BURNERS

- .1 Gas fired, multiple flue passes welded stainless steel construction.
 - .1 Gas burner: factory mounted, wired and fire tested complete with operating and safety controls.
 - .2 Induced draft type.
 - .3 Spark ignited pilot with pilot flame safety shut-off.
- .2 Gas fired, multiple flue passes welded stainless steel construction.

2.7 REFRIGERATION

- .1 Conform to CSA B52 and UL 465 requirements.
- .2 Compressor/Condenser Section:
 - .1 Hermetic compressors, vibration isolated with flexible suction and discharge connections, oil sight glass, oil pressure switch, crankcase heater, and with control to liquid line solenoid valve.
 - .2 Fans: propeller type with single piece spun venturi outlets and zinc plated guards. Motors shall be sequenced for head pressure control.
 - .3 Electrical system shall have operating controls, oil and refrigerant pressure protection, motor overload protection, weatherproof electrical wiring with weatherproof, rain tight disconnect.
 - .4 Include refrigerant piping with sight glass, filter and valves.
 - .5 Condenser: staggered copper tube aluminum fin coil assembly.

- .6 Capacity reduction: cylinder unloading. Provide fan control and flooding for head control for low ambient operation down to 14 degrees C ambient temperature.
- .3 Evaporator:
 - .1 Rated to ANSI/ARI 210/240.
 - .2 Thermostatic expansion valve, with adjustable super heat and external equalizer.
 - .3 Coil: NPS5/8 od staggered seamless copper tubes expanded into aluminum fins and insulated condensation pan.
 - .4 Cooling coil condensate drain pans: designed to avoid standing water, to be easily cleaned or removable for cleaning. Drain connection to have deep seal trap and be complete with trap seal primer.
- .4 Refrigerant: Shall be Type R410A

2.8 CONTROLS

- .1 In addition to combustion safety controls, provide smoke sensors in return to NFPA standards, low limit on supply and freeze protection on steam and water coils.
- .2 Control Panels:
 - .1 Provide local panels of unitized cabinet type for each system under automatic control. Mount relays and controllers with control point adjustment in cabinet and temperature indicators, pressure gauges, pilot lights, pushbuttons and switches flush on cabinet panel face.
 - .2 Panel shall be general purpose utility enclosures having an enamelled finish face panel and CSA approval for line voltage applications.
 - .3 Mount panels adjacent to associated equipment or as shown on the drawings on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved lamicoid nameplates on cabinet face.
 - .4 All wiring and tubing within the control panel shall be either run in tray or placed neatly and securely fastened.
 - .5 All wiring within control panels shall be terminated at a terminal strip and shall be numbered with heat shrink markers.
 - .6 The use of "Easy On" self-adhesive markers is not acceptable.
 - .7 Provide control wiring to remote control panels provided by others.
- .3 Single Zone Cooling Control:
 - .1 Room thermostat to activate cooling relay in control circuit cycling compressor. Provide safeties and pressure controls. Condenser fans to operate in sequence.
 - .2 As back pressure is reduced, hot gas bypass opens to maintain set back pressure.
 - .3 When call for cooling is satisfied, relay is de-energized closing liquid line solenoid valve. On two compressor units provide separate circuits to evaporator and condenser and manual double pole double throw switch for lead-lag unit choice.

- .4 Mixed Air Single Zone Unit:
 - .1 Automatic outside and return air dampers for fixed outside air quantity.
 - .2 Motorized outside, return and automatic power exhaust gravity relief dampers with spring return damper operator and control package to automatically vary outside air quantity. Outside air and exhaust air dampers, normally closed.
 - .3 Tight fitting opposed blade dampers with neoprene or suitable gaskets, bronze or synthetic bushings and 1% maximum leakage.
 - .4 Damper operation: 24V, spring return motor with gear train sealed in oil, and heater for operation under minus 18 degrees C.
 - .5 Mixed air controls: maintain 13 degrees C indicated mixed air temperature, lock out compressor below 14 degrees C ambient, restart 17 degrees C, revert dampers to provide 15% fresh air above 21 degrees C adjustable for RTU-1.
- .5 Single Zone Heat-Cool Unit:
 - .1 Low voltage, adjustable room thermostat controls burner operation, compressor and supply fan shall maintain room temperature setting.
 - .2 Thermostat: include system selector switch day-night, heat-cool-off, and fan control switch (on-auto).
- .6 Night mode: unit cycles as unit heater with 100% recirculation on winter or summer cycles unit off.

2.9 MAKE-UP AIR Controls

- .1 Provide terminals for connection to BMS system for activation schedule, temperature control and monitoring.
- .2 Provide factory controls for 2 speed operation with interlocks, and heating modulation for supply air set point provided by BMS.
- .3 Provide remote readout panel for Make Up Air Units each unit containing:
 - .1 Signal lights indicating system status, heating system failure, and dirty filters.
 - .2 Check switches proving signal light operation.
 - .3 System on-off-Auto switch.

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 material installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Install as per manufacturers' instructions on roof curbs as indicated.
- .2 Manufacturer to certify installation, supervise start-up and commission unit.
- .3 Run drain line from cooling coil condensate drain pan to discharge over roof drain.

3.3 FIELD QUALITY CONTROL

- .1 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 Refer to Commissioning Specifications.
 - .1 Start up of unit.
 - .2 Functional Testing
- .2 Obtain reports within 4 days of review and submit immediately to Departmental Representative.
- .3 Performance Verification:
 - .1 General:
 - .1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems, supplemented as specified herein.
 - .2 Rooftop Air Handling Units:
 - .1 Set zone mixing dampers for full cooling, except that where diversity factor forms part of design set that percentage of zone dampers to full heating.
 - .2 Set outside air and return air dampers for minimum outside air.
 - .3 Set face and bypass dampers so face dampers are fully open and bypass dampers are fully closed.
 - .4 Check for smooth, vibration less correct rotation of supply fan impeller.
 - .5 Measure supply fan capacity.
 - .6 Adjust impeller speed as necessary and repeat measurement of fan capacity.
 - .7 Measure pressure drop each component of air handling unit.
 - .8 Set outside air and return air dampers for the percentage of outside air required by design and repeat measurements of fan capacity.
 - .9 Reduce differences between fan capacity at minimum and maximum outside air less than 5%.
 - .10 Set face and bypass dampers to full bypass and repeat measurement of fan capacity.

- .11 Reduce difference between fan capacity with F&BPD fully closed to bypass and fully open to bypass to less than 5%.
- .12 Reduce difference between fan capacity at full cooling and fan capacity at full heating to less than 5%.
- .13 OAD: verify for proper stroking, interlock with RAD.
- .14 Measure DBT, WBT of SA, RA, EA.
- .15 Measure air cooled condenser discharge DBT.
- .16 Measure flow rates (minimum and maximum) of SA, RA, EA, relief air.
- .17 Simulate maximum cooling load and measure refrigerant hot gas and suction temperatures and pressures.
- .18 Use smoke test to verify no short-circuiting of EA, relief air to outside air intake or to condenser intake.
- .19 Simulate maximum heating load and:
 - .1 Verify temperature rise across heat exchanger.
 - .2 Perform flue gas analysis. Adjust for peak efficiency.
 - .3 Verify combustion air flow to heat exchanger.
 - .4 Simulate minimum heating load and repeat measurements.
- .20 Measure radiated and discharge sound power levels under maximum heating demand and under maximum cooling demand with compressors running.
- .21 Verify operating control strategies, including:
 - .1 Heat exchanger operating and high limit.
 - .2 Early morning warm-up cycle.
 - .3 Freeze protection.
 - .4 Economizer cycle operation, temperature of change-over.
 - .5 Alarms.
 - .6 Voltage drop across thermostat wiring.
 - .7 Operation of remote panel including pilot lights, failure modes.
- .22 Set zone mixing dampers for full heating and repeat measurements.
- .23 Measure leakage past zone mixing dampers by taking temperature measurements. Reduce leakage to less than 5%.
- .24 Measure return fan capacity.
- .25 Adjust impeller speed as necessary and repeat measurement of return fan capacity.
- .26 Check capacity of heating unit.
- .27 Refer to other sections of these specifications for PV procedures for other components.
- .3 Start-Up:
 - .1 General: in accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
- .4 Verify accessibility, serviceability of components including motorized dampers, filters coils, fans, motors, operators, humidifiers, sensors, electrical disconnects.
- .5 Verify accessibility, clean ability, drainage of drain pans for coils, humidifiers.

- .4 Commissioning Reports:
 - .1 In accordance with Section 01 91 13 - General Commissioning (Cx)
Requirements: reports supplemented as specified herein. Include:
 - .1 Report forms as specified Section 01 91 13 - General Commissioning (Cx) Requirements: Report Forms and Schematics.

3.4 DEMONSTRATION

- .1 Training: in accordance with Section 01 91 13 - General Commissioning (Cx)
Requirements: Training of O&M Personnel, supplemented as specified.

3.5 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute/American Society of Heating, Refrigeration and Air-Conditioning Engineers (ANSI/ASHRAE)
 - .1 ANSI/ASHRAE 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particulate Size.
 - .2 ANSI/ASHRAE 127, Method of Testing for Rating Computer and Data Processing Room Unitary Air-Conditioners.
- .2 ASTM International
 - .1 ASTM C547, Specification for Mineral Fiber Pipe Insulation.
- .3 CSA International
 - .1 CSA B52, Mechanical Refrigeration Code.
 - .2 CAN/CSA-C656, Performance Standard for Single Package Central Air-Conditioners and Heat Pumps.
- .4 Canada Federal Halocarbon Regulations, 2003
- .5 Canadian Correctional Service Canada
 - .1 Internal Service Directive 318-4 – Environmental Management of Halocarbons
- .6 Environment Canada (EC)
 - .1 Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems. (2015).

1.2 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 air conditioning components and accessories and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Indicate on drawings:
 - .1 Major components and accessories including sound power levels of units.
 - .2 Type of refrigerant used.
- .4 Complete the forms noted within CSC ISD 318-4.
- .5 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

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

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Submit the form for Halocarbon tracking per the CSC ISD 318-4.
- .3 Operation and Maintenance Data: submit operation and maintenance data for air conditioning components for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and 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 indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect air conditioning components from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

1.5 WARRANTY

- .1 For computer room air conditioning system, the 12 months' warranty period is extended to 60 months.

Part 2 Products

2.1 Supplier Requirements

- .1 Supplier Service and Support
 - .1 The supplier must have existing factory trained sales force locally available for applications assistance and to answer maintenance questions.
 - .2 The Supplier is to provide a 24 hour, seven (7) day a week, assistance call line for maintenance and troubleshooting requirements with the equipment operation.
 - .3 Supplier is to be capable of providing factory trained on-site technical support of the within a four (4) hour time period from notification.
- .2 Supplier Spare Parts Availability
 - .1 The supplier is to have a distributor organization, which locally stocks standard parts, modification kits, and spare parts.
 - .2 Components not regularly stocked are to be capable of being provided to the site in less than 36 hours.

- .3 Supplier Organization
 - .1 The supplier must have been in operation within the local Edmonton area for at least 5 years with product installed within the local area.
 - .2 The local supplier must have at least 5 years of representation history of the equipment brand.
 - .3 The supplier must have factory trained service representatives within the local Edmonton area. The factory representatives must be trained in the maintenance and troubleshooting of the equipment as specified herein.
 - .4 The factory representative is to be conversant in the requirements of the specific equipment.
- .4 Supplier Maintenance and Training Schools
 - .1 Supplier must offer maintenance and training in North America on the equipment supplied.
 - .2 Training programs are to be offered by the supplier on a yearly cycle (minimum).

2.2 DESCRIPTION

- .1 Single refrigeration circuit shall include a liquid line filter drier, a refrigerant sight glass with moisture indicator, an expansion valve, pressure safety switches, and a liquid line solenoid valve. The indoor evaporator refrigerant piping shall be filled with a nitrogen holding charge and spun shut. Field relief of the Schrader valve shall indicate a leak-free system.
- .2 The direct-expansion, tilted-slab cooling coil shall be constructed of copper tubes and hydrophilic-coated aluminum fins. The hydrophilic coating shall significantly improve the speed of condensate drainage from the fins and shall provide superior water carryover resistance. One stainless steel condensate drain pan shall be provided.
- .3 The system shall be designed for use with R-410A refrigerant.
- .4 Refer to Equipment schedule on drawings.

2.3 CABINET

- .1 Cabinet to house: compressors, cooling coil, reheat coil, fans, filters, humidifier, unit environmental control system, motor starters or contactors.
- .2 Include adequate access to components for servicing.
- .3 Cabinet Construction: The exterior panels shall be 20-gauge steel and powder-coated with RAL 7021 black color paint to protect against corrosion. The exterior panels shall be insulated with 1/2" to 1" (12.7 to 25.4 mm), 1-1/2 lb. (0.68 kg) insulation. Front and side panels shall have captive, quarter-turn fasteners. The cabinet shall be designed so that all components are serviceable and removable using the front and right sides of the unit.
- .4 Locking Disconnect Switch: A locking-type fused disconnect switch shall be mounted in the electrical panel and shall be capable of disrupting the flow of power to the unit. The locking type shall consist of a main unit switch operational from outside the unit. The

electric panel compartment shall be accessible only with the switch in the Off position. The locking disconnect shall be lockable in support of lockout/tagout safety programs.

- .5 Short-Circuit Current Rating (SCCR): The electrical panel shall provide at least 65,000A SCCR. Short-circuit current rating (SCCR) is the maximum short-circuit current a component or assembly can safely withstand when protected by a specific overcurrent protective device(s) or for a specified time.

2.4 COMPRESSORS

- .1 Digital Scroll Compressor: The compressor shall be an R-410A scroll-type with variable capacity operation from 20-100%, commonly known as a digital scroll. The compressor solenoid valve shall unload the digital scroll compressor to provide variable capacity operation. The compressor shall have a suction gas cooled motor, EPDM Rubber vibration isolators, internal thermal overloads, automatic reset high pressure switch with lockout after three failure occurrences, rota-lock service valves, low pressure transducer, and crankcase heater. The compressor shall be removable and serviceable from the front of the unit. The crankcase heater and a discharge check valve shall be provided for additional system protection from refrigerant migration during Off cycles.

2.5 COOLING COIL

- .1 Direct expansion: with separate refrigerant circuit for each compressor.
- .2 Tilted slab constructed of copper tubes and hydrophilic coated aluminum fins with hydrophilic coating to provide water carryover resistance.
- .3 Stainless steel condensate drain pans.
- .4 Cooling coil condensate drain pans: designed to avoid standing water, easily cleaned or removable for cleaning.

2.6 FANS

- .1 The unit shall be equipped with one plug fan: integral direct driven fan with backward-curved blades and electronically commutated DC motor; commonly referred to as EC fan. The fan speed shall be variable and automatically regulated by the controller through all modes of operation. The fan shall have a dedicated motor, fault monitoring circuitry, and speed controller, which shall provide a level of redundancy. The impeller shall be made of aluminum and dynamically balanced. The EC fan shall be located within the unit. The EC fan shall also provide greater energy savings than forward curved centrifugal fan and variable speed drives.
- .2 Upflow Supply with Front Air Return: The supply air shall exit from the top of the cabinet. The return air shall be through the front factory installed grilles. The EC fan shall be factory mounted in the upper portion of the unit. The fan shall be located to pull air through the filters and cooling coil to ensure even air distribution and maximum coil performance.

2.7 FILTERS

- .1 Filters: 100 mm pleated, disposable type: MERV 11.
- .2 Mounting: in corrosion resistant racks with service access.
- .3 Filter Clog Alarm.

2.8 HUMIDIFIER

- .1 Steam generator type: plastic disposable reservoir-boiler, latticed electrode heating elements complete with steam distributor, supply and drain valves, and electronic controls.
- .2 Capacity: 2.27 kg/h.
- .3 Water level control, overflow and drain, strainer and automatic flush, CSA or ULC approved.

2.9 CONDENSER

- .1 Air cooled: free standing, Aluminum unit construction, corrosion protected.
 - .1 Structural support members, including coil support frame, motor, and drive support, are galvanized steel for strength and corrosion resistance.
 - .2 363mm Aluminum legs with rigging holes for hoisting the unit into position.
 - .3 Circuited to provide separate refrigerant circuit for each compressor/evaporator combination.
 - .4 Microchannel Aluminum fins, mechanically bonded to copper tubes, tested to 3.1 MPa.
 - .5 Propeller type fans – Variable speed EC.
 - .6 Electrical and control components housed in weather-tight access panels with electrical disconnect switch and control cable for control interconnection and designed for year-round operation.
 - .7 Capacity: to heat rejection capacity to meet indoor unit capacity at 35°C.
 - .8 Head pressure control complete with heated receiver tank, for low outdoor ambient of -34°C operation. Low ambient kit with 150W heater.

2.10 REFRIGERANT PIPING, VALVES, FITTINGS AND ACCESSORIES WITHIN UNIT

- .1 To CSA B52.
- .2 Include for each refrigerant circuit:
 - .1 Thermal expansion valve, external equalizing type.
 - .2 Combination filter-dryer.
 - .3 Solenoid valves.
 - .4 Liquid sight glass with moisture indicator.
 - .5 Suction line insulation: flexible elastomeric unicellar to ASTM C547, 12 mm minimum thickness.

2.11 ENVIRONMENTAL CONTROLS

- .1 Electronic control system.
- .2 Front mounted color, touch screen user interface (200 mm diagonal min).
- .3 Panel to include following:
 - .1 Manual operation and adjustment:
 - .1 On-Off air conditioning system control.
 - .2 Temperature set point, indicator and sensitivity adjustment controller.
 - .3 Room humidity set point, indicator and sensitivity adjustment controller.
 - .4 Alarm silencing switch for each alarm point.
 - .5 Password access.
 - .2 Operational: Alarms:
 - .1 Loss of air flow.
 - .2 High room temperature.
 - .3 Low room temperature.
 - .4 High humidity.
 - .5 Low humidity.
 - .6 Change filter.
 - .3 Operational: Visual display:
 - .1 Cooling each stage.
 - .2 Capacity
 - .3 Humidification.
 - .4 Change filter.
 - .4 Outputs:
 - .1 Remote shutdown relay.
 - .2 Common alarm contact.
 - .3 Capacity.
 - .4 Humidification.
 - .5 Change filter.
 - .5 Additional Controls:
 - .1 Humidifier/reheat lockout contact (24 volt) for emergency operation.
 - .2 Gateway card for Ethernet connectivity for connection to a BACnet BMS system.

2.12 REFRIGERANT CHARGE

- .1 Charge refrigerant system at factory, seal and test.
- .2 Holding charge of refrigerant applied at factory.

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 material installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 GENERAL

- .1 Install as indicated, to manufacturer's recommendations, and to EPS 1/RA/2.
- .2 Manufacturer to certify installation.
- .3 Run drain line from cooling coil condensate drain pan to terminate over nearest floor drain.
- .4 Complete and submit the form for Halocarbon tracking per the CSC ISD 318-4.

3.3 EQUIPMENT PREPARATION

- .1 Provide services of manufacturer's field engineer to set and adjust equipment for operation as specified.

3.4 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by computer room air conditioning installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute/American Society of Heating, Refrigeration and Air-Conditioning Engineers (ANSI/ASHRAE)
 - .1 ANSI/ASHRAE 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particulate Size.
 - .2 ANSI/ASHRAE 127, Method of Testing for Rating Computer and Data Processing Room Unitary Air-Conditioners.
- .2 CSA International
 - .1 CSA B52-Mechanical Refrigeration Code.
 - .2 CAN/CSA-C656, Performance Standard for Single Package Central Air-Conditioners and Heat Pumps.
- .3 Canada Federal Halocarbon Regulations, 2003
- .4 Canadian Correctional Service Canada
 - .1 Internal Service Directive 318-4 – Environmental Management of Halocarbons
- .5 Environment Canada (EC)
 - .1 Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems. (2015)

1.2 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 cooling units and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Include information as follows:
 - .1 Replacement data for motor element, thermostat and switch.
 - .2 Mounting methods.
 - .3 kW rating.
 - .4 Cabinet material thicknesses.
 - .5 Cabinet surface temperature.
 - .6 Thermostat, transformer, controls where integral.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Complete the forms noted within CSC ISD 318-4.
- .5 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

- .6 Manufacturer's Field Reports: Submit manufacturer's field reports specified.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .1 Submit the form for Halocarbon tracking per the CSC ISD 318-4.
- .2 Operation and Maintenance Data: submit operation and maintenance data for cooling units for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and 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 indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect cooling units from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 EQUIPMENT

- .1 Refer to Equipment schedule on drawings.

2.2 COOLING UNITS:

- .1 Indoor Unit General Configuration:
 - .1 Adjustable outlet vanes.
 - .2 Cross finned aluminum and copper tube.
 - .3 Sirocco type fans. Direct drive.
- .2 Controls:
 - .1 Wall mounted microprocessor controller with:
 - .1 Status display with operating mode indication.
 - .2 Central control override.
 - .3 7-day programmable schedule.
 - .4 Fans speed selection and indication.
 - .5 Dirty Filter Alarm.
 - .6 Self-diagnostics.
 - .7 Common Alarm output for BMS monitoring.
 - .8 Auxiliary connection to a BACnet BMS system.
- .3 Washable air filters arranged for easy removal.

- .4 Unit capacity as follows:
 - .1 Total cooling: based on D.B. 27°C, W.B. 19°C
 - .2 Capacity control: 25% to 100%.
 - .3 Electrical characteristics: 208/1/60.

2.3 CONDENSER

- .1 Air cooled: free standing, coated steel unit construction, corrosion protected.
 - .1 Circuited to provide separate refrigerant circuit for each compressor/evaporator combination.
 - .2 Compressor: Inverter-Driven variable speed hermetic scroll.
 - .3 Cross fin copper tubes.
 - .4 Propeller type fans. Direct drive, DC control.
 - .5 Refrigerant Type: R410A.
 - .6 Electrical and control components housed in weather-tight access panels with electrical disconnect switch and control cable for control interconnection and designed for year round operation.
 - .7 Internal vibration isolation.
 - .8 Capacity: to heat rejection capacity of based on 35°C DB.
 - .9 Factory installed low ambient system for operation in outdoor temperature of -40°C.

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 material installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Install in accordance with manufacturer's written instructions.
- .2 Make power and control connections.
- .3 Ensure positive contact between condenser frame and exterior louvre to prevent cross-ventilation of supply and discharge air.

3.3 FIELD QUALITY CONTROL

- .1 Site Tests/Inspection:
 - .1 Perform tests in accordance Section 26 05 00 - Common Work Results for Electrical.
 - .2 Set controls and operate each unit.
 - .3 Take readings and record:
 - .1 Current.
 - .2 Air velocity at discharge.
 - .3 Discharge air temperature.
- .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 After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.
 - .2 Twice during progress of work at 25% and 60% complete.
 - .3 Upon completion of work, after cleaning is carried out.
- .3 Complete and submit the form for Halocarbon tracking per the CSC ISD 318-4.
- .4 Obtain reports within 3 days of review and submit immediately to Departmental Representative.

3.4 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 CSA International
 - .1 CSA C22.2 No.46, Electric Air-Heaters.
- .2 Underwriters' Laboratories (UL)
 - .1 UL 1042, Standard for Electric Baseboard Heating Equipment.

1.2 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 convectors and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit product data sheets for baseboard convectors, including:
 - .1 Product characteristics.
 - .2 Performance criteria.
 - .3 Mounting methods.
 - .4 Physical size.
 - .5 kW rating, voltage, phase.
 - .6 Cabinet material thicknesses.
 - .7 Limitations.
 - .8 Colour and finish.
- .3 Manufacturer's Instructions: provide to indicate special handling criteria, installation sequence, cleaning procedures.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for convectors for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and/or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 UNIT HEATERS

- .1 Horizontal Unit Heaters: to UL 2021.
- .2 Casing: 1.2mm (18-gauge) steel with threaded connections for hanger rods.
- .3 Coils: Seamless copper tubing, 0.6 mm (24 gauge.) minimum wall thickness, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.
- .4 Fan: Direct drive propeller type, statically and dynamically balanced. Horizontal models complete with sleeve bearings and fan guard. Vertical model complete with grease lubricated ball bearings.
- .5 Air Outlet: Adjustable pattern diffuser on projection models and four-way louvers on horizontal throw models.

2.2 RADIANT CEILING PANELS

- .1 Panels shall be constructed of extruded 2.92 mm (12 gauge) thick aluminium. 16 mm O.D copper tubing shall be formed into an oval shape and mechanically bonded to the face plate with heat conductive paste, do not fasten tubing to non-radiant sections. Provide V-Grooved, finish on face plate. Cover back of panel with 25 mm (1") 340 gram (0.75 lb) density glass fibre insulation.
- .2 Non-active Radiant Panels shall be identical in appearance, constructed of 0.6 mm 26-gauge steel face plate. Install same insulation as noted in previous subsection.
- .3 Panel widths are minimum acceptable. Panels shall run continuous from wall-to-wall unless detailed otherwise. Non active panels shall be of same material and finish as active portion.
- .4 Test data to be based on a panel installed in ceiling with 21°C (70°F) ambient air temperature and 19.5°C (67°F) AUST (average unheated surface temperature), with natural convection. Certified test data shall clearly indicate AUST.
- .5 Finish: Panels shall be finished with Manufacturer's standard white color.

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 material installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Install baseboard convector heaters, blank sections and controls.
- .2 When wireway is used, remove knock-outs and insert insulating bushing between units.
- .3 Install grounding wire to maintain ground integrity between heating, blank, and auxiliary sections.
- .4 Install thermostats in locations indicated.
- .5 Make power and control connections.
- .6 Provide each terminal heat transfer unit with shut-off valve on supply and Lockshield balancing valve on return piping.
- .7 Provide each unit at high points with easily accessible manual air vent. If not easily accessible, extend vent to exterior surface of cabinet for each servicing.
- .8 Copper tube elements to be joined by sweat solder joints using 95-5 solder for working pressure of 345 kPa (50 psi) and less, and silver brazing for higher pressures.

3.3 RADIANT CEILING PANELS

- .1 Grade piping to allow for air elimination. Radiant ceiling panels are to be installed with extreme care and caution so as not to soil the panel face. Panel supplier is to provide adequate instructions to all contractors involved of proper installation procedures.
- .2 Do not install finished ceiling surface panels and/or sound absorbing element until all glazing has been completed and all exterior openings are closed in.
- .3 All heating system piping shall be thoroughly cleaned, flushed, drained and refilled before radiant panels are connected to the system.
- .4 Submit complete (scale) drawings showing layouts, interconnections and circuiting details for areas where radiant panels are indicated. These drawings shall be coordinated with and interference shall be cleared with other trades. Shop drawings shall indicate locations of supply and return hook-ups in addition to interconnection details for each zone.
- .5 Radiant panels shall run continuous from wall-to-wall and shall be field trimmed to length, ensuring adequate expansion allowance while maintaining panel end coverage by

architectural mouldings. Inactive filler panels will be permitted only where indicated on drawings.

- .6 Interconnecting of radiant panels by the mechanical contractor shall consist of 12.7 mm (½") OD (9.5 mm (3/8") nominal) Type "L", soft copper tubing or other devices as recommended by the manufacturer (i.e., 360 deg. interconnecting loops and 180 deg. return U-bends). Multiple panels shall be circuited to ensure serpentine flow over complete length of zone. Individual serpentine panels coils connected in series are unacceptable for multiple-panel zones, except where noted otherwise in mechanical drawings.
- .7 Ensure ceiling openings and wall mouldings are installed to suit panel installation.

3.4 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Ensure heaters and controls operate correctly.

3.5 COMMISSIONING

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical and Section 01 91 13 - General Commissioning (Cx) Requirements.
- .2 Ensure that heaters and thermostatic controls operate correctly.
- .3 Provide reports in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements.

3.6 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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.7 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by commercial convectors installation.

END OF SECTION